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EVOLUTION

SYLLABUS

Origin of life; Biological evolution and evidences for biological evolution from Paleontology, comparative anatomy, embryology and molecular evidence); Darwin's contribution, Modern Synthetic theory of Evolution; Mechanism of evolution-Variation (Mutation and Recombination) and Natural Selection with examples, types of natural selection; Gene flow and genetic drift; Hardy-Weinberg's principle; Adaptive Radiation; Human evolution.

KEY CONCEPTS

BIG-BANG THEORY

* This theory was proposed by Abbe Lemaitre.
* According to it, the universe originated about 20 billion years ago due to a thermonuclear explosion of a dense entity. This thermonuclear explosion is called Big-bang.
* About 4.5 billion years ago, the origin of our solar system took place by the gaseous clouds formed due to this explosion.
* These gaseous clouds collapsed and converted into flat disc-like structure made up of atoms and small particles due to their own gravitational pull.
* These flat-disc like structure is called SOLAR-NEBULA.
* The very hot central part of this solar Nebula became still hotter & converted into the sun.
* Now, due to condensation of atoms & dust particles moving around the sun formation of the other planets took place [Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune).
* The solid part of our planet earth was called Lithosphere & the gaseous part was known as atmosphere. When the earth's surface cooled down and its temperature decreased to 100° C, water formed on it.

ANCIENT THEORIES FOR ORIGIN OF LIFE

1. Mythology based theory :

* The greatest supporter of this theory was father Suarez according to Bible life and everything was created by god in 6 days.

on first day	:	Earth and heaven
on second day	:	Sky and water
on third day	:	Land and plants
on forth day	:	Sun, moon and stars
on fifth day	:	Fishes and birds
on sixth day	:	Land animals and first man Adam and from his 12th Rib first woman Eve.

* According to hindu mythology the world was created by God Brahma. (The first man was Manu and the first woman was Shraddha).
* According to it, life has not changed ever since its origin. Special creation theory lacks scientific evidences so it is not accepted.

2. Theory of Spontaneous Generation (Abiogenesis or Auto genesis) :

* This hypothesis was supported by ancient Greek philosophers like Thales, Anaximander, Xenophanes Plato, Empedocles, Aristotle.

* According to this theory life was originated from nonliving things spontaneously. They believed that the mud of the Nile river could give rise to frogs, snakes, crocodiles.
* Abiogenesis was strongly supported by Von Helmont. He claimed formation of mice in 21 days. If a sweat soaked dirty shirt is kept in wheat barn.

3. Cosmozoic Theory :

* Proposed by Richter.
* Protoplasm reached on earth in the form of spores or other simple particles from some unknown part of the universe with cosmic dust and they gave rise to various forms of life.

4. Cosmic panspermia theory :

* Proposed by Arrhenius.
* According to this theory organisms existed throughout the universe and their spores could freely travel through space from one star to the other.

5. Theory of Eternity of life :

Helmhotz believed that life is immortal.

6. Theory of Biogenesis :

* Harvey (1651) and Huxley (1870).
* Omnis vivum ex ovo or vivo.
* New organisms can be originated on earth only by preexisting life.
* This theory reject the theory of Spontaneous generation but cannot explain origin of life.
* To prove Biogenesis and to disprove abiogenesis experiments were performed by :
* **Francesco Redi's Experiment (Italian 1668)** He took cooked meat in three jars one was uncovered, the second was covered with parchment and the third was air tight. He observed that maggots developed only in the uncovered jar while maggots could not develop in the meat in closed jars. This proved that larvae were formed from eggs laid by the flies in open jars. Since the meat in closed jars could not be visited by flies so no larvae could develop. Therefore life originated from preexisting life.
* **Lazzaro Spallanzani (Italian 1767) :** He boiled vegetables and meat to prepare a sterlized nutritive soup and he kept some of it in air sealed flasks and some in loosely corked flasks. He observed that the soup in sealed flask remained sterile while microorganisms appeared in the soup in loosely corked flasks. Thus even microorganisms were formed from prexisting ones in the air rather then spontaneously.
* **Louis Pasteur (French 1862) :** Pasteur is popular for Germ Theory of Diseases or Germ theory and he disproved abiogenesis. He prepared sterlized syrup of sugar and yeast by boiling them in flasks. He took two flasks one of broken neck and another of curved neck (swan neck flask). No life appeared in swan neck flask because germ laden dust particles in the air were trapped by the curved heck which serves as filter while in broken neck flask colonies of microorganism were developed.

MODERN THEORY OF ORIGIN OF LIFE

(Oparin-Haldane theory of origin of life)

Naturalistic theory OR Theory of Chemical Evolution :

* This theory was proposed by Russian Scientist A.I. Oparin and J.B.S.Haldane (England born Indian scientist) Oparin's theory was published in his book 'ORIGIN OF LIFE'.
* According to this theory life originated by the composition of chemicals.
* Oparin's theory is based on Artificial Synthesis. So also called as artificial synthetic theory.
* 1st life originated in the water of oceans. So water is essential for origin of life.
  There is no life on moon due to absence of water.
* At the time of origin of life free O_2 was absent, so first life was anaerobic.
* In the primitive atmosphere free oxygen was present but complete oxygen consumed in composition so primitive atmosphere of earth was reducing.
* Oxygen was reproduce by photosynthesis and atmosphere converted in oxydising.

Miller's Experiment:

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

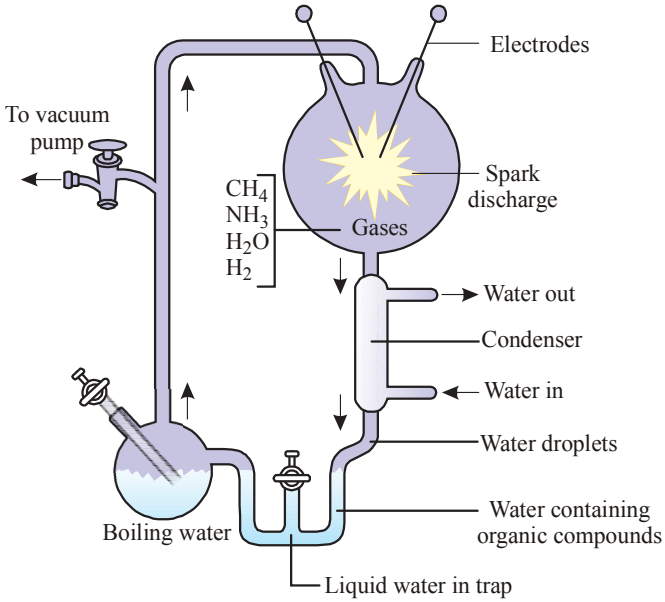


Figure : Diagrammatic representation of Miller's experiment

* 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 containing 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 and nitrogenous bases which are found in the nucleus of a cell.

Formation of first cell:

* The first non-cellular forms of life could have originated 3 billion years back.
* They would have been giant molecules (RNA, proteins, Polysaccharides, etc).
* These capsules reproduced their molecules perhaps, named as **coaservates.**
* The first cellular form of life did not possibly originate till about 2000 millions years ago.
* The first cellular forms of life were probably unicellular.
* All life forms were in water environment only.
* First form of life arose **(biogenesis)** through evolutionary forces from non-living molecules was accepted by majority.

EVOLUTION

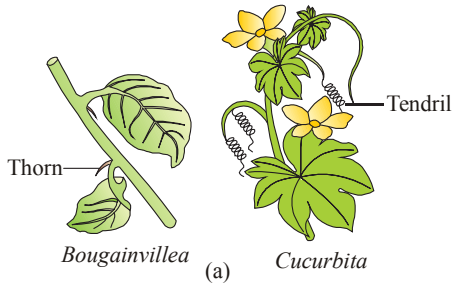
* Process that results in heritable changes in a population spread over many generations (change in allele frequencies over time) leading to diversity of organisms on earth.
* It is the genetic change in a population or species over generations(Genes mutate, individuals are selected, and populations evolve).

Evidences of evolution:

(i) Morphological Evidences:

(a) Homologous organs (Divergent Evolution):

* Organs having similar embryonic origin and basic plan, but differing in their functions are known as homologous organs. E.g., The arm of man, the leg of a horse, the wing of a bat, the wing of a bird and the flippers of a seal have the same basic plan of development but they are used for different works. All of them possess humerus in upper arm, radius and ulna in the forearm, carpals in the wrist, metacarpals in the palm and phalanges in digits. They also show similarities in the arrangement of the muscles and nerves and also show same pattern of embryonic development.
* **Homology in plants:** In plants, the homologous organs are a thorn of Bougainvillea and a tendril in Cucurbita both arising in the axillary position, but perform different functions, Thorn for protection and tendril for support.



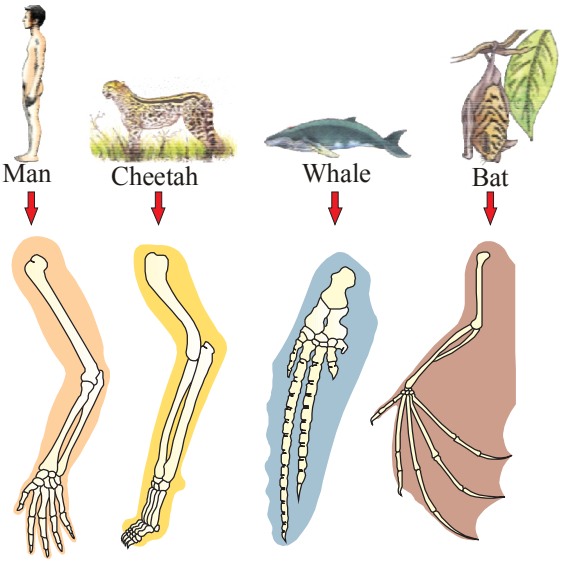


Figure : Homologous organs in (a) Plants and (b) Animals

(b) Analogous organs (Convergent Evolution): Organs having similar functions but different in their basic plan of development are known as analogous organs. For example, the wing of insects and that of birds or bats are analogous structure. Their basic plan of development is different but has a similar function of flying. In insects wing is an extension of the integument whereas a bird's wing is formed of bones covered with flesh, skin and feathers.

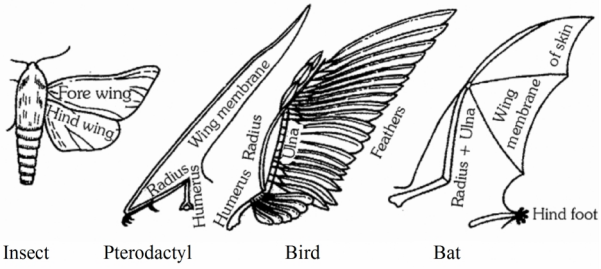


Fig.: Analogy in the wings

In plants:

* In Opuntia / Cactus, a stem is modified to look like a leaf and may perform the function of a leaf (photosynthesis).
* In potato and sweet potato, potato is a stem tuber and sweet potato is a root tuber. Storage of food is the same function.

(c) Vestigial organs : The organs which are present in reduced form and do not perform any function in the body but correspond to the fully developed functional organs of related animals are called vestigial organs. They are remainants of organs which were complete and functional in their ancestors.

Vestigial organs in Human body :

Human body possess about 180 vestigial organs. **a.** nictitating membrane b. muscles of pinna (auricular muscles) **c.** vermiform appendix **d.** coccyx **e.** canine teeth **f.** third molars (wisdom teeth) **g.** segmental muscles of abdomen **h.** caecum **i.** body hairs **j.** nipples in male **k.** ear pinna

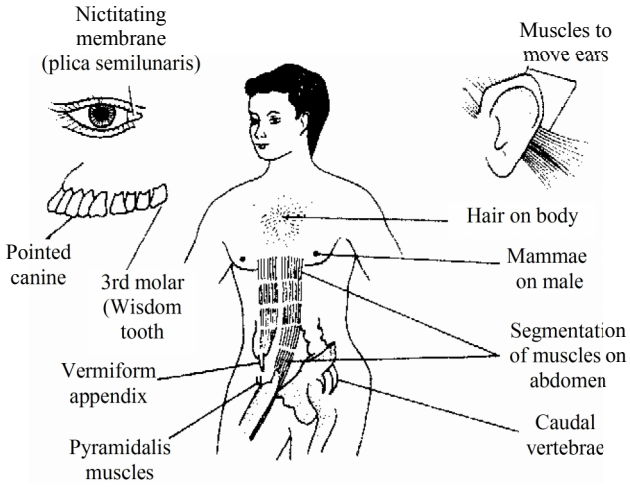


Fig.: Different vestigial organs in man

(ii) Geological time scale (Paleontological evidence):

* It shows the ages of the various eras and periods together with the major groups of plants and animals that are believed to have existed during that period. It helps in the study of palaeontology.
* It has been divided into 6 eras which are further divided into periods or epochs. Each being characterised by some specific living forms and climatic changes, geological time scale is the calender of earth past history indicating the evolution of life through time recorded in sequence of rocks.
* Father of Palaeontology : Leonard da vinci
* Founder of modern palaeontlogy: George cuvier
* Birbal Sahni is famous for Indian palaeonotology
* Definition of Fossils was given by Charls Lyell "Impression of past organism found in Rocks called fossils."

* **By studying fossils following facts about organic evolution are evident :**

(1) Fossils found in older rocks are of simple type and those found in newer rocks are of complex types.

(2) In the beginning unicellular protozoans were formed from which multicellular animals evolved.

(3) Some fossils represents connecting links between two groups.

(4) Angiosperms among plants and mammals among animals are highly developed and modern organism.

(5) By fossils, we can study the evolutionary pedigree of an animal like stages in evolution of horse, elephant and man etc.

* **Archaeopteryx :**

Fossil connective link between birds and reptiles. Fossil was discovered by Andreas wagner from Bavaria in Germany. It was found in the rocks of the Jurassic period.

Reptilian Characters :

(1) Long tail is present.

(2) Bones were not pneumatic.

(3) Presence of weak sternum.

(4) Presence of free caudal vertebrae as found in Lizard.

(5) Teeth present in Jaws.

* **Avian Characters :**

(1) Presence of feathers on the body

(2) The two jaws were modified into beak

(3) The fore limbs were modified into wings

(4) The hind limbs were built in the typical avian plan.

* **Evolution (PEDIGREE) of Horse**

Evolution of horse was described by C. Marsh. The primitive fossil of the horse was found in North America named Eohippus.

* **Changes during evolution of horse are as follows :**

(1) Increment in body height

(2) Increment in the length of neck

(3) Development of high crown on the surface of teeth and formation of cement.

(4) There is gradual increase in the length of legs.

(5) Number of toes or fingers in legs have reduced in modern horse. Only middle toe touches the ground, other toes reduced gradually.

(6) Legs become more powerful for fast running.

(7) As new species were formed, previous ones become extinct.

(8) Enlargement of brain size.

* **Fossils of important Ancestores of horse**

(1) **Eohippus or Hyracotherium :** It evolved in Eocene Epoch. It's size was like a fox.
(Orohippus : It evolved in middle Eocene epoch.)

(2) **Mesohippus :** It evolved from eohippus during oligocene epoch. It's size was like a sheep.
(Miohippus : In the late oligocene Mesohippus was replaced by another slightly advanced horse like form named miohippus. It was much like mesohippus in appearance but somewhat large in size).
(Parahippus : It evolved in early miocene).

(3) **Merychippus :** It evolved in middle and upper miocene epoch. It's size was like a donkey.

(4) **Pliohippus :** This horse evolved during pliocene epoch. It was of the size of modern pony.

(5) **Equus :** This is modern horse which evolved from pliohippus during pleistocene epoch (height 60-64 inches).

(iii) **Biochemical evidences:**

Different organism show similarities in physiology and biochemistry. Some clear examples are

(1) **Protoplasm :** Structure and chemical composition of protoplasm is same from protozoa to Mammalia.

(2) **Enzymes:** Enzymes perform same function in all animals like Trypsin digest protein from amoeba to man. Amylase digest starch from porifera to mammalia.

(3) **Blood :** Chordates show almost same composition of blood.

(4) **ATP :** This energy rich molecule is formed for biological oxidation in all animals.

(5) **Hormones:** Secreted in different vertebrates performs same function.

(6) **Hereditary material :** Hereditary material is DNA in all organism and its basic structure is same in all animals.

(7) **Cytochrome C** is a respiratory protein situated in the mitochondria of all organism. In this protein from 78-88 AA. are identical in all organism, which show common ancestory.
Physiology and biochemistry thus prove that all animals have evolved from some common ancestor.

(iv) Embryological support for evolution:

* Proposed by Ernst Heckel based upon observation of certain features during embryonic stage common to all vertebrates that are absent in adult.
* The embryos of all vertebrates including human develop a row of vestigial gill slits just behind the head but it is a functional organ only in fish and not found in any other adult vertebrates.
* This is disproved on careful study performed by Karl Ernst von Baer. He noted that embryos never pass through the adult stages of other animals.
* In fishes, the young individual, developing from gastrula, is almost-like the adult, but the tadpole larvae of Amphibians bear more resemblance to the young once of fishes than to their own Adults. This indicates Origin of Amphibians from fishes.
* When the heart first develops in the embryos of Amphibians, reptiles, Birds and Mammals, it is 2-chambered same as in the embryos and Adults of fishes. In later stages of Embryonic development in Amphibians, reptiles, Birds and Mammals the heart become, 3-chambered. This condition is retained in Adults of Amphibians and most reptiles. In Birds and Mammals the heart becomes 4-chambered in the last embryonic stages to continue as such in the Adults.
* Modern Scientists have discovered "Biochemical recapitulation" also, for example, fishes mainly excrete Ammonia. Adult Amphibians Excrete urea, but their tadpoles excrete Ammonia like the fishes. Birds excrete uric acid, but their embryos excrete first Ammonia and then urea during earlier stages.
* In embryonic stage birds showed tooth buds for some time, which became extinct later. It show that birds evolved from toothed reptile like ancestors.

(v) Evolution by natural selection:

* **Industrial melanism :** It is an adaptation where moths living in the industrial area developed melanin pigments to match their body colour to the tree-trunk. Before Industralisation in England, it was observed that there were more white-winged moths on trees than dark-winged moths (melanised moths). After industrialisation (in 1920), there were more darkwinged moths in some areas. After industrialisation, trees got covered by smoke. So white-winged moth were picked up by the birds but dark-winged moths escaped and survived. Thus, industrial melanism supports the evolution by natural selection.

(vi) Evolution by anthropogenic action:

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

(vii) Evidences from connecting links:

* Some animals and plants possess characters of two separate groups. One being primitive and the other is advanced group.
* These species act as bridge between two taxonomic groups such organism are called connecting link.
* They provide good example of organic evolution and common ancestory.

(1) Virus : between living and non living.
(2) Euglena: Between plants and animals.
(3) Proterospongia : Between protozoa and porifera
(4) Neopilina : Between mollusca and annelida.
(5) Peripatus : Between Annelida and arthropoda.
(6) Archaeopteryx: Between reptiles and birds.
(7) Balanoglossus : Between nonchordates and chordates.

(8) Chimera: Between cartilagenous fish and Boney fish.
(9) Lung fish (Protopterus) : Between fishes and amphibia.
(10) Platypus: Between reptiles and mammals.
(11) Echidina : Between reptiles and mammals.

(viii) Evidences from Atavism (Reversion) :

* Sometimes in some individuals such characters suddenly appears which were supposed to be present in third ancestors but were lost during the course of development.
* This phenomenon is known as atavism or reversion. Atavism proves that animals developing atavistic structure have evolved from such ancestors in which these structures were fully developed.
* **Examples:**

(1) Human baby with tail
(2) Cervical fistula - in some human babies an aperture is present on neck behind the ear called as cervical fistula. It represents pharyngeal gill slits which were present in aquatic vertebrate ancestors.
(3) Long and pointed canine teeth represents carnivorous ancestors.
(4) Large and thick body hair reflect our relationship with apes.
(5) Extra nipples (more than two)

(ix) Evidences from bio geographical distribution

* The study of geographical distribution of animal and plant species in different parts of earth is called Biogeography.
* Different animal species occurring in an area are called Fauna and those of plants are called Flora.
* On the basis of fauna and flora Alfred Russel Wallace divided the whole world into six major biogeographical regions called realms.
* **Nearctic :** North America from Mexican highlands to Arctic islands and Greenland.
* **Palaearctic :** Europe, North Asia up to Himalayas and North Africa up to Sahara desert.
* **Neotropical :** Central and South America, Mexican lowlands and West Indies.
* **Oriental :** Asia, South of Himalayas; India, Ceylon, Malay, Peninsula, Sumatra, Borneo, Java Celebes and Philippines.
* **Ethiopian:** South Africa from Sahara Desert, Madagascar and Adjacent islands.
* **Australian:** Australia, Tasmania, New Guinea, New Zealand and Oceanic islands of the pacific.

It is believed that millions of years ago all the continents were present in the form of a single land mass called Pangaea. Later on due to various geological changes, these continents drifted from one another. As these continents moved away they got separated from each other by the seas. As these continents had different environmental conditions so plants and animals evolved there were of different varieties. (New species).

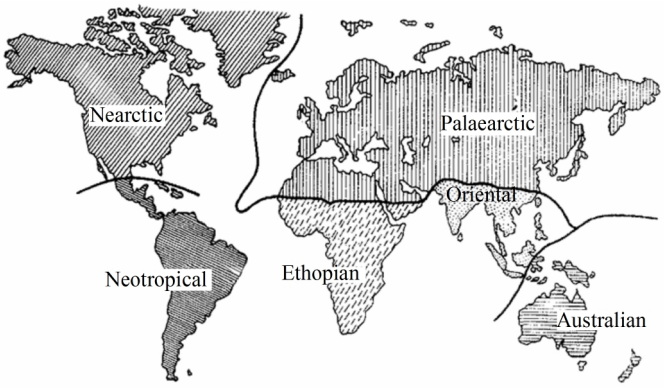


Fig The biogeographical realms of the world

ADAPTIVE RADIATION

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

(i) Darwin's Finches:

* In Galapagos Islands Darwin observed small black birds later called Darwin's Finches.
* He realized that there were many varieties of finches in the same island.
* All the varieties, he came across, evolved on the island itself.
* Form the original seed-eating features, many other forms with altered beaks arose, enabling them to become insectivorous and vegetarian finches.

(ii) Australian marsupial:

* A number of marsupials each different from the other evolved from an ancestral stock. But all within the Australian island continent.
  - When more than one adaptive radiation appeared to have occurred in an isolated geographical area (representing different habitats), one can call this **convergent evolution.**

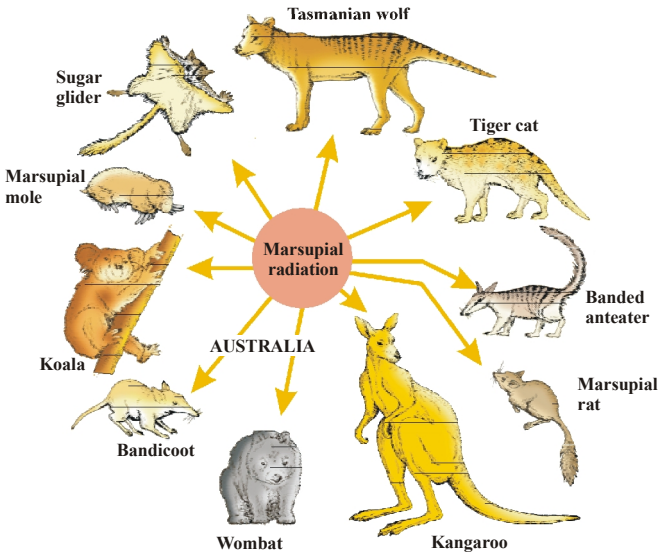


Figure : Adaptive radiation of marsupials of Australia

(iii) **Placental mammals** in Australia also exhibit adaptive radiation in evolving into varieties of such placental mammals each of which appears to be 'similar' to a corresponding **marsupial** (e.g. placental wolf and Tasmanian wolf-marsupial).

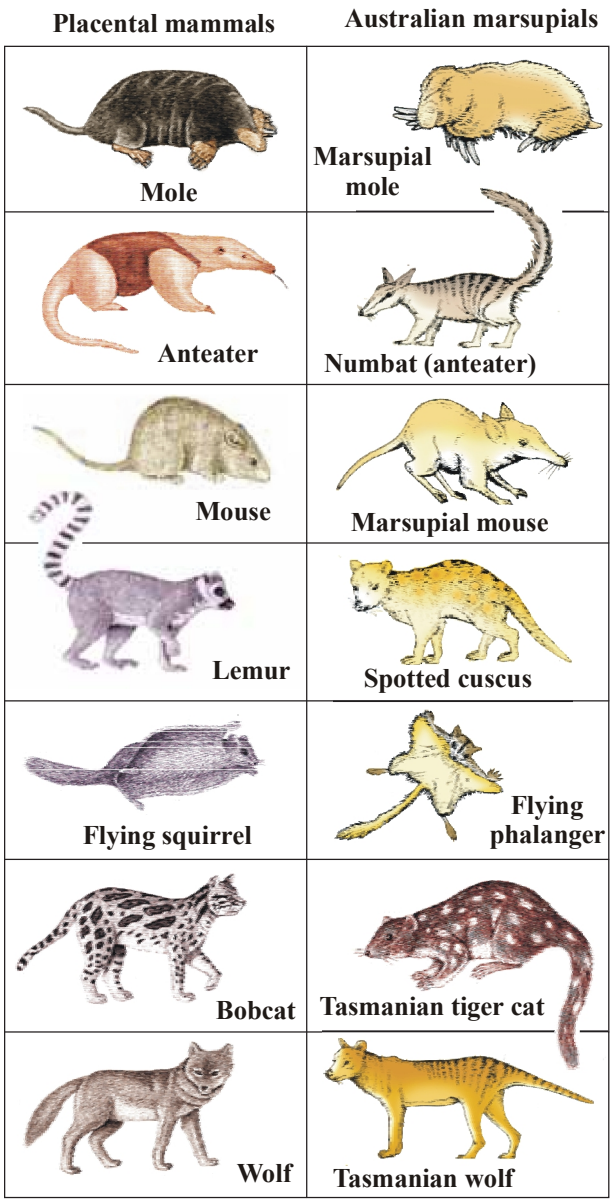


Figure : Picture showing convergent evolution of Australian Marsupials and placental mammals.

THEORY OF ORGANIC EVOLUTION

Lamarckism :

* First theory of evolution was proposed by
* Jean Baptiste de Lamarck (1744-1829)
* Book: Philosophie Zoologique (1809)
* Lamarck coined the terms - Invertebrates, Annelida.
* The term Biology was given by Lamarck & Treviranus.
* Theory of Inheritance of Acquired Character

Basic Concepts of Lamarckism

(i) **Internal Vital Forces :** Some internal forces are present in all organisms. By the presence of these forces organism have the tendency to increase the size of their organs or entire body.

(ii) **Effect of environment and new needs :** Environment influences all type of organisms. Changing environment gives rise to new needs. New needs or desires produce new structures and change habits of the organism.

(iii) **Use and disuse of organs :** If an organ is constantly used, it would be better developed whereas disuse of organ result in its degeneration.

(iv) **Inheritance of acquired character :** During the life time of an organism new characters develop due to internal vital forces, effect of environment, new needs and use and disuse of organs.

These acquired characters are inherited from one generation to another. By continuous inheritance through many generation these acquired characters tend to make new generation quite different from its Ancestors resulting in the formation of new species.

Examples in support of Lamarckism :

1. Long neck and high fore limb of Giraffe.
2. Aquatic birds stretched their toes and developed web.
3. Snakes lost their legs,
4. Deers became good runners by the development of strong limbs and streamlined body.
5. Retractile claws of carnivorous animals.

Criticism of Lamarckism :

1. According to first concept organism tends to increase their size but it is not universally true. For example among angiosperm the trees seem to be primitive and the shrubs, herbs and grasses have evolved from trees but the size was reduced during evolution.
2. Second concept is false. Can we sprout wings wishing to fly like birds.
3. The third concept is some what true like the well developed biceps muscles of blacksmith and less developed wings in flight less birds. But this concept also have many objections like the eyes of a student/reader do not increase in size and power with increasing age, the constantly beating heart maintains a constant size through generation.
4. Fourth concept is completely false because acquired characters are not inherited.

Weismann : Weismann cut off the tails of rats for about 22 generations but there was no reduction in the size of tail. On the basis of this experiment Weismann proposed the theory of continuity of germplasm.

According to Weismann.

(i) Two type of matters are present in organism, somatoplasm and germplasm.

(ii) Somatoplasm in somatic cells and germplasm in Germinal cell.

(iii) Somatoplasm dies with the death of organism while germ plasm transfers into the next generation.

(iv) If any variation develops in germplasm, it is inherited, while if variation develop in somatoplasm it is not transmitted.

Pyane : Pyane kept drosophila in dark up to 69 generation, but there was no reduction in the size or sight of eyes.

Boring of ear and nose in Indians.

Iron shoes of chinese.

Neolamarckism -Term by Pakard

* Although Lamarckism remained controversial but some scientists gave the following evidences in favour of Lamarckism. They are known as neo-lamarckians.

* According to neolamarckism environment effected the inheritance of acquired character. According to it changing' environment give rise some physical and chemical changes in organism, which effect their germplasm, and these acquired characters are definitely inherited.

1. **Sumner's Experiment :** Sumner kept white rat in warm temperature resulting in elongation of body, large pinna and long tail. These features were inherited by the offspring:
2. **Kammerer's Experiment :** Kammerer kept salamander in dark background. The black spots found on skin were widely spread. In lighter background the skin became yellow with limited

black spots. These character were inherited by the offspring.

3. **Mac Dugal's Experiment :** Mac Dugal trained white rats to cross a tank of water following definite route. These trained rats were mated and their offspring were again trained. It was observed that there was decrease in the number of errors by offsprings of white rats

Note :

(i) **Allen's law :** It states that animals which live in very cold climate, their extremities such as ears, tails, etc. become progressively smaller.

(ii) **Cop's law :**It states that there is a tendency of animals to increase in size, during the long course of evolution.

Darwinism

* Darwin was influenced by two books.
* "Principles of population" by Malthus.
* "Principles of Geology" by Charls Lyell.
* **Alfred Russel Wallace :** He travelled South eastern Asia and South America. The idea of natural selection striked in his mind. Wallace wrote an essay and sent it to Darwin. "On the tendency of varieties to depart indefinitely from original type". There was striking similarity between the views of Darwin and Wallace.
* "Darwinism" or "The theory of Natural Selection" was proposed jointly by Charles Darwin and A.R. Wallace. This theory was explained by Darwin in his book 'On the origin of species by the means of Natural Selection' (1859).

The main features of theory of Natural Selection are :

1. **Over Production :** All organisms have capability to produce enormous number of offspring, organisms multiply in geometric ratio.

e.g. - Plants produce thousands of seeds.

– Insects lay hundreds of egg.

– One pair elephant gives rise to about six offspring and if all survived in 750 years a single pair would produce about 19 million elephants. Thus some organisms produce more offspring and other produce fewer offspring This is called differential reproduction.

2. **Struggle for existence :**

Every individual competes with others of the same and other species for basic necessities like space, shelther and food, it is called struggle for existence and it continues for the whole life from zygote stage to its natural death.

The struggle for existence is of three types

(i) **Intra-specific struggle:** It is competition between the individuals of same species for same needs like food, shelter and breeding (most acute type of struggle).

(ii) **Inter-specific struggle:** It is the struggle between the individuals of different species for food and shelter.

(iii) **Environmental struggle:** This struggle is between the organism and their environment. All organism struggle with cold, heat, wind, rain, drought and flood etc.

3. **Variations and heredity :** Except the identical twins no two individuals are similar and their requirements are also not same. It means there are differences among the individuals. These differences are called variations. Due to variations some individuals would be better adjusted towards the surroundings than the others.

According to Darwin the variations are continuous and those which are helpful in the adaptations of an organism towards its surroundings would be passed on to the next generation, while the others will disappear.

4. **Survival of the fittest or natural selection :**

The original idea of survival of fittest was proposed by Herbert Spencer.

According to Darwin most suitable and fit individuals are successful in struggle for existence. The individuals with. most favourable adaptations are able to lead most successful life and are able to win over their mating partners. Darwin called it Sexual Selection.

In the struggle for existence only those members survive which posses useful variations means nature selects fit individuals. This was called Natural Selection. Fitness is the end result of the ability to adapt and get selected by nature.

5. **Origin of New Species :** Darwin explained that variations appearing due to environmental changes are transmitted to the next generation. ·So offspring become different from ancestors. In next generation process of Natural selection repeats so after many generation a new species is formed.

Criticism of Darwinism :

1. Darwin does not explain the development of vestigial organs.
2. This theory has no satisfactory explanation for the cause, origin and inheritance of variation.
3. Darwin is unable to explain why in a population only a few individuals develop useful variation and others have harmful variations.
4. Criticism of Darwinism was based on sexual selection. Why only female selects the male for mating why not vice versa.
5. Darwin was unable to differentiate somatic and germinal variations.
6. This theory was unable to explain over-specialization of some organs "like tusk of elephants, antelers of deer.
7. This theory only explain the survival of fittest but unable to explain arrival of fittest.
8. The main drawback of Darwinism was lack of the knowledge of heredity.

Theory of Pangenesis :

* According to this theory all organs of an individual produce Pangenes, which are minute particles carrying information about the organs.
* The pangenes travelling through the blood stream will ultimately reach the gametes, so that each gamete will have pangenes for each of the different organs.
* After zygote formation, the pangenes tend to form the same organs from which these pangenes were produced.

Neodarwinism

* Neodarwinism is a modified form of Darwinism along with recent researches of Weismann, Mendel, Devries, Huxley, Gates, Stebbins etc.
* They performed many experiments to remove the objections against Darwin's theory.
* The salient features of neodarwinism are as follows

1. **Rapid multiplication :** All organism multiply in geometrical ratio.
2. **Limited food and space:** Food and space are limited.
3. **Struggle for existence:** It is of three types. Intraspecific, Interspecific and environmental.
4. **Genetic Variations:** They are inheritable variation which can occur due to the following reasons.

(a) **Mutation :** They are discontinuous variations which develop due to permanent changes in genotype. Mutations are of three types

* Genomatic mutations: Change in number of chromosome.
* Chromosomal Aberrations: Change in structure of chromosome.
* Gene Mutation: Change in nucleotide.

(b) **Gene recombination :** They are new combination of genes which are usually caused by crossing over.

(c) **Hybridisation and gene migration:** It is crossing of organisms which are genetically different in one or more traits.

(d) **Genetic drift :** It is the elimination or addition of the genes of certain characters when some animals in population migrate or dies or immigrate. It changes the gene frequency of remaining population. Genetic drift operates only in small population. (Change in frequency of genes in a gene pool is called genetic drift)

Founder effect : Gene pool is the sum total of all the genes found in a population. Change in the frequency of gene in a gene pool is called genetic drift. Genetic drift always operates in small population. By genetic drift often the phenotype of this small population quickly become different from the parental population and some time form a new sp. Such an effect is called Founder effect.

Bottleneck effect : Death of several members of a population due to natural calamities (Earthquake, Storm, Flood) also leads to genetic drift. The original size of population is then restored by mating among the survivor. The new population may lack the genes of certain traits. This may produce a new species after some time. The loss of a section of population by death and after sometime a new species is formed that effect is known as Bottleneck effect.

5. **Natural Selection :** If differential reproduction (some individuals produce more, some only few and still others none) continuous for many generations, genes of the individuals which produce more offspring will become predominant in the gene pool of the population. Thus natural selection occurs through differential reproduction in successive generations.

6. **Isolation :** Isolation is a segregation of populations by some barriers which prevent interbreeding. The reproductive isolation between the populations due to certain barriers leads to the formation of new species.

7. **Origin of new species :** An isolated population of a species independently develops different types of mutations. They latter accumulate in its gene pool. After several generations the isolated population becomes genetically and reproductively different from others so as to constitute a new species.

Examples of Natural Selection

1. **Industrial Melanism:**

* This phenomenon was studied by Barnard kettlewell.
* Before industrial revolution, the dull grey forms of peppered moth-Biston betularia - were dominant; the Carbonaria form (Black) was rare because it was susceptible to predation by birds.
* The reason was that it was conspicuously visible while resting on tree trunks.
* The industrial revolution, resulted in large scale smoke which got deposited on tree trunks turning them Black.
* Now grey varieties became susceptible-the Black forms flourished. Replacement of coal by oil and Electricity reduced production of black moth so the frequency of Grey moths increased again.

2. **Drug resistance :** The drugs which eliminate pathogens become ineffective in the course of time because those individuals of pathogenic species which can tolerate them, survive, flourish to produce tolerant population.

3. **Sickle cell Anaemia and Malaria :** Individuals homozygous for sickle cell Anaemia die at an early age. In heterozygous individuals, the cells containing abnormal haemoglobin become Sickle shaped. In fact, when an RBC becomes sickle-shaped, it kills Malarial parasite effectively so that these individuals are able to cope with malaria infection much better than normal persons. The process of Natural selection thus maintains the abnormal form of haemoglobin along with the normal form in a region where Malaria is common.

4. **Malaria and G - 6 - PD deficiency :** Glucose-6-Phosphate dehydrogenase deficiency is a common abnormality in Negroids. Haemoglobin gets denatured and is deposited on cell membrane. The disease is called favism. In these RBC, the malarial parasite cannot complete it's life cycle. Such persons get protection from Malaria.

Artificial Selection : Man has been taking the advantage of genetic variations for improving the qualities of domesticated plants and animals. He selects the individuals with desired characters and separates them from those which do not have such characters. The selected individuals are interbred. This process is termed as Artificial Selection. Thus this process is man made. If it is repeated for many generations it produces a new breed with desired characters.

By artificial selection animal breeders are able to produce improved varieties of domestic animals like dogs, horse, pigeons, poultry, cows, goats, sheep and pigs from their wild ancestors.

Similarly the plant breeders have obtained improved varieties of useful plants like wheat, rice, sugarcane, cotton, pulses, vegetables fruits etc.

Artificial Selection is similar to natural selection except that the role of nature is taken overby man and the characters selected are of human use.

Note :

* The breeders have successfully produced the toy-like shetland pony, the Great Dane dog, the sleek Arabian race horse by selection.
* Many crop plants like broccoli, kale, cabbage, Cauliflower, Brussels sprouts and kohirabi have been produced through selective breeding.
* The various breeds of fowl ranging from the ceremonial cocks (the Japanese onago-dori) to the broiler, leghorns are all derived from a single jungle fowl Gallus gallus.

Synthetic theory :

* Dobzhansky (1937) in his book 'Genetics and Origin of Species' provided the initial basis of synthetic theory.
* 'Modern synthetic theory of evolution' was designated by Huxley in 1942.
* 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.
* According to synthetic theory there are five basic factors involved in the process of organic evolution. These are :

(a) Gene mutations
(b) Changes in chromosome structure and number
(c) Genetic recombinations
(d) Natural selection and
(e) Reproductive isolation.

* The most accepted and recent theory of organic evolution is the synthetic theory.

HARDY - WEINBERG PRINCIPLE

* The principle states that allele frequencies in a population are stable and is constant from generation to generation.
* The gene pool (total genes and their alleles in a population) remains a constant. This is called genetic equilibrium:
* Sum total of all the allelic frequencies is 1.
* $(p + q)^2 = p^2 + 2pq + q^2 = 1$.

In a diploid, p and q represent the frequency of allele A and allele a.

The frequency of AA individuals in a population is simply p^2.

Similarly of aa is q^2, of Aa 2pq.

* When frequency measured, differs from expected values, the difference (direction) indicates the extent of evolutionary change.
* Disturbance in genetic equilibrium, or i.e. change of frequency of alleles in a population would then be interpreted as resulting in evolution.

Factors affecting Hardy-Weinberg equilibrium:

(i) **Gene migration:** When migrations of a section of population to another place occur, gene frequencies change in the original as well as in the new population. New genes /alleles are added to the new population and these are lost from the old population.Gene migration occurs many time is termed as gene flow.

(ii) **Genetic drift:** change in gene frequency takes place by chance.Sometimes the change in allelic frequency is so different in the new sample of population that they became a different species. The original drifted population becomes founder species and the effect is called founder effect.

(iii) **Mutation:** Advantageous mutation lead to new phenotypes and over few generations result in speciation.

(iv) **Genetic recombination:**During gametogenesis, variation due to recombination results in new phenotypes.

(v) **Natural selection can lead to :**

* Stabilization: in which more individuals acquire mean character value.
* Directional changes i.e. more individuals acquire value other than the mean character value.
* Disruption: more individuals acquire peripheral character value at both ends of the distribution curve.

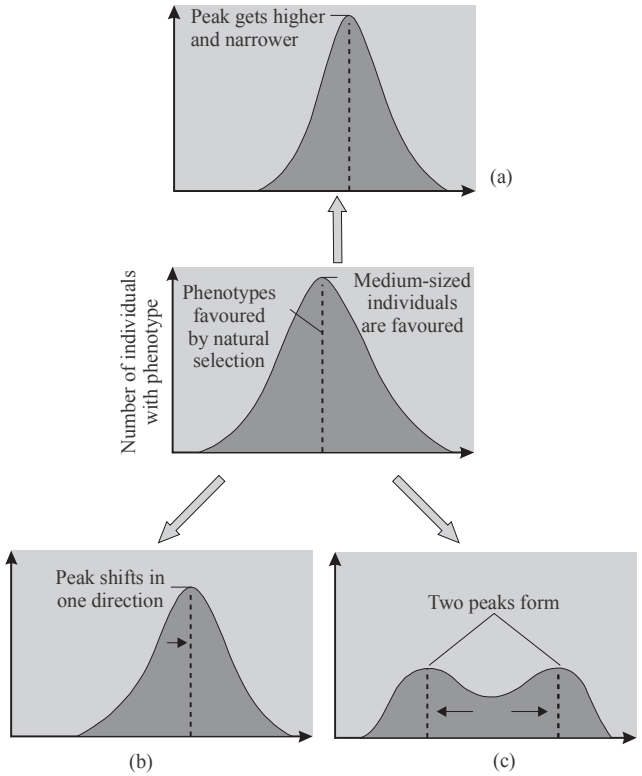


Figure : Diagrammatic representation of the operation of natural selection on different traits : (a) Stabilising (b) Directional and (c) Disruptive

A BRIEF ACCOUNT OF EVOLUTION

* About 2000 mya the first cellular forms of life appeared on earth. Some cellular form had the ability to release O_2. Slowly single cell organisms became multi-cellular life forms.
* By the time of 500 mya invertebrates were formed and active.
* Jawless fish probably evolved around 350 mya.
* Sea weeds and few plants existed probably around 320 mya.
* **Coelacanth** a lobe finned fish discovered in South Africa in 1938 evolved into first amphibians that lived on both land and water. These were ancestors of modern day frogs and salamanders.
* The amphibian evolved into reptiles.
* Reptiles lays eggs which did not dry up in sun unlike those of amphibians.
* **Giant ferns** (pteridophytes) were present but they fell to form **coal deposits** slowly.
* Some of the reptiles went back into water to evolve into fish like reptiles probably 200 mya *(Ichthyosaurs)*
* The land reptiles were the dinosaurs.
* The biggest dinosaurs are *Tyrannosaurus* rex was about 20 ft. in height and had huge fearsome dagger like teeth. About 65 mya the dinosaurs suddenly disappeared from the earth.
* The first mammals were like shrews. Their fossils were small sized.
* Mammals were viviparous and protected their unborn young inside the mother's body.
* Due to continental drift, pouched mammals of Australia survived because of lack of competition from any other mammals.
* **Evolution of Plants :** Unicellular → Multicellular → Algae → Rhynia type plants → Cycads → Gnetales → Dicot → Monocot.

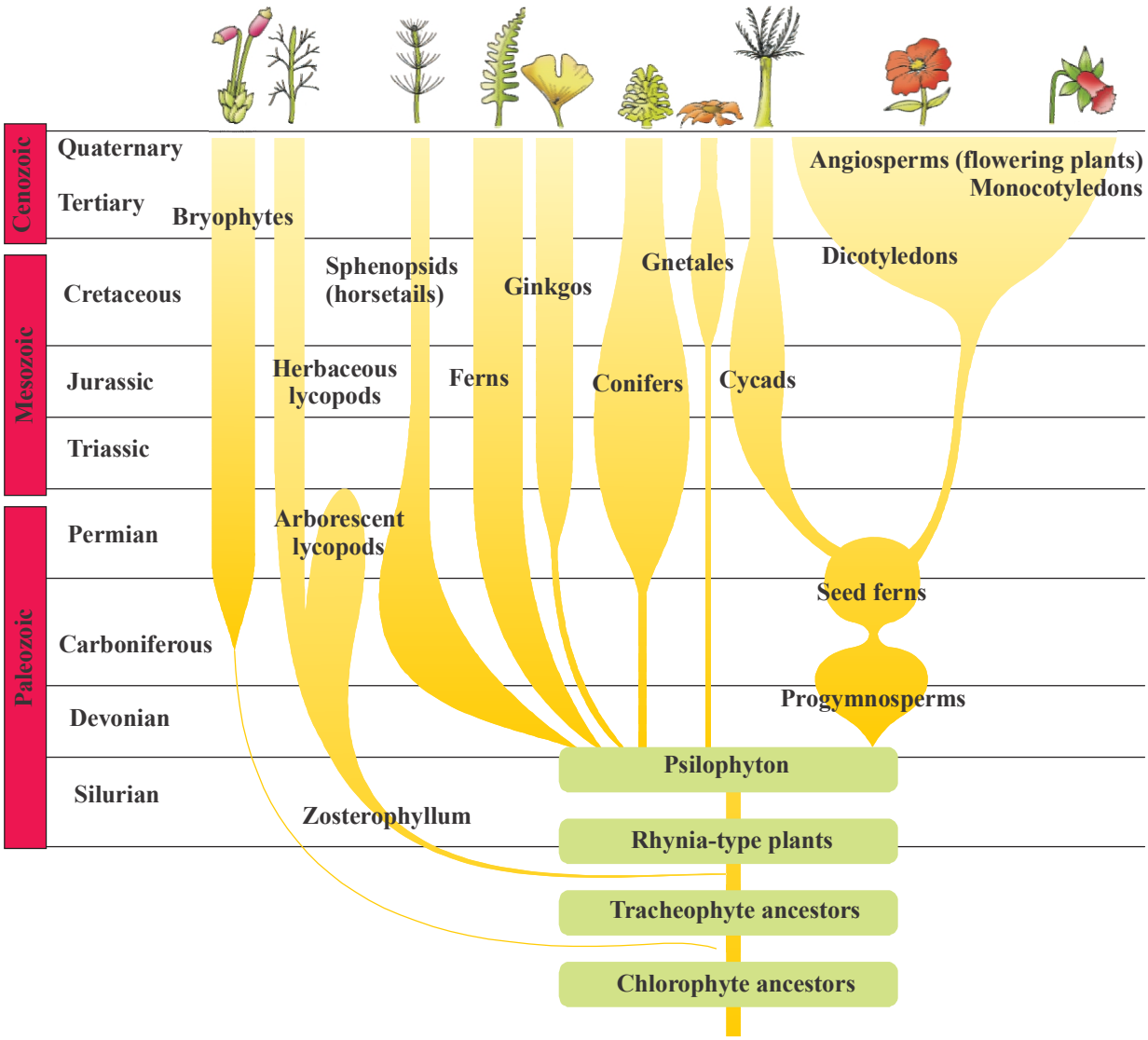


Figure : A sketch of the evolution of plant forms through geological periods

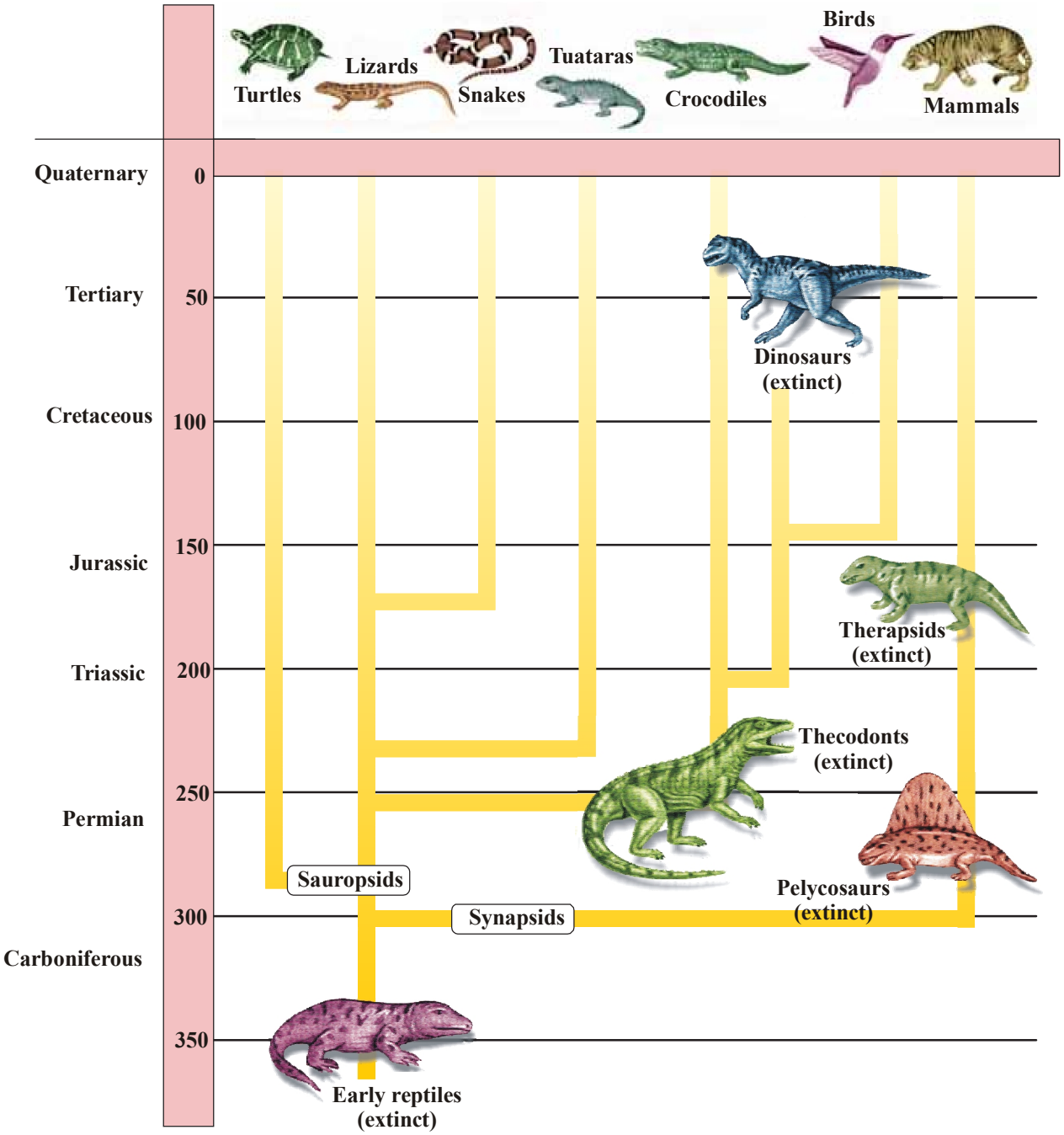


Figure : Representative evolutionary history of vertebrates through geological periods

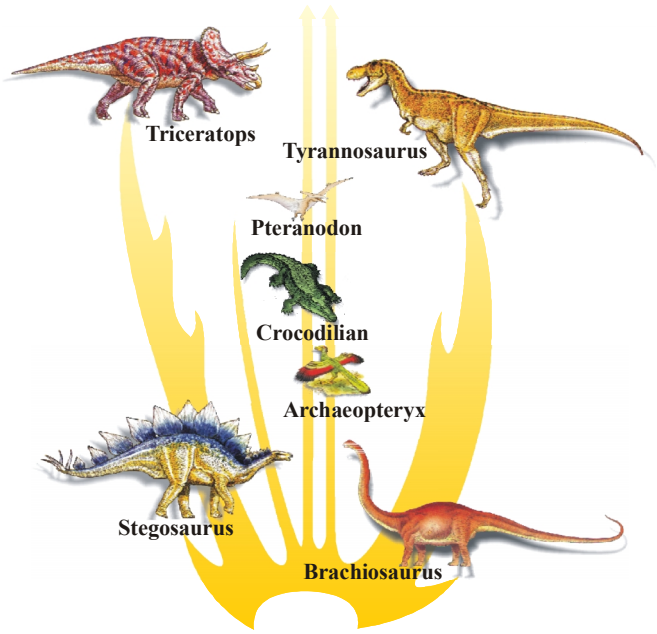


Figure : A family tree of dinosaurs and their living modern day counterpart organisms like crocodiles and birds.

HUMAN EVOLUTION

Classification of Man :

Phylum	- Chordata
Subphylum	- Vertebrata
Class	- Mammalia
Subclass	- Eutheria
Oder	- Primates
Suborder	- Anthropoidea
Super family	- Hominoidae
Family	- Hominideae
Genus	- Homo
Species	- Sapiens

* The primates include Prosimians (Lemurs, tarsiers and related forms) and Anthropoids (Monkeys, apes and Human).
* They are descended from small rodent like or insectivorous mammals that evolved about 80 million years ago.

Evolutionary characteristics of man :

* The modern man possesses following special features, which have been acquired during the course of evolution-

(i) Bipedal locomotion.
(ii) Large brain and cranial cavity.
(iii) Grasping hands and feet.
(iv) Erect posture.
(v) Stereoscopic (binocular) vision.
(vi) Sensitivity
(vii) Social organisation.
(viii) Expression by speech.

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

(i) Increase in brain size and intelligence.
(ii) Attainment of erect posture.
(iii) Flattening of face.
(iv) Shortening of body hair and reduction in their number.
(v) Elevation and narrowing of nose.
(vi) Increase in height.
(vii) Reduction of brow ridges.
(viii) Rounding and enlargement of cranium.
(ix) The bowl like form of pelvic girdle and broad ilia to support the viscera.
(x) Formation of chin.

Fossils of apes :

1. **Propliopithecus :** Origin & evolution in Oligocene epoch so called as Oligocene apes. Evolution about 30-35 million years ago.
2. **Agyptopithecus :** Origin and evolution in late Oligocene and Miocene epoch so called as Miocene apes.
3. **Proconsul :** Its fossils were discovered by Leakey from East Africa near Victoria lake in Kenya from Miocene rocks. It walked on its four legs (considered as common ancestor of man and apes.
4. **Dryopithecus :** Evolution ≈ 15-20 million years ago.

* Direct ancestor of modern day apes.
* They were forest dwellers spending most of the time on the trees.
* Origin & evolution in Miocene epoch.
* Semi erect posture
* Quadra pedal locomotion, forlimbs longer than hind limbs.
* Thick growth of hair
* U shaped jaws
* Teeth larger and sharper
* By nature vegetarian, fruit eater

5. **Ramapithecus, Shivapithecus :** Fossils dicovered by Lewis from Shivalik hills in India.
6. **Australopithecus :** Prof. Raymond dart discovered a fossil of skull of 5 - 6 year old baby from the old pliocene rocks of Tuang region (S. Africa). He named it Tuang baby, later on he renamed it A. africanus.

* About 3-2 million years ago it lived in East African grasslands.
* Evidences shows they hunted with stone.
* It was an apeman because it have many characters of man and apes so it is also considered as connecting link between apes and man.

Prehistoric man :

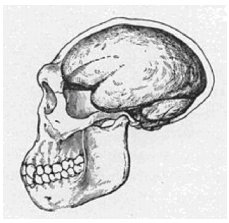
Homo habilis : The tool maker man or Handy man.

* First human being like.
* Its fossils were discovered by Dr. Leakey from 2 million years old rocks in Africa.
* Lived in caves.
* Cranial capcity - 650-800 cc
* Complete erect posture.
* Chin absent, dental formula same as human.
* Jaw U shaped (Prognathous).
* First man who made tools of stones for hunting animals.
* They probably did not eat meat.

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.

Homo erectus skull



Java man skull

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.

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 850-1200ml. and averaging 1075 c.c.

Peking man skull

Homo sapiens Skull

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.

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.

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.
* 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.

Cromagnon man : Homo sapiens fossils

* Origin and evolution 10,000-50,000 years ago.
* Fossils dicovered by Mac gregor from Cromagnon rocks of France.
* Lived in caves.
* Cranial capacity - 1650 c.c. (maximum)
* Complete erect posture
* Larger forehead, well developed speech centre.
* Semi circular jaw, well developed chin, orthognathous jaw.
* Wore cloth of animal skin.
* This man was hunter and used domesticated dogs in hunting, so domestication of animals started by cromagnon man.
* They also painted beautiful painting on cave walls. Pre-historic cave art developed about 18,000 years ago One such cave paintings by Pre-historic humans can be seen at Bhimbetka rock shelter in Raisen district of Madhya Pradesh. Agriculture came around 10,000 years back and human settlements started.
* The cromagnon man is regarded as the direct ancesntor of modern man.
* By nature carnivorous.

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 Rhodensian 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.

CONCEPT REVIEW

* Biologists generally agree that life originated from nonliving matter by **chemical evolution**. Although chemical evolution is very difficult to test experimentally, hypotheses about the origin of life are testable.
* Four requirements for chemical evolution are (1) the absence of oxygen, which would have reacted with and oxidized abiotically produced organic molecules; (2) energy to form organic molecules; (3) chemical building blocks, including water, minerals, and gases present in the atmosphere, to form organic molecules; and (4) sufficient time for molecules to accumulate and react.
* During chemical evolution, small organic molecules formed spontaneously and accumulated.
* The first cells were prokaryotic **heterotrophs** that obtained organic molecules from the environment. They were almost certainly **anaerobes**. Later, **autotrophs**, arose-organisms that produce their own organic molecules by photosynthesis.
* The evolution of photosynthesis ultimately changed earlylife because it generated oxygen, which accumulated in the atmosphere, and permitted the evolution of **aerobes**, organisms that could use oxygen for a more efficient type of cellular respiration.
* Eukaryotic cells arose from prokaryotic cells. According to the **endosymbiont theory**, certain eukaryotic organelles (mitochondria and chloroplasts) evolved from prokaryotic **endosymbionts** within larger prokaryotic hosts.
* The Paleozoic era began about 543 mya and ended 251 mya.

* The Mesozoic era began about 251 mya and ended 65 mya.
* The Cenozoic era began about 65 mya and extends to the present.
* During **Precambrian time**, which extended from approximately 3.8 bya up to 543 mya, life began and diverged into different groups of bacteria, protists (including algae), fungi, and simple multicellular animals.
* During the **Paleozoic era**, which lasted approximately 292million years, all major groups of plants, except for flowering plants, and all animal phyla appeared. Fish and amphibians flourished, and reptiles appeared and diversified. The greatest mass extinction of all time occurred at the end of the Paleozoic era, 251mya. More than 90% of all existing marine species and more than 70% of land-dwelling vertebrate genera became extinct, as well as many plant species.
* The **Mesozoic era** lasted some 186 million years. During the Mesozoic era, flowering plants appeared and reptiles diversified. Dinosaurs, which descended from early reptiles, dominated. Insects flourished, and birds and early mammals appeared. At the end of the Cretaceous period, 65 mya, a great many animals abruptly became extinct. A collision of Earth with a large extraterrestrial body may have resulted in dramatic climate changes that played a role in this mass extinction episode.
* In the **Cenozoic era**, which extends from 65 mya to the present, flowering plants, birds, insects, and mammals diversified greatly.
* Jean Baptiste de Lamarck was the first scientist to propose that organisms undergo change over time as a result of some natural phenomenon rather than divine intervention. Lamarck thought organisms were endowed with a vital force that drove them to change toward greater complexity over time. He thought organisms could pass traits acquired during their lifetimes to their offspring.
* Charles Darwin's observations while voyaging on the H.M.S. *Beagle* was the basis for his theory of evolution. Darwin tried to explain his observations of the similarities between animals and plants of the arid Galapagos Islands and the humid South American mainland.
* Darwin was influenced by **artificial selection**, in which breeders develop many varieties of domesticated plants and animals in just a few generations. Darwin applied Thomas Malthus's ideas on the natural increase in human populations to natural populations. Darwin was influenced by the idea that Earth was extremely old,an idea promoted by Charles Lyell and other geologists.
* **Evolution**, the accumulation of inherited changes within a **population** over time, is the unifying concept of biology. Evolution is the corner stone of biology because it links all fields of the lifesciences into a unified body of knowledge.
* Charles Darwin and Alfred Wallace independently proposed the theory of evolution by **natural selection,** which is based on four observations. First, genetic variation exists among the individuals in a population. Second, the reproductive ability of each species causes its populations to geometrically increase in number overtime. Third, organisms compete with one another for the resources needed for life, such as food, living space, water, and light.Fourth, offspring with the most favorable combination of characteristics are most likely to survive and reproduce, passing those genetic characteristics to the next generation.
* Natural selection results in **adaptations**, evolutionary modifications that improve the chances of survival and reproductive success in a particular environment. Over time, enough changes may accumulate in geographically separated populations to produce new species.
* The **modern synthesis**, or **synthetic theory of evolution** combines Darwin's theory of evolution by natural selection with modern genetics to explain how species adapt to their environment.
* **Mutation** provides the genetic variability that natural selection acts on during evolution.
* Direct evidence of evolution comes from **fossils**, the remains or traces of ancient organisms.
* Layers of sedimentary rock normally occur in their sequence of deposition,with the more recent layers on top of the older, earlier ones. **Index fossils** characterize a specific layer over large geographical areas. **Radioisotopes** present in a

rock provide a way to accurately measure the rock's age.

* **Homologous features** have basic structural similarities, even though the structures may be used in different ways, because homologous features derive from the same structure in a common ancestor. Homologous features indicate evolutionary affinities among the organisms possessing them.
* **Homoplastic features** have similar functions in quite different, distantly related organisms. Homoplastic features demonstrate convergent evolution, in which organisms with separate ancestries adapt in similar ways to comparable environmental demands.
* **Vestigial structures** are nonfunctional or degenerate remnants of structures that were present and functional in ancestral organisms. Structures occasionally become vestigial as species adapt to different modes of life.
* **Biogeography**, the geographical distribution of organisms, affects their evolution. Areas that have been separated from the rest of the world for a long time have organisms unique to those areas.
* At one time the continents were joined to form a supercontinent. **Continental drift**, which caused the various landmasses to break apart and separate, has played a major role in evolution.
* Evolutionary changes are often the result of mutations in genes that affect the orderly sequence of events during development. Development in different animals is controlled by the same kinds of genes, which indicates these animals have a shared evolutionary history.
* Primates are **placental mammals** that arose from small, **arboreal** (treedwelling), shrewlike mammals. Primates possess five grasping digits, including an opposable thumb or toe; long, slender limbs that move freely at the hips and shoulders; and eyes located infront of the head.
* Anthropoids include monkeys, apes, and humans. Early anthropoids branched into two groups: the New and Old World monkeys.
* **Hominoids** include apes and humans. Hominoids arose from the Old World monkey lineage. There are four modern genera of apes:gibbons, orangutans, gorillas, and chimpanzees.
* The **hominid** line consists of humans and their ancestors.
* Unlike ape skeletons, hominid skeletons have adaptations that reflect the ability to stand erect and walk on two feet. These adaptations include a complex curvature of the spine; a shorter, broader pelvis; a **foramen magnum** at the base of the skull; and a first toe that is aligned with the other toes.
* The human skull lacks a pronounced **supraorbital ridge**, is flatter in the front, and has a pronounced chin. The human brain is larger,and the jaw is structured so that the teeth are arranged in a U shape.
* Hominid evolution began in Africa. The earliest known hominids belong to ***Sahelanthropus tchadensis.***
* *Ardipithecus* and *Australopithecus* species are often referred to as ***australopithecines***. *Australopithecus* species were **bipedal** (walked on two feet), a hominid feature. ***Ardipithecus ramidus***, which appeared about 5.2 to 5.8 mya, presumably gave rise to ***Australopithecus anamensis***. A. *anamensis* may have given rise to another primitive hominid, ***Australopithecus afarensis***. Many paleoanthropologists think A. *afarensis* gave rise to several australopithecine species, including *Australopithecus africanus*.
* The genus *Australopithecus* contains the immediate ancestors of the genus *Homo*.
* ***Homo habilis*** was the earliest known hominid with some of the human features lacking in the australopithecines, including a slightly larger brain. *H. habilis* fashioned crude tools from stone.
* ***Homo erectus*** had a larger brain than *H. habilis*; made more sophisticated tools; and may have worn clothing, built fires, and lived in caves or shelters. Some scientists hypothesize that fossils identified as *Homo erectus* represent two different species, ***Homo ergaster***, an earlier African species that gave rise to archaic *Homo sapiens*, and *Homo erectus*, a later Asian offshoot that may be an evolutionary dead end.
* **Archaic *Homo sapiens*** lived in Africa, Asia,

and Europe from about 800,000 to 100,000 years ago.

Some researchers classify archaic *Homo sapiens* as a separate species, ***Homo heidelbergensis***.

* **Neandertals** lived from about 230,000 to 30,000 years ago. Neandertals had short, sturdy builds; receding chins and foreheads; heavy supraorbital ridges and jawbones; larger front teeth; and nasal cavities with unusual triangular bony projections. Many scientists think that Neandertals were a separate species, ***Homo neanderthalensis***, whereas some scientists think Neandertals were a type of modern human.
* Anatomically modern humans (***Homo sapiens***) existed 100,000 years ago. By about 30,000 years ago, anatomically modern humans were the only members of genus Homo remaining. European remains of these ancient people are referred to as **Cro-Magnons**.
* Two hypotheses purport to explain the origin of modern humans. The out-of-Africa hypothesis holds that modern *H. sapiens* arose in Africa and migrated to Europe and Asia, displacing the more primitive humans living there. According to the multiregional hypothesis, modern humans originated as separately evolving populations of *H. erectus* living in several parts of Africa, Asia, and Europe. Each of these populations occasionally met and interbred with other populations, thereby preventing complete reproductive isolation.
* **Speciation** is the evolution of a new species from an ancestral population. **Allopatric speciation** occurs when one population becomes geographically isolated from the rest of the species and subsequently diverges. Speciation is more likely to occur if the original isolated population is small, because genetic drift is more significant in small populations. Examples of allopatric speciation include Death Valley pupfish, Kaibab squirrels, and Porto Santo rabbits.
* **Sympatric speciation** does not require geographic isolation.
* Sympatric speciation in plants results almost exclusively from **allopolyploidy**, in which a **polyploid** individual (one with more than two sets of chromosomes) is a hybrid derived from two species. Two examples of sympatric speciation by allopolyploidy are the kew primroses and hemp nettles.
* Sympatric speciation occurs in animals, such as fruit maggot flies and cichlids, but how often it occurs and under what conditions remain to be determined.
* **Adaptive radiation** is the process of diversification of an ancestral species into many new species. **Adaptive zones** are new ecological opportunities that were not exploited by an ancestral organism. When many adaptive zones are empty, colonizing species rapidly diversify and exploit them. Hawaiian honeycreepers and silverswords both underwent adaptive radiation after their ancestors colonized the Hawaiian Islands.
* **Extinction** is the death of a species. When species become extinct, the adaptive zones that they occupied become vacant, allowing other species to evolve and fill those zones. **Background extinction** is the continuous, low-level extinction of species. **Mass extinction** is the extinction of numerous species and higher taxonomic groups in both terrestrial and marine environments.

IMPORTANT POINTS

* Organic compounds first evolved on earth and required for origin of life were proteins and nucleic acids.
* Swan-necked flask experiment was performed by Louis Pasteur.
* Spark discharge apparatus for testing chemical origin of life was designated by Urey and Miller.
* Stanley Miller's experiment supports chemical theory.
* RNA is considered the first biological catalysed when life originated on earth.
* Homologous organs are similar origin with similar or dissimilar functions.
* 'Golden Age of Dinosaurs'/Age of reptiles was mesozoic.
* Analogous organs are different origin but similar functions.

* Vermiform appendix, ear muscles and coccyx and wisdom tooth represents vestigial organs.
* Analogous organs are wings of birds and butterfly.
* *Archaeopteryx* shows origin of birds from reptiles.
* Presence of tail and coarse hair in human baby is atavism.
* Duck-billed platypus is connecting link between reptilia and mammalia.
* Analogous organs are a result of convergent evolution.
* Mammal like reptiles evolved during permian.
* Theory of inheritance of acquired characters was given by Lamarck.
* Hugo de Vries contribution is Theory of Mutations.
* Origin of species was written by Charles Darwain.
* Species are not immutable - Lamarck
  Allopatric – Separated by space.
  Darwin's finches – unique to Galapagos
  Hugo de Vries – Evolution is discontinuous.
* Hardy-Weinberg principle explains genetic equilibrium.
* Two species occupying same or overlapping area are sympatric.
* An example of reproductive isolation is Mule.
* Hardy-Weinberg equilibrium is influenced by gene flow, genetic drift, mutation, genetic recombination and natural selection.
* Cro-Magnon Man is the closest to modern man.
* The correct sequence of stages in evolution of Modern man/Homo sapiens is *Australopithecus, Homo erectus*, Neanderthal Man, Cro-Magnon Man, Modern Man.
* Neanderthal man lived in caves.
* Cranial capacity of humans is 1470 cc.
* *Homo erectus* is scientific name of Java Man.
* *Homo erectus* is real ancestor of man.
* The primate which existed 15 mya was *Homo habilus*.
* Homo sapeins evolved during *Pleistocene*.

* **Various components of human evolution.**

S.No.	Human Ancestors	Time of Origin	General Features
1.	*Dryopithecus*	20-25 mya	Ape-like, hairy, arms and legs of same length, large brain, ate soft fruits and leaves.
2.	*Ramapithecus*	14-15 mya	More man-like, walked more erect, teeth like modern man.
3.	*Australopithecus*	3-4 mya	Fossils found in Tanzania and Ethiopia, manlike primates, 4 feet tall, walked upright, ate fruit, hunted with stone weapons, brain capacity was 400-600 cc.
4.	*Homo habilis*	2 mya	Fossils found in East Africa, first human-like being, brain capacity 650-800 cc, did not eat meat.
5.	*Homo erectus* (java man)	1.5 mya	Fossils found in Java, brain capacity 900cc, ate meat.
6.	*Homo sapiens neanderthalesis* (Neanderthal man)	100,000-40,000 year ago	Fossils found in east and central Asia, brain size 1400 cc, used hides to protect body, buried their dead.
7.	*Homo sapiens* (Modern man)	75,000-10,000 years ago	Developed cave art, agriculture, started human civilisation.

*

S.No.	Modern day Animals	Corresponding Ancient Fossil
1.	Man	*Homo sapiens neanderthalesis*
2.	Chimpanzee	*Dryopithecus*
3.	Gorilla	*Dryopithecus*
4.	Orangutan	*Dryopithecus*
5.	Gibbon	*Propliopithecus*
6.	Nautilus	*Gyroceros*
7.	Octopus	*Belemnite*
8.	Elephant	*Stegolophodon*
9.	Camel	*Procamelus*
10.	Horse	*Pliohippus*

QUESTION BANK

EXERCISE - 1 (LEVEL-1) [NCERT EXTRACT]

SECTION - 1 (VOCABULARY BUILDER)

Choose one correct response for each question.
For Q.1-Q.4
Match the column I with column II.

Q.1

	Column A	Column B
a.	*Dryopithecus*	i. 2.5 million years ago
b.	*Ramapithecus*	ii. 4 million years ago
c.	*Australopithecus*	iii. 15 million years ago
d.	*A. africanses*	iv. 25 million ears ago

(A) (a) – (i), (b) – (ii), (c) – (iii), (d) – (iv)
(B) (a) – (i), (b) – (ii), (c) – (iv), (d) – (iii)
(C) (a) – (i), (b) – (iv), (c) – (ii), (d) – (iii)
(D) (a) – (iv), (b) – (iii), (c) – (ii), (d) – (i)

Q.2

	Column I	Column II
a.	Wallace	i. Naturalselection
b.	Malthus	ii. Essay of population
c.	Hardy-Weinberg law	iii. Biston betularia
d.	Industrial melanism	iv. $(p + q)^2 = 1$

Codes
(A) (a) – (i), (b) – (ii), (c) – (iv), (d) – (iii)
(B) (a) – (i), (b) – (ii), (c) – (iii), (d) – (iv)
(C) (a) – (i), (b) – (iii), (c) – (iv), (d) – (ii)
(D) (a) – (ii), (b) – (iii), (c) – (iv), (d) – (i)

Q.3

	Column I	Column II
a.	Darwin	i. Natural selection
b.	Lamarck	ii. Inheritance of acquired character
c.	Pasteur	iii. Swan-necked experiment
d.	de Vries	iv. Mutational theory of inheritance

Codes
(A) (a) – (i), (b) – (ii), (c) – (iv), (d) – (iii)
(B) (a) – (i), (b) – (ii), (c) – (iii), (d) – (iv)
(C) (a) – (i), (b) – (iii), (c) – (iv), (d) – (ii)
(D) (a) – (ii), (b) – (iii), (c) – (iv), (d) – (i)

Q.4

	Column I	Column II
a.	Analogous organs	i. Ontogeny repeat phylogeny
b.	Miller and Urey	ii. Experiment (chemical evolution)
c.	Oparin and Haldane	iii. Chemical evolution (theory)
d.	Human embryo have gill	iv. Wings of bird and butterfly

Codes
(A) (a) – (iv), (b) – (iii), (c) – (i), (d) – (ii)
(B) (a) – (iv), (b) – (ii), (c) – (iii), (d) – (i)
(C) (a) – (i), (b) – (ii), (c) – (iii), (d) – (iv)
(D) (a) – (iv), (b) – (iii), (c) – (ii), (d) – (i)

SECTION - 2 (BASIC CONCEPTS BUILDER)

For Q.5 to Q.19 :
Choose one word for the given statement from the list.

HF Osborn, Oparin, Haldane, Miller, *Ramapithecus*, Triassic period, Convergent evolution, Ordovician period , Retrogressive evolution, Mesozoic, Hugo de Vries, Palaeontology, SW Fox , Pre-existing, 2 : 1 : 2, Sewall Wright, organic evolution.

Q.5 ____ of Russia and ____ of England proposed that the first form of life could have come from ____ non-living organic molecule.

Q.6 Study of fossils is called _____.

Q.7 The ratio of methane, ammonia and hydrogen in Stanley Miller's experiment was _____.

Q.8 Analogous organs appears as the result of _____ evolution.

Q.9 First dinosaurs and first egg-laying mammals were originated in _____.

Q.10 The concept of adaptive radiation was developed by _____.

Q.11 Mutational theory of evolution was given by ___.

Q.12 The theory of random genetic drift was proposed by _____.

Q.13 Formation of simple and less elaborated forms from the more complex and specialised one is called _____.

Q.14 Giant dinosaurs and reptiles predominated during the Jurassic period. This period was also marked the evolution of higher insects and angiosperms, conifers, cycads, etc. Jurassic period belongs to _____ era.

Q.15 The concept that the species have changed over long period of time is known as _____.

Q.16 First land plants (psilophyte) were originated in _____.

Q.17 Artificial synthesis of ATP, porphyrin and nucleotides was detained by _____.

Q.18 Name given to the fossil 'Hominid of Shivalik hills' in India is _____.

Q.19 Experimental evidence of chemical evolution was given by _____.

SECTION - 3 (ENHANCE PROBLEM SOLVING SKILLS)

Choose one correct response for each question.

PART - 1 : ORIGIN OF LIFE

Q.20 Abiogenesis means
(A) origin of eukaryotes
(B) origin of life from living organisms
(C) origin of life from non-living organisms
(D) origin of prokaryotes

Q.21 Oparin and Haldane's theory is also called –
(A) Chemical theory of origin of life
(B) Modern theory of origin of life
(C) Naturalistic theory
(D) All of the above

Q.22 The first non-cellular form of life could have originated –
(A) 3 billion years back (B) 2 billion years back
(C) 4 billion years back (D) 1 billion years back

Q.23 The first life on the earth was consisted of
(A) provirus (B) protovirus
(C) virus (D) bacteria

Q.24 Who discarded the theory of spontaneous generation forever?
(A) Louis Pasteur (B) Francisco Redi
(C) Spallanzani (D) Aristotle

Q.25 On the early earth, organic acids were produced by the combination of H_2 with –
(A) ammonia and methane
(B) hydrogen
(C) organic matter
(D) sulphates and nitrates

Q.26 What did Miller obtained from his experiment?
(A) Amino acid (B) Organic compounds
(C) Peptide (D) All of these

Q.27 Which of the following gas was absent in the atmosphere at the time of origin of life?
(A) NH_3 (B) H_2
(C) O_2 (D) CH_4

Q.28 The first cellular form of life could have originated
(A) 2000 million years back
(B) 11000 million years back
(C) 1500 million years back
(D) 500 million years back

Q.29 Most probably, the first living beings were –
(A) heterotrophs (B) chemoheterotrophs
(C) autotrophs (D) photoautotrophs

Q.30 Which of the following evolved first on the primitive earth?
(A) Viroids (B) Coacervates
(C) Cyanobacteria (D) Mycoplasma

Q.31 Theory of origin of life as a result of chemical evolution has been properly explained by –
(A) Stanley Miller (B) Darwin
(C) Oparin (D) S. Fox

Q.32 First autotrophs on the primitive earth was/were
(A) aerobic
(B) anaerobic
(C) Both (A) and (B)
(D) photosynthetic protist

Q.33 Miller synthesised simple amino acids from one of the following mixtures in his experiment
(A) CH_4, NH_3, H_2 and water vapour.
(B) H_2, O_2, N_2 and water vapour.
(C) H_2,O_2, C_2 and water vapour
(D) CH_4, NH_3, O_2 and water vapour

Q.34 The first life on the earth was developed through
(A) chemical evolution (B) penspermia
(C) biogenesis (D) abiogenesis

Q.35 Information molecule to get evolved first on the primitive earth was –
(A) Protein (B) DNA
(C) RNA (D) All of these

Q.36 Theory of spontaneous generation or abiogenesis was first disapproved by
(A) AI Oparin (B) Louis Pasteur
(C) Sydney Fox (D) Francisco Redi

PART - 2 : EVOLUTION OF LIFE FORMS

Q.37 Theory of natural selection was given by
(A) Lamarck (B) Darwin
(C) Alfred Wallace (D) JBS Haldane

Q.38 'Descent with modification' is the main theme of
(A) genetics and interpretation
(B) biogenesis
(C) evolution
(D) recapitulation

Q.39 Organic evolution means –
(A) cumulative change of living population.
(B) progressive development of an organ.
(C) development of different races.
(D) history of human races.

PART - 3 : EVIDENCES FOR EVOLUTION

Q.40 In the animals, the same structures developed along the different directions due to the adaptations to different needs. This is called –
(A) convergent evolution
(B) divergent evolution
(C) disruptive evolution
(D) directional evolution

Q.41 Anthropogenic actions that leads to evolution is the use of –
(A) herbicides (B) pesticides
(C) antibiotics (D) All of these

Q.42 What do homologous organs indicates?
(A) Different ancestry
(B) Common ancestry
(C) Independent development
(D) Dependent development

Q.43 Divergent evolution gives rise to
(A) homologous organ (B) analogous organs
(C) Both (A) and (B) (D) None of these

Q.44 Human arm is homologous to
(A) seal flipper (B) Octopus tentacle
(C) bird wing (D) Both (A) and (C)

PART - 4 : ADAPTIVE RADIATION

Q.45 Development of different functional structures from a common ancestral form is called
(A) differential evolution
(B) adaptive radiation
(C) non-adaptive radiation
(D) regressive evolution

Q.46 Development of similar adaptive functional structural features in an unrelated group of organism is called
(A) adaptive radiation
(B) adaptive convergence
(C) Both (A) and (B)
(D) evolution

Q.47 Australian marsupials are the example of –
(A) homologous radiation (B) analogous radiation
(C) adaptive radiation (D) convergent radiation

Q.48 Adaptive radiations refers to –
(A) adaptations due to geographical isolation.
(B) evolution of different species from a common ancestor.
(C) migration of the members of a species to different geographical areas.
(D) power of adaptation in an individual to a variety of environments.

PART - 5 : BIOLOGICAL EVOLUTION & MECHANISM

Q.49 First theory of evolution was given by
(A) Charles Darwin (B) Hugo de Vries
(C) Lamarck (D) Wallace

Q.50 When and who wrote the book 'The origin of species?'
(A) Mendel in 1809 (B) Wallace in 1858
(C) Lamarck in 1869 (D) Darwin in 1859

Q.51 The present concept of evolution is known as
(A) Neo-Darwinism theory of evolution.
(B) synthetic theory of evolution.
(C) modern concept theory of evolution.
(D) All of the above

Q.52 *Philosophie Zoologique* book was written by
(A) Wallace (B) Charles Darwin
(C) Lamarck (D) Hugo de Vries

Q.53 Which concept was not included in Charles Darwin's theory of natural selection?
(A) Survival of the fittest.
(B) Struggle for existence.
(C) Over production of offspring.
(D) Punctuated equilibrium.

Q.54 Which of the following factor was not taken into account by Darwin in his theory of natural selection?
(A) Struggle for existence
(B) Discontinuous variations
(C) Parasites and predators as natural enemies
(D) Survival of the fittest

Q.55 According to de Vries theory, evolution is?
(A) discontinuous (B) jerky
(C) continuous and smooth (D) Both (A) & (B)

Q.56 Origin of different types of beaks occur due to
(A) natural selection
(B) interspecific competition
(C) genetic drift
(D) interspecific variation

Q.57 Which of the following is a unit of natural selection?
(A) Genus (B) Species
(C) Individual (D) Population

Q.58 According to the Neo-Darwinian theory, which of the following is responsible for the origin of new species?
(A) Mutations
(B) Useful variations
(C) Mutation together with natural selection
(D) Hybridisation

Q.59 Rapid evolution of a number of new taxa in a short span of time due to large scale of environmental change is called –
(A) coevolution (B) quantum evolution
(C) convergent evolution (D) divergent evolution

Q.60 Lamarck's theory of evolution is also known as
(A) theory of acquired characters.
(B) theory of genetic characters.
(C) theory of spontaneous characters.
(D) theory of impose characters.

Q.61 Identify the phenomenon in which the members of a species do not interbreed with the members of other species or same species.
(A) Habitat species
(B) Geographical isolation
(C) Temporal isolation
(D) Reproductive isolation

Q.62 What is meant by the term 'Darwin fitness'
(A) The ability to survive and reproduce.
(B) High aggressiveness.
(C) Healthy appearance.
(D) Physical strength.

Q.63 Some persons can move their pinnae. This ability is imparted by
(A) recapitulation (B) atavism
(C) over specialisation (D) regeneration

Q.64 Example of convergent evolution is
(A) Darwin finches and marsupial mouse
(B) Placental wolf and Tasmanian wolf
(C) Placental wolf and Darwin finches
(D) Tasmanian wolf and marsupial mouse

Q.65 Which of the following are homologous organs?
(A) Wing of butterfly, wing of bird, wing of bat
(B) Forelimb of frog, wing of bird, forelimb of rabbit, flipper of whale.
(C) Thoracic leg of cockroach, hindleg of frog, forelimb of rabbit.
(D) Wing of bird, wing of bat, wing of flying lizard.

Q.66 'Population tends to increase geometrically, while food supply increases arithmatically'. This concept was put forward by
(A) TR Malthus (B) Struart Mill
(C) Charles Darwin (D) Adam Smith

PART - 6 : HARDY-WEINBERG PRINCIPLE

Q.67 Identify the phenomenon in which a new set of population is formed from the set of existing population due to the excessive change in the allele frequency.
(A) Founder effect
(B) Evolutionary effect
(C) Bottle-neck effect
(D) None of the above

Q.68 A population containing a gene 'X' with two alleles 'Aa' is in Hardy-Weinberg equilibrium for gene 'X'. If the gene frequency of allele 'A' is 0.2, allele frequency of 'a' is
(A) 0.2 (B) 0.42
(C) 0.8 (D) 1

Q.69 Genetic equilibrium refers to phenomenon that
(A) the traits remains constant in a population.
(B) the total genes remains constant in a population.
(C) the total genes keeps on varying in a population.
(D) traits keeps on varying in a population.

Q.70 Evolution is the –
(A) disturbance in the genetic equilibrium.
(B) disturbance in Hardy-Weinberg principle.
(C) change in frequency of alleles in population.
(D) All of the above.

Q.71 Mutation results in –
(A) change in gene frequency
(B) stabilisation of allele frequency
(C) change in phenotypic frequency
(D) stabilisation of selection pressure

Q.72 Hardy-Weinberg principle can be expressed as
(A) $p^2 + 3pq + q^2 = 1$
(B) $p^2 + 2pq + q^2 \geq 1$
(C) $p^2 + 2pq + q^2 \leq 1$
(D) $p^2 + 2pq + q^2 = 1$

PART - 7 : BRIEF ACCOUNT OF EVOLUTION

Q.73 The Cenozoic era is often designated as –
(A) age of fish (B) age of reptiles
(C) age of mammals (D) age of amphibians

Q.74 Which era is called the age of angiosperms?
(A) Cenozoic era (B) Mesozoic era
(C) Proterozoic era (D) Palaeozoic era

Q.75 In which epoch, only modern humans prevails?
(A) Pleiostocene (B) Holocene
(C) Pliocene (D) Miocene

Q.76 The most recent era in geological time scale is
(A) Mesozoic (B) Cenozoic
(C) Palaeozoic (D) Proterozoic

Q.77 Trilobites were evolved during which of following periods?
(A) Silurian (B) Cambrian
(C) Ordovician (D) Precambrian

Q.78 During which period the first seed plant appeared
(A) Silurian (B) Devonian
(C) Carboniferous (D) Cretaceous

Q.79 There was no life in
(A) Cenozoic era (B) Mesozoic era
(C) Palaeozoic era (D) Azoic era

Q.80 In which of the following era first mammal like reptile originated?
(A) Permian period (B) Triassic period
(C) Jurassic period (D) Tertiary period

Q.81 Which of the following is an extinct animal?
(A) *Protopterus* (B) *Equus*
(C) *Archaeopteryx* (D) *Columba*

PART - 8 : ORIGIN AND EVOLUTION OF MAN

Q.82 First human like hominid is known as –
(A) Neanderthal man (B) *Homo habilis*
(C) *Dryopithecus* (D) *Homo erectus*

Q.83 Which of the following presumbly possesses a cranial capacity larger then modem man?
(A) Neanderthal man (B) Peking man
(C) *Australopithecus* (D) Cro-magnon man

Q.84 Scientific name of Solo man is
(A) *Homo soloensis* (B) Neanderthal
(C) *Ramapithecus* (D) *Homo erectus*

Q.85 Which of the following is the most primitive ancestor of man?
(A) *Homo habilis*
(B) *Homo neanderthalensis*
(C) *Australopithecus*
(D) *Ramapithecus punjabicus*

Q.86 Somatic cells of gorilla, chimpanzee and orangutan have –
(A) 44 chromosomes (B) 42 chromosomes
(C) 46 chromosomes (D) 48 chromosomes

Q.87 The stage next to *Homo habilis* was –
(A) *Homo erectus* (B) *Homo sapiens*
(C) *Dryopithecus* (D) Neanderthal man

Q.88 *Australopithecus africanus* is also known as
(A) first ape man (B) modern man
(C) erect man (D) cro-magnon man

Q.89 Brain (cranial) capacity of *Homo hahilis* was –
(A) 750-850 cc (B) 750-800 cc
(C) 650-700 cc (D) 550-700 cc

Q.90 Modern man differs from the apes in –
(A) proturding eyes
(B) sparse body hairs
(C) wearing of clothes
(D) arms shorter than legs

Q.91 Which one of the following is the most primitive ancestor of man?
(A) *Homo habilis*
(B) *Australopithecus*
(C) *Ramapithecus punjabicus*
(D) *Homo neanderthalensis*

EXERCISE - 2 (LEVEL-2)

Choose one correct response for each question.

Q.1 Name of the scientist who gave Mutation Theory
(A) Wallace (B) Mathus
(C) Darwin (D) De Vries

Q.2 Darwin's Theory of Natural Selection was based on –
(A) Inheritance of acquired characters
(B) Mutation
(C) Enormous rate of reproduction in organisms, struggle for existence and survival of the fittest.
(D) Changes due to the use and disuse of organ.

Q.3 What was the basic principle of Lamarckism –
(A) Inheritance of acquired characters
(B) Survival of the fittest
(C) Natural selection
(D) Variations

Q.4 Select the wrong statements
I. Swan-neck flask experiment was performed by Louis Pasteur.
II. Louis Pasteur is famous for germ theory of disease.
III. Louis Pasteur disapproved spontaneous theory forever.
IV. Cosmozoic theory of origin of life was proposed by Richter.
V. Theory of catatrophism was given by Georges Cuvier.
Choose the correct option.
(A) I, II and IV (B) I, III and IV
(C) III, IV and V (D) None of these

Q.5 Diversity in the type of beaks of finches adapted to different feeding habits on the Galapagos islands as observed by Darwin provides evidence for –
(A) Origin of species by natural selection
(B) Intraspecific variations
(C) Interspecific variations
(D) Interspecific competition

Q.6 Which scientist gave the initial idea of survival of the fittest
(A) Wallace (B) Spencer
(C) Darwin (D) Mendel

Q.7 New breeds in domestic dogs are developed by–
(A) Sexual selection (B) Natural selection
(C) Youth selection (D) Artificial selection

Q.8 Darwin explained origin of species through –
(A) Hybridization (B) Mutation
(C) Acquired characters (D) Natural selection

Q.9 The ship on which Darwin worked as naturalist was –
(A) Beagle (B) Century
(C) Seagel (D) Norway

Q.10 There would be no evolution if –
(A) The inheritance of acquired characters did not take place.
(B) Somatic variations were not inheritable
(C) Genetic variations were not found among members of population.
(D) Somatic variations would not transform into germinal variations.

Q.11 The book Origin of Species was published in the year –
(A) 1956 (B) 1809
(C) 1859 (D) 1844

Q.12 Darwin was influenced by the writings of –
(A) Malthus (B) Wallace
(C) Lyell (D) All of them

Q.13 If population of a species is transferred to more suitable environment then it will show –
(A) Protection against enemies
(B) More individuals would survive
(C) Rate of reproduction increases
(D) Unlimited food would be available

Q.14 The weakest point of Darwinism was that it had no explanation for –
(A) Struggle for existence
(B) Survival of the fittest
(C) Variations
(D) Enormous rate of production

Q.15 Snakes do not have legs because –
(A) Legs are lost during their entry in tunnels.
(B) Legs are lost during evolution.
(C) The ancestors of reptiles did not have legs.
(D) There are no legs in lizards.

Q.16 Which of the following facts develop suspicions in Lamarckism –
(A) Human females are not born with bored ear pinna although they have beer bored for thousands of years.
(B) Giraffe has long neck to eat leaves of tall trees.
(C) A stag can run fast to protect against the enemies.
(D) None of them

Q.17 Which primate is closest to man regarding organic evolution –
(A) Gibbon (B) Gorilla
(C) Sinanthropus (D) Orangutan

Q.18 The prehistoric man who lived on earth during late Pleistocene period –
(A) Neanderthal man (B) Australopithecus
(C) Java man (D) Atlantic man

Q.19 Which character applies to Homo sapiens –
(A) Opposable toe
(B) Large canine
(C) Cranial capacity 1450 cc
(D) Chin prominence absent

Q.20 Fossils of Pithecanthropus have been recovered from –
(A) China (B) Germany
(C) Java (D) Japan

Q.21 Ancestor of man who first time showed bipedal movement
(A) Cro-magnon (B) Australopithecus
(C) Java apeman (D) Peking man

Q.22 Homo erectus is biological name of –
(A) Modern man (B) Neanderthal man
(C) Java man (D) Peking & Java man

Q.23 Homo erectus differed from Cro-magnon man in having –
(A) Jaws protruding out (B) Tool making
(C) Sloping jaws (D) Arts and paintings

Q.24 The probable direct ancestor of modern man is :
(A) Java man (B) Peking man
(C) Cromagnon man (D) Neanderthal man

Q.25 The probable first prehistoric man was –
(A) Ramapithecus (B) Homo habilis
(C) Australopithecus (D) Zinjanthropus

Q.26 Which of the following statement is correct –
(A) Proconsul was ancestor of man and ape.
(B) Proconsul was ancestor of man and not of ape.
(C) Apes were ancestor of man anatomically.
(D) None of them

Q.27 Scientific name of man is –
(A) *Canis familiaris* (B) *Homo habilis*
(C) *Homo erectus* (D) *Homo sapiens*

Q.28 The first ancestor of man whose fossils have been discovered was –
(A) Pithecanthropus (B) Zinjanthropus
(C) Australopithecus (D) Neanderthal man

Q.29 On which continent maximum fossils of prehistoric man have been found –
(A) Africa (B) Europe
(C) Asia (D) America

Q.30 Genetic drift operates only in –
(A) Island population
(B) Smaller population
(C) Larger population
(D) Mendalian population

Q.31 The fossil of primitive man recovered from shivalik hills in India –
(A) Oligopithecus (B) Paranthropus
(C) Ramapithecus (D) Propliopithecus

Q.32 What was the cranial capacity of java man:
(A) 400 cc (B) 650 cc
(C) 900 cc (D) 1450 cc

Q.33 Who discovered Java ape man –
(A) Leakey (B) Mayr
(C) Davidson Black (D) Dubois

Q.34 The proper burial of dead for the first time started with which prehistoric man –
(A) Peking man (B) Neanderthal man
(C) Java man (D) Cromagnon man

Q.35 Evolution of man was possible because our ape like ancestors –
(A) Showelbipedal movement on open land
(B) Used fire
(C) Felt difficulty in nutrition
(D) Developed community hunting

Q.36 What is the contribution of W.C. Pei –
(A) He discovered Cro-magnon man
(B) He discovered peking man
(C) He discovered Java man
(D) None of them

Q.37 C.Fuhlrott made an important discovery in evolution and he discovered –
(A) Neanderthal man
(B) Cro-magnon man
(C) Classification of man
(D) Characters of modern apes

Q.38 Cranial capacity of Cro-magnon man was –
(A) 900 cc (B) 1075 cc
(C) 1450 cc (D) 1600 cc

Q.39 Characteristics of primitive monkey which was in the direction of evolution of man :
(A) Thumb parallel to fingers (B) 32 teeth
(C) Prehensile tail (D) Rat nose

Q.40 Successful adaptation simply means:
(A) An increase in fitness
(B) Producing offsprings
(C) Moving to a new place
(D) Evolving new characters

Q.41 Which fossil man had cranial capacity almost equal to modern man :
(A) Australopithecus (B) Java ape man
(C) Neanderthal man (D) Peking man

Q.42 Fire for protection and cooking was first used by –
(A) Neanderthal man (B) Cro-magnon man
(C) Java man (D) Peking man

Q.43 Lamarck's theory is an evergreen superstition was reported by –
(A) Charles Darwin (B) Darlington
(C) Hugo de Vries. (D) Carlson

Q.44 Largest cranial capacity was found in –
(A) Peking man (B) Neanderthal man
(C) Java man (D) Cro-magnon man

Q.45 Founder of Palaeontology is –
(A) Lamarck (B) Erasmus Darwin
(C) G Cuvier (D) Empedocles

Q.46 Which of the following cannot be explained by Lamarckism
(A) Absence of lips in snakes
(B) Long neck of giraffe
(C) Degeneration of visual apparatus in cave dwellers
(D) Dull progeny of Noble Laureate

Q.47 Selecting the genetically improved domesticated plants and animals by man is –
(A) Natural selection (B) Artificial selection
(C) Hybrid selection (D) Any of above

Q.48 Theory of Pangenesis was proposed by :
(A) Lamarck (B) Darwin
(C) Hugo de Vries (D) Dobzhansky

Q.49 Organic compounds first evolved on earth and required for origin of life were –
(A) Urea and amino acid
(B) Protein & nucleic acid
(C) Protein and amino acid
(D) Urea and nucleic acid

Q.50 Speciation occurs when –
(A) Populations are isolated by geographical barrier
(B) Populations are reproductively isolated
(C) Both of these
(D) None of these

Q.51 Struggle for existence and survival of fittest are related to–
(A) Lamarckism (B) Darwinism
(C) Oparin's theory (D) Mendelism

Q.52 Lamarckism fails to explain –
(A) Long neck of giraffe
(B) Loss of limbs in snake
(C) Presence of tail in mouse
(D) Webbed feet in swimming birds

Q.53 Gene frequency in a population remains stable unless and until there is –
(A) Random drift (B) Random mating
(C) Selection (D) Mutation

Q.54 Which is most important in speciation –
(A) Geographical isolation
(B) Reproductive isolation
(C) Ecological isolation
(D) Ethological isolation

Q.55 Darwin's explanation of the way in which evolution occurs
(A) God determines which species should evolve.
(B) Progressive adaptations enable one species to leave more offsprings.
(C) Certain species have 'built in' plans of evolution.
(D) Those traits used most often persist longer.

Q.56 Life cannot originate from inorganic materials upon the present earth because of
(A) High pollution
(B) Low temperature of earth
(C) Large amount of oxygen in atmosphere
(D) High temperature of earth

Q.57 The modern human skull lacks
(A) small canines
(B) a foramen magnum centered in the base of the skull
(C) pronounced supra orbital ridges
(D) a U-shaped arrangement of teeth on the jaw

Q.58 The correct chronological order of geological eras, starting with the oldest, is
(A) Paleozoic, Cenozoic, and Mesozoic
(B) Mesozoic, Cenozoic,and Paleozoic
(C) Mesozoic, Paleozoic, and Cenozoic
(D) Paleozoic,Mesozoic, and Cenozoic

Q.59 The time of greatest evolutionary diversification in the history of life occurred during the
(A) Cambrian period
(B) Ordovician period
(C) Silurian period
(D) Carboniferous period

Q.60 The Earth is thought to be about how many years old?
(A) 10-20 billion (B) 4,000
(C) 3.5 billion (D) 4.6 billion

Questions 61-65

Refer to the fields of study listed below. Choose the one that has provided each of the following pieces of evidence that biological evolution has occurred.
(A) Comparative biochemistry
(B) Comparative anatomy
(C) Comparative embryology
(D) Geographic distribution

Q.61 Giraffes have the same number of vertebrae in the neck as do humans.

Q.62 Kangaroos are found in only Australia.

Q.63 Human embryos have tails.

Q.64 Humans and sea stars both have radial cleavage in early embryonic development.

Q.65 Humans can be made temporarily immune to various human diseases by receiving antibodies against those diseases from horses.

Q.66 The Greek philosopher is considered the first student of natural history. His ideas on classification of organisms still influenced thinking in Darwin's time.
(A) Archimedes (B) Aristotle
(C) Euclid (D) Plato

Q.67 Which of the following structures is NOT homologous with the others?
(A) a bat's wing (B) a fly's wing
(C) a human arm (D) a whale's flipper

Q.68 Fossils collected from the same geologic stratum are probably similar in .
(A) age (B) appearance
(C) size (D) structure

Q.69 Jean Baptiste de Lamark proposed as mechanism of evolution.
(A) DNA analysis
(B) the inheritance of acquired characteristics
(C) the principle of use and disuse
(D) B and C

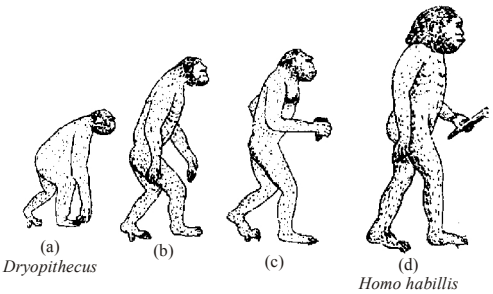
Q.70 Miller's classic experiment demonstrated that a discharge of sparks through a mixture of gases could result in the formation of a large variety of organic compounds. Miller used all of the following gases in his experiment EXCEPT
(A) methane (B) ammonia
(C) water (D) oxygen

Q.71 Far a long time it was believed that life came out of decaying and rotting matter like straw mud, etc. This was the theory of –
(A) catastrophism (B) abiogenesis
(C) panspermia (D) chemogeny

Q.72 Choose the homologous organs from the options.
I. Vertebrate hearts.
II. Vertebrate brains.
III. Thorn and tendrils of *Bougainvillea* and *Cucurbita*.
IV. Vertebrate limbs.
The correct combination is
(A) I and II (B) II and III
(C) III and IV (D) I, II and III

Q.73 Which of the following examples supports Lamarckism?
(A) Webbed toes of aquatic bird
(B) Cave dwellers
(C) Flightless bird
(D) All of these

Q.74 Give the name of b and c.



(A) b-*Ramapithecus*; c-*Homo erectus*
(B) b-*Ramapithecus*; c-*Australopithecus*
(C) b-*Australopithecus*; c-*Ramapithecus*
(D) b-*Australopithecus*; c-*Homo erectus*

Q.75 Select the examples which favours the mutational theory of evolution.
I. Ancon sheep II. Hornless cattle
III. Cicer gigas IV. Noval oranges
V. Hairless cat VI. Double toed cat
The correct combination is –
(A) I, II and III (B) III, IV and V
(C) IV, V and VI (D) I, II, III, IV, V and VI

Q.76 'XX' lived 100000-40000 years ago, in Europe. Asia and Africa. 'XX' was short stature, hairy eyebrows, sctreating forehead and large jaws. Identify 'XX'
(A) Neanderthal man (B) *Homo bebilis*
(C) Cro-magnon man (D) *Dryopithecus*

Q.77 Genus *Homo erectus* includes 3 fossil(s) namely.
I. Java ape man II. Neanderthal man
III. Cro-magnon man IV. Peking man
V. Heidelberg man
The correct options is
(A) I, II and III (B) II, III and IV
(C) I, IV and V (D) III, IV and V

Q.78 The sequence of origin of life could be
(A) organic materials → inorganic materials → colloidal aggregate → eobiont → cell
(B) inorganic materials → organic materials → colloidal aggregates → eobiont → cell
(C) inorganic materials → organic ma.terials → eobiont → cell → colloidal aggregate
(D) organic materials → inorganic materials → eobiont → cell → colloided aggregate

Q.79 Which of the following is the first vascular plant to be represented by an extinct group?
(A) Bryophytes (B) Lycopods
(C) Conifers (D) Cycads

Q.80 In human beings, vestigial organs are
(A) wisdom teeth, coccyx, vermiform appendix, nail eyelid.
(B) wisdom teeth, coccyx, vermiform appendix, pancreas, elbow joint.
(C) wisdom teeth, coccyx, vermiform appendix, nictitating membrane, auricular muscles
(D) coccyx, wisdom teeth, nail, auricular muscles.

Q.81 Which of the following statement is correct regarding the evolution of humans?
I. The skull of adult chimpanzee is more like adult human skull than baby chimpanzee skull.
II. The skull of baby chimpanzee is more like adult human than adult chimpanzee skull.
III. *Dryopithecus* is oldest human like fossil.
IV. *Dryopithecus* was found in Miocene rock of Africa and Europe.
The correct option is
(A) I and II (B) I and III
(C) I and IV (D) All except I

Q.82 'Darwin's natural selection theory' could not explain –
(A) retention of characters of no use or vestigial organ.
(B) giraffe has long neck
(C) giraffe has long legs
(D) survival of the fittest

Q.83 Separate the following into homologous and analogous organs.
I. Sweet potato II. Potato
III. Filippers of penguins and dolphins.
IV. Hearts of different vertebrate.
V. Forelimbs of whales, bat and cheetah.
The correct option is
(A) Homologous organs = I, II, III
Analogous organs = IV, V
(B) Homologous organs = IV, V
Analogous organs = I, II, III
(C) Homologous organs = I, II
Analogous organs = III, IV, V
(D) Homologous organs = I, II, V
Analogous organs = IV, III

Q.84 Correct order of evolutionary scale is
(A) Palaeozoic → Archaeozoic → Cenozoic
(B) Archaeozoic → Palaeozoic → Proterozoic
(C) Palaeozoic → Mesozoic → Cenozoic
(D) Mesozoic → Archaeozoic → Proterozoic

Q.85 Industrial melanism was highlighted in
(A) *Mimosa pudica* (B) *Triticum aestivum*
(C) *Biston betularia* (D) *Rock python*

Q.86 A population exhibiting Hardy-Weinberg equilibrium possesses 25% recessive traits. Find out the frequency of recessive alleles in the gene pool of the same population.
(A) 0.5 (B) 0.4
(C) 0.3 (D) None of these

Q.87 Arrange the following events of modern concept of evolution sequentially.
I. Genetic variations in population
II. Natural selection III. Heredity
IV. Isolation V. Speciation
The correct option is
(A) I, II, III, IV, V (B) I, III, II, IV, V
(C) I, IV, III, II, V (D) I, IV, II, III, V

EXERCISE - 3 (LEVEL-3)

Choose one correct response for each question.

Q.1 Which is a key component of Darwin's theory?
(A) descent with modification
(B) inheritance of acquired characteristics
(C) special creation
(D) spontaneous generation

Q.2 Which of the following is least likely to have occurred after a small population of finches reached the Galapagos Islands from the South American mainland?
(A) after many generations, the became increasingly different from the original population.
(B) over time, the finches adapted to their new environment
(C) after many generations, the finches were unchanged and unmodified in any way
(D) the finches were unable to survive in their new home and died out.

Q.3 Humans have bred dairy cows to produce 100 pints of milk per day. Choose the correct option
(A) Stabilizing selection
(B) Disruptive selection
(C) Directional selection
(D) Artificial selection

Q.4 Adaptive radiation is common following a period of mass extinction, probably because
(A) the survivors of a mass extinction are remarkably well adapted to their environment.
(B) the unchanging environment following a mass extinction drives the evolutionary process.
(C) many adaptive zones are empty.
(D) many ecological niches are filled.

Q.5 According to DNA sequence data, the closest living relative of whales and other cetaceans is the
(A) hippopotamus (B) camel
(C) anteater (D) Basilosaurus

Q.6 The comparison of genetic material from individuals of regional populations of humans, used to help unravel the origin and migration of modern humans, is known as
(A) paleoarchaeology
(B) cultural anthropology
(C) molecular anthropology
(D) cytogenetics

Q.7 Place the following hominids in chronological order of appearance, beginning with the earliest: *H. habilis, H. sapiens, H. neanderthalensis, and H. erectus.*
(A) *H. habilis, H. erectus, H. sapiens, H. neanderthalensis*
(B) *H. erectus, H. habilis, H. sapiens, H. neanderthalensis*
(C) *H. erectus, H. habilis, H. neanderthalensis, H. sapiens*
(D) *H. habilis, H. erectus, H. neanderthalensis, H. sapiens*

Q.8 Populations of the same species occupying different environments may exhibit over time.
(A) evolutionary convergence
(B) evolutionary divergence
(C) orthogenesis
(D) stratification

Q.9 The condition in which there are barriers to successful interbreeding between individuals of different species in the same community is referred to as
(A) sexual dependency
(B) reproductive isolation
(C) geographic isolation
(D) adaptive radiation

Q.10 Microevolution may be synonymous with
(A) adaptation (B) gradualism
(C) historical biogeography (D) mutationism

Q.11 Comparing the of organisms can often yield information about evolutionary relationships.
(A) embryology (B) macromolecules
(C) morphology (D) all of the above

Q.12 The greatest mass extinction episode in the history of life occurred at what boundary?
(A) Pliocene-Pleistocene
(B) Permian-Triassic
(C) Mesozoic-Cenozoic
(D) Cambrian-Ordovician

Q.13 The first primates evolved about 55 mya from
(A) shrewlike monotremes
(B) therapsids
(C) shrewlike placental mammals
(D) tarsiers

Q.14 The oldest evidence of bipedalism is found in the tibia of
(A) *Australopithecus afarensis*
(B) *Australopithecus anamensis*
(C) *Australopithecus africanus*
(D) *Homo erectus*

Q.15 The Mesozoic era is divided into three periods, which are
(A) Cambrian, Ordovician, and Silurian
(B) Devonian, Carboniferous, and Permian
(C) Triassic, Jurassic, and Cretaceous
(D) Cretaceous, Tertiary, and Quaternary

Q.16 Evidence exists that a catastrophic collision between Earth and a large extraterrestrial body occurred 65 mya, resulting in the extinction of
(A) Precambrian worms, mollusks, and soft-bodied arthropods.
(B) Jawless ostracoderms and jawed placoderms.
(C) Dinosaurs, pterosaurs, and many gymnosperm species
(D) Mastodons, saber-toothed cats, and giant ground sloths.

Q.17 Which part of the theory of evolution did Darwin develop after reading Thomas Malthus?
(A) Evolution occurs as advantageous traits accumulate in a population.
(B) In any population, there is variation and an unequal ability of individuals to survive and reproduce.
(C) Only the best-fit individuals survive and get to pass on their traits to offspring.
(D) Populations tend to grow exponentially, overpopulate, and exceed their resources.

Q.18 In a population of 1,000 people, 90 have blue eyes. What percent of the population has hybrid brown eyes?
(A) 3% (B) 9%
(C) 21% (D) 42%

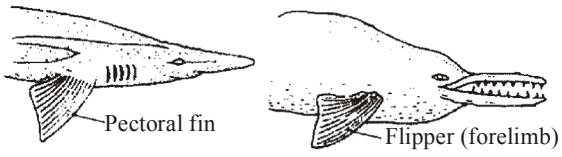
Q.19 Flowering plants and mammals diversified and became dominant during the –
(A) Paleozoic era (B) Mesozoic era
(C) Cenozoic era (D) Devonian period

Q.20 About how many years passed between the Earth's formation and the appearance of recognizable cells?
(A) 10 million (B) 100 million
(C) 800 million (D) five billion

Q.21 The establishment of a genetically unique population through genetic drift.
Choose the correct option
(A) Founder effect (B) Parallel evolution
(C) Adaptive radiation (D) Convergent evolution

Q.22 The independent development of similarities between unrelated groups resulting from adaptation to similar environments.
Choose the correct option
(A) Founder effect
(B) Parallel evolution
(C) Adaptive radiation
(D) Convergent evolution

Q.23 Diagram given below indicates.



(A) Homologous organs (B) Analogous organs
(C) Atavism (D) Divergent evolution

Q.24 The chronological order of human evolution from early to the recent stages is –
(A) *Ramapithecus* → *Australopithecus* → *Homo habilis* → *Homo erectus*
(B) *Australopithecus* → *Ramapithecus* → *Homo habilis* → *Homo erectus*
(C) *Pithecanthropus pekinensis* → *Homo habilis* → *Homo erectus*
(D) *Australopithecus* → *Ramapithecus* → *Pithecanthropus pekinensis* → *Homo erectus*

Q.25 Arrange the periods of Palaeozoic era in ascending order of a geological time scale.
(A) Cambrian → Ordovician → Silurian → Devonian → Carboniferous → Permian
(B) Cambrian → Devonian → Ordovician → Silurian → Carboniferous → Permian
(C) Cambrian → Ordovician → Devonian → Silurian → Carboniferous → Permian
(D) Silurian → Devonian → Cambrian → Ordovician → Permian → Carboniferous

Q.26 Lamarck's concept of inheritance of acquired characters was discarded by
I. Mendel's laws of inheritance
II. Theory of natural selection
III. Mutational theory
IV. Theory of continuity of germplasm
Choose the correct combination of the given options to complete the given statement.
(A) I and II (B) II and III
(C) I and IV (D) III and IV

Note (Q.27-Q.33) :
(A) Statement- 1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True ; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement- 2 is False.
(D) Statement-1 is False, Statement -2 is False.

Q.27 **Statement 1 :** Natural selection is the outcome of difference in survival and reproduction among individuals that show variation in one or more traits.
Statement 2 : Adaptive forms of a given trait tend to become more common; less adaptive ones become less common or disappear.

Q.28 **Statement 1 :** Ginkgo biloba is a living fossil.
Statement 2 : Organism which have persisted and remain unchanged for the past several million years while their relative disappeared.

Q.29 **Statement 1 :** Earliest organisms that appeared on the earth were non-green and presumably anaerobes.
Statement 2 : The first autotrophic organisms were the chemoautotrophs that never released oxygen.

Q.30 **Statement 1 :** Coacervates are believed to be the precursors of life.
Statement 2 : Coacervates are self-duplicating aggregates of proteins surrounded by lipid bilayer.

Q.31 **Statement 1 :** Animals adopt different strategies to survive in hostile environment.
Statement 2 : Praying mantis is green in colour, which merges with plant foliage.

Q.32 **Statement 1 :** Natural selection is an outcome of the differences in survival and reproduction among individuals that shows variations in one or more traits.
Statement 2 : Adaptive forms of a given trait tends to become more common. Less adaptive ones becomes less common or disappear.

Q.33 **Statement 1 :** Among the primates, chimpanzee is the closest relative of the present day humans.
Statement 2 : The banding pattern in the autosome number 3 & 6 of man and chimpanzee is remarkably similar.

EXERCISE - 4 (PREVIOUS YEARS AIPMT/NEET EXAM QUESTIONS)

Choose one correct response for each question.

Q.1 According to Darwin, the organic evolution is due to **[NEET 2013]**
(A) Competition within closely related species
(B) Reduced feeding efficiency in one species due to the presence of interfering species
(C) Intraspecific competition
(D) Interspecific competition

Q.2 The tendency of population to remain in genetic equilibrium may be disturbed by **[NEET 2013]**
(A) Lack of mutations
(B) Lack of random mating
(C) Random mating
(D) Lack of migration

Q.3 Variation in gene frequencies within populations can occur by chance rather than by natural selection, this is referred as – **[NEET 2013]**
(A) Random mating (B) Genetic load
(C) Genetic flow (D) Genetic drift

Q.4 The process by which organisms with different evolutionary history evolve similar phenotypic adaptations in response to a common environmental challenge, is called **[NEET 2013]**
(A) Non-random evolution
(B) Adaptive radiation
(C) Natural selection
(D) Convergent evolution

Q.5 The eye of octopus and eye of cat show different patterns of structure, yet they perform similar function. This is an example of **[NEET 2013]**
(A) Analogous organs that have evolved due to convergent evolution
(B) Analogous organs that have evolved due to divergent evolution
(C) Homologous organs that have evolved due to convergent evolution.
(D) Homologous organs that have evolved due to divergent evolution.

Q.6 In a population of 1000 individuals 360 belong to genotype AA, 480 to Aa and the remaining 160 to aa. Based on this data, the frequency of allele A in the population is – **[AIPMT 2014]**
(A) 0.4 (B) 0.5
(C) 0.6 (D) 0.7

Q.7 Forelimbs of cat, lizard used in walking; forelimbs of whale used is swimming and forelimbs of bats used in flying are an example of **[AIPMT 2014]**
(A) Analogous organs
(B) Adaptive radiation
(C) Homologous organs
(D) Convergent evolution

Q.8 Which of the following are analogous structures? **[AIPMT 2014]**
(A) Wings of bat and wings of pigeon.
(B) Gills of prawn and lungs of man.
(C) Thorns of Bougainvillea and tendrils of Cucurbita.
(D) Flippers of dolphin and legs of horse.

Q.9 A population will not exist in Hardy-Weinberg equilibrium if **[AIPMT 2015]**
(A) There is no migration
(B) The population is large
(C) Individuals mate selectively
(D) There are no mutations

Q.10 Which is the most common mechanism of gentic variation in the population of a sexually reproducing organism ? **[AIPMT 2015]**
(A) Genetic drift
(B) Recombination
(C) Transduction
(D) Chromosomal aberrations

Q.11 Which of the following had the smallest brain capacity ? **[AIPMT 2015]**
(A) *Homo neanderhalesis* (B) *Homo habilis*
(C) *Homo erectus* (D) *Homo spaiens*

Q.12 The wings of a bird and the wings of an insect are – **[RE-AIPMT 2015]**
(A) Phylogenetic structures and represent divergent evolution
(B) Homologous structures and represent convergent evolution
(C) Homologous structures and represent divergent evolution
(D) Analogous structures and represent convergent evolution

Q.13 Industrial melanism is an example of **[RE-AIPMT 2015]**
(A) Mutation (B) Neo-Lamarckism
(C) Neo-Darwinism (D) Natural selection

Q.14 Which of the following structures is homologus to the wing of a bird? **NEET 2016 PHASE 1]**
(A) Dorsal fin of a Shark (B) Wing of a Moth
(C) Hind limb of Rabbit (D) Flipper of Whale

Q.15 Following are the two statements regarding the origin of life **[NEET 2016 PHASE 1]**
(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.
On the above statements which one of the following options is correct?
(A) (a) is correct but (b) is false
(B) (b) is correct but (a) is false
(C) Both (a) & (b) are correct
(D) Both (a) & (b) are false

Q.16 Analogous structures are a result of **[NEET 2016 PHASE 1]**
(A) Divergent evolution
(B) Convergent evolution
(C) Shared ancestry
(D) Stabilizing selection

Q.17 Genetic drift operates in **[NEET 2016 PHASE 2]**
(A) Small isolated population
(B) Large isolated population
(C) Non-reproductive population
(D) Slow reproductive population

Q.18 In Hardy-Weinberg equation, the frequency of heterozygous individual is represented by **[NEET 2016 PHASE 2]**
(A) p^2 (B) 2pq
(C) pq (D) q^2

Q.19 The chronological order of human evolution from early to the recent is **[NEET 2016 PHASE 2]**
(A) *Australopithecus* → *Ramapithecus* → *Homo habilis* → *Homo erectus*
(B) *Ramapithecus* → *Australopithecus* → *Homo habilis* → *Homo erectus*
(C) *Ramapithecus* → *Homo habilis* → *Australopithecus* → *Homo erectus*
(D) *Australopithecus* → *Homo habilis* → *Ramapithecus* → *Homo erectus*

Q.20 Which of the following is the correct sequence of events in the origin of life? **[NEET 2016 PHASE 2]**
(i) Formation of protobionts
(ii) Synthesis of organic monomers
(iii) Synthesis of organic polymers
(iv) Formation of DNA-based genetic systems
(A) (i) (ii) (iii) (iv) (B) (i) (iii) (ii) (iv)
(C) (ii) (iii) (i) (iv) (D) (ii) (iii) (iv) (i)

Q.21 According to Hugo de Vries, the mechanism of evolution is **[NEET 2018]**
(A) Phenotypic variations
(B) Saltation
(C) Multiple step mutations
(D) Minor mutations

Q.22 Among the following sets of examples for divergent evolution, select the incorrect option : **[NEET 2018]**
(A) Brain of bat, man and cheetah
(B) Heart of bat, man and cheetah
(C) Forelimbs of man, bat and cheetah
(D) Eye of octopus, bat and man

Q.23 The similarity of bone structure in the forelimbs of many vertebrates is an example of **[NEET 2018]**

(A) Convergent evolution
(B) Analogy
(C) Homology
(D) Adaptive radiation

Q.24 Match the hominids with their correct brain size

(a) *Homo habilis*	(i) 900 cc
(b) *Homo neanderthalensis*	(ii) 1350 cc
(c) *Homo erectus*	(iii)650-800 cc
(d) *Homo sapiens*	(iv) 1400 cc

Select the correct option. **[NEET 2019]**

(A) a-(iii), b-(i), c-(iv), d-(ii)
(B) a-(iii), b-(ii), c-(i), d-(iv)
(C) a-(iii), b-(iv), c-(i), d-(ii)
(D) a-(iv), b-(iii), c-(i), d-(ii)

Q.25 Variations caused by mutation, as proposed by Hugo de Vries are **[NEET 2019]**

(A) random and directional
(B) random and directionless
(C) small and directional
(D) small and directionless

ANSWER KEY

EXERCISE-1 (SECTION-1&2)

(1) (D) **(2)** (A) **(3)** (B) **(4)** (B)
(5) Oparin, Haldane, Pre-existing
(6) Palaeontology **(7)** 2 : 1 : 2
(8) Convergent **(9)** Triassic period
(10) HF Osborn **(11)** Hugo de Vries
(12) Sewall Wright **(13)** Retrogressive evolution
(14) Mesozoic **(15)** Organic evolution
(16) Ordovician period **(17)** SW Fox
(18) *Ramapithecus* **(19)** Miller

EXERCISE - 1 [SECTION-3]

Q	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
A	C	D	A	A	A	A	D	C	A	B	B	C	B	A	A	C	D	B	C	A
Q	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59
A	B	D	B	A	D	B	C	C	D	C	D	D	C	D	B	D	A	D	C	B
Q	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
A	A	D	A	B	B	B	A	A	C	B	D	A	D	C	A	B	B	B	B	D
Q	80	81	82	83	84	85	86	87	88	89	90	91								
A	A	C	B	D	A	D	D	A	A	C	D	C								

EXERCISE - 2

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

EXERCISE - 3

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A	A	C	D	C	A	C	D	B	B	A	D	B	C	B	C	C	D	D	C	C
Q	21	22	23	24	25	26	27	28	29	30	31	32	33							
A	A	D	B	A	A	C	A	A	B	B	B	A	A							

EXERCISE - 4

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
A	C	B	D	D	A	C	C	A	C	B	B	D	D	D	C	B	A	B	B	C	B	D	C	C	B

SOLUTIONS

EXERCISE-1

(1) (D) **(2)** (A) **(3)** (B) **(4)** (B)
(5) Oparin, Haldane, Pre-existing
(6) Palaeontology **(7)** 2 : 1 : 2
(8) Convergent **(9)** Triassic period
(10) HF Osborn **(11)** Hugo de Vries
(12) Sewall Wright **(13)** Retrogressive evolution
(14) Mesozoic **(15)** Organic evolution
(16) Ordovician period **(17)** SW Fox
(18) *Ramapithecus* **(19)** Miller
(20) (C) **(21)** (D) **(22)** (A) **(23)** (A)
(24) (A) **(25)** (A) **(26)** (D) **(27)** (C)
(28) (A) **(29)** (B) **(30)** (B) **(31)** (C)
(32) (B) **(33)** (A) **(34)** (A) **(35)** (C)
(36) (D) **(37)** (B) **(38)** (C) **(39)** (A)
(40) (B) **(41)** (D) **(42)** (B) **(43)** (A)
(44) (D)

(45) **(B).** The evolutionary process, which produces new species, diverged from a single ancestral form adapted to new invaded habitats and to modes of life necessary there, is known as adaptive radiation.

(46) **(C).** Adaptive radiation or adaptive convergence both forms are used interchangeably for the divergent evolution.

(47) (C) **(48)** (D) **(49)** (C)

(50) **(D).** In 1859, Darwin published his observations and conclusion under the name 'origin of species'. Darwin's book became very popular and it had changed people's thinking about organic evolution.

(51) **(D).** The present concept of evolution is a modified form of the Darwin's theory of natural selection and often called Neo-Darwinism.
According to it, only genetic variations (mutations) are inherited and not all variations as the held by Darwin.
Thus, modern concept of evolution is synthesis of Darwin's and Hugo de Vries theories. This is also called synthetic theory of evolution.

(52) (C) **(53)** (D)

(54) **(B).** Natural selection theory of Darwin did not believe in any role of discontinuous variation. Darwin called these variations as sports, while Hugo de Vries used the term mutation for these variations. These variations are sudden heritable changes, which can occur in any stage of development.

(55) **(D).** According to de Vries, evolution is a discontinuous and jerky process.

(56) **(A).** The possibility of the new characters is always present in the organisms. But, it is the condition of nature, which gives the chance of that character to come forward. Therefore any new character is favoured because of nature selection.

(57) **(D).** Natural selection is the differential success in reproduction and it leads to the adaptation of organisms to their environment. Thus, natural selection occurs through an interaction between the environment and the population.

(58) **(C).** According to Neo-Darwinism theory, the processes that bring about the changes at the genetic level and are responsible for the origin of new species are mutations, recombinations, gene migration (gene exchange, genetic drift and natural selection.

(59) **(B).** **Quantum Evolution :** Development of land plants, wingless insects and scorpions occured due to quantum evolution.

(60) **(A).**

(61) **(D).** When the members of a species do not interbreed with the members of other species or same species due to differential modification is called reproductive isolation. The criterion of the reproductive isolation can not be used in asexual organisms.

(62) **(A).** Darwin's fitness is related to the organisms ability to survive and reproduce better then the other members the species.

(63) **(B).**

(64) **(B).** In convergent evolution two or more different group of organisms develops similar characters due to the same

environmental forces Tasmanian wolf and placental wolf are the examples of convergent evolution.

(65) (B) **(66)** (A)

(67) **(A).** **Founder Effect :** Sometime the change in allele frequency is so different in the new sample of population that they become a different species.
The original drifted population becomes founders and the effect is called founder effect. Generally, this effect operates when a population drifted to the new geographical area permanently.

(68) **(C).** Allielic/gene frequency of 'A' = 0.2
For allelic frequency A + a = 1
So, allelic frequency of 'a' = 1 – 0.2 = 0.8

(69) **(B).**

(70) **(D).** Constant gene frequencies over several generations indicates that the evolution is not taking place. Changing gene frequencies would indicate that the evolution is in progress. In other would evolution occurs when the genetic equilibrium is upset. Evolution is the departure from Hardy-Weinberg equilibrium principle.

(71) (A) **(72)** (D) **(73)** (C)

(74) **(A).** Cenozoic era. The tertiary period of this era is called as age of angiosperms.

(75) **(B).** In the quaternary period there were two epochs
(i) **Holocene :** It includes only moderns humans.
(ii) **Pleistocene :** It includes ice age and various human species.

(76) (B) **(77)** (B) **(78)** (B)

(79) **(D).** Azoic means no life. It was the era which prevailed during the origin of earth. At that time there was no hostile condition for the survival of any living organisms.

(80) **(A).**

(81) **(C).** *Archaeopteryx* (*Archlae* - primitive; *pteryx* - wing). It was found in the rocks of Jurassic period. It was discovered by Andreas Wagnar in 1861. It displays both the characters of reptiles and birds.

(82) **(B).** *Homo habilis* : (*homo* = human, *habilis* = able) 2-1.5 mya. Brain of *Homo habilis* was one half of the size of a modern human. They were more sophisticated with rudimentary speech.

(83) (D)

(84) **(A).** Solo man (*Homo soloensis*) : Its fossils were found on the banks of the Solo river in 1954. That's why it was named *Homo soloensis*.

(85) (D)

(86) **(D).** Somatic cell of gorilla, chimpanzee and orangutan have 48 chromosome (24 pairs) while humans have 46 chromosome (23 pairs).

(87) (A)

(88) **(A).** *Australopithecus* (first ape man). Raymond Dart (1924) discovered *Australopithecus africanus* from Pliocene rocks.

(89) (C)

(90) **(D).** The modern man differs from the apes in arms, which are shorter than legs.

(91) **(C).** *Ramapithecus* (*pithecus* - ape)
This creature lived about 14-8 my a (Million years ago). It was the most ancient human ancesstor and a small ape-like creature (14kg) which probably walked upright.

EXERCISE-2

(1) (D) **(2)** (C) **(3)** (A) **(4)** (D)
(5) (A) **(6)** (B) **(7)** (D) **(8)** (D)

(9) **(A).** From 1831-1836, Darwin was able to journey on the HMS Beagle, a ship whose mission was to travel around the world in search of new scientific discoveries. Darwin served as the naturalist on board the ship, collecting thousands of specimens from various countries around the world, mostly being from South America.

(10) (C)

(11) **(C).** On the Origin of Species, published on 24 November 1859, is a work of scientific literature by Charles Darwin which is considered to be the foundation of evolutionary biology.

(12) (D) **(13)** (B) **(14)** (C) **(15)** (B) **(16)** (A)

(17) **(C).** Sinanthropus : A primitive apelike man of the genus Sinanthropus, now considered a subspecies of Homo erectus.

(18) **(A).** The Neanderthal or Neandertal was a species of genus Homo (Homo neanderthalensis) that inhabited Europe and parts of western Asia from about 230,000 to 29,000 years ago (the Middle Palaeolithic and Lower Paleolithic, in the Pleistocene epoch).

(19) (C) **(20)** (C)

(21) **(B).** The fossil record offers clues as to the origins of bipedalism, which in turn helps us to identify those species ancestral to modern humans. One of the most abundant sources for early bipedalism is found in Australopithecus afarensis.

(22) **(D).** **(23)** (A)

(24) **(C).** Cro-Magnon is a common name that has been used to describe the first early modern humans (early Homo sapiens sapiens) that lived in the European Upper Paleolithic.

(25) (B) **(26)** (A) **(27)** (D) **(28)** (C)

(29) (A) **(30)** (B) **(31)** (C) **(32)** (C)

(33) **(D).** The 'Java man' was a group of fossils found by Dutch physician Eugene Dubois in the Dutch East indies.

(34) (B) **(35)** (A) **(36)** (B) **(37)** (A)

(38) **(D).** Cranial capacity : The cubic capacity of the braincase estimated for the living by a formula based on head measurements and determined for the skull by filling the cranial cavity with particulate material (as mustard seed or small shot) and measuring the volume of the latter.

(39) (B) **(40)** (D) **(41)** (C) **(42)** (C)

(43) (B) **(44)** (D) **(45)** (C) **(46)** (D)

(47) (B) **(48)** (B) **(49)** (B) **(50)** (B)

(51) (B) **(52)** (C) **(53)** (D)

(54) **(B).** Speciation is the evolutionary process by which reproductively isolated biological populations evolve to become distinct species.

(55) (B) **(56)** (C) **(57)** (C) **(58)** (D)

(59) (A) **(60)** (D) **(61)** (B) **(62)** (D)

(63) (C) **(64)** (C) **(65)** (A)

(66) **(B).** The other choices are incorrect because they were Greek philosophers but not mainly concerned with natural history.

(67) **(B).** The fly's wing is analogous to the bat's wing because they have the same function (flight) but are structurally unrelated; the bat's wing, human arm and whale's flipper all are derived from the same basic bone structure.

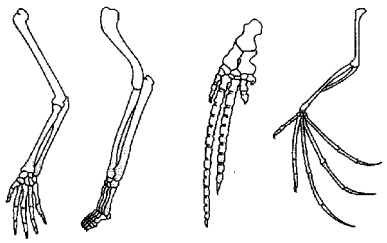
(68) **(A).** Fossils collected from the same stratum may be very different in terms of appearance, size, and structure.

(69) **(D).** DNA and its importance to evolution was unknown in Lamarck's day.

(70) **(D).** Free oxygen was not available in the early earth's atmosphere. Scientists believe that since oxygen is very reactive, had it been present in the ancient atmosphere, it would have reacted with and degraded all the other chemicals in the atmosphere. The consequence would be that evolution of the early earth would not have occurred as it did.

(71) **(B).** Theory of spontaneous generation (Abiogenesis or Autogenesis).
This theory states that life originated from non-living things in a spontaneous manner. This concept was held by early Greek philosophers like Thales, Anaximander, Xanophanes, Empedocies, Plato, Aristotle, etc.

(72) **(D).** Vertebrates hearts, vertebrate brains and vertebrate limbs have the same basic plan of organisation during development. But in adult condition they are modified. This indicates their homology.



Man Cheetah Whale Bat

(73) **(D).** Examples is support of Lamarckism
(i) Evolution of giraffe
(ii) Webbed toes of aquatic birds
(iii) Disappearance of limbs in snakes.
(iv) Flat fishes
(v) Flightless birds
(vi) Retractile claws of carnivorous animal
(vii) Cave dwellers
(viii) Emergent of hydrophytes.

(74) (B) **(75)** (D)

(76) **(A).** Neanderthal human were most numerous from about 100000 years ago. They become extinct 10000 years ago. Neanderthals were legendary cave dwellers. They have been portraited as having heavy brows ridges and hamped back. Their fossils were heavy found in Europe and West Asia.

(77) **(C).** *Homo erectus* includes three fossils

(i) **Java Ape Man :** Body 1.65 to 1.75 m tall, weight 70 kg cranial capacity 800 to 1000 cc.

(ii) **Peking Man :** About 1.55 to 1.60 m tall. Peking man was slightly shorter and weaker. They have the cranial capacity which range from 850 to 1100 cc.

(iii) **Heidelberg Man :** He used the tool and fire. Cranial capacity is believed to be about 1300 cc. It is regarded as intermediate between *Pithecanthropines* and neandertales.

(78) (B) **(79)** (B)

(80) **(C).** Human body has been described to possess about 90 vestigial organ. Some of them are

(i) Nictitating (plica semilunar's) membrane
(ii) Auricular muscles
(iii) Segmental muscle of abdomen
(iv) Panniculus carnosus
(v) Vermiform appendix
(vi) Caudal vertebrae
(vii) Third molar
(viii) Hairs on body
(ix) Nipples in male.

(81) **(D).** The skull of baby chimpanzee is more like adult human skull than the adult chimpanzee skull.

Dryopithecus is the most oldest human like fossil. It is considered as the common ancestor of both human and ape.

Dryopithecus was found in miocene rock of Africa and Europe.

(82) **(A).** Objection/criticism of the natural selection theory.

(i) Inheritance of small variation.
(ii) Vestigial organs.
(iii) Over specialisation of some organs.
(iv) Arrival of fittest.
(v) Degeneration of organs.
(vi) Discontinuous variation.

(83) **(B).**

S.N.	Homologous Structures	Analogous Structures
1.	Similar in anatomy.	Dissimilar in anatomy.
2.	Doing dissimilar functions.	Doing similar functions.
3.	Develop in related animals.	Develop in unrelated animals.
4.	Inherited from a common ancestor.	Not inherited from common ancestor.
5.	Similar developmental pattern.	Developmental pattern is not similar.
6.	Similar structure and origin.	Dissimilar in structure and origin.

(84) (C) **(85)** (C)

(86) **(A).** Presence of recessive traits = 25%

$(q_1^2) = 25\%$; $q_1 = 0.5$

Total allelic frequency $(p + q) = 1$

$p + 0.5 = 1$; Allelic frequency, $p = 0.5$

(87) **(C).**

EXERCISE-3

(1) **(A).** Inheritance of acquired characteristics and spontaneous generation have been disproven by experimentation; special creation is an idea that cannot be tested by the scientific method.

(2) (C)

(3) **(D).** Humans controlled the breeding that produced a cow that gives a certain amount of milk. This is an example of artificial selection; it would not have occurred without human intervention.

(4) (C) **(5)** (A) **(6)** (C) **(7)** (D)

(8) **(B).** Selection will favor different traits in different environments & thus, cause evolutionary divergence.

(9) **(B).** Any barrier that isolates organisms fosters evolution. Barriers to interbreeding are caused by reproductive isolation.

Geographic isolation refers to organisms being isolated by geography, such as mountains or rivers. Balanced polymorphism refers to two different versions of the same species living in one area, such as a speckled snail and a plain snail. Both are camouflaged in different environments. Sexual dependency is not related to the topic in any way.

(10) **(A).** Microevolution is subtle change in the genetic makeup of a population leading to increased adaptation.

(11) **(D).** Comparative embryology, comparative molecular biology, and comparative anatomy may all yield information about evolutionary relationships.

(12) (B) **(13)** (C) **(14)** (B)

(15) (C) **(16)** (C)

(17) **(D).** Malthus was a mathematician studying populations. He stated that populations tend to overpopulation and exceed their resources. This leads to starvation, disease, and death.

(18) **(D).** Of the total population, 9% have blue eyes (90 out of 1000), so $q^2 = 0.09$ and $q = 0.3$. Therefore, $p = 0.7$ and the frequency of hybrid brown = $2pq = 42\%$.

(19) (C) **(20)** (C)

(21) **(A).** Genetic drift is evolution through chance. The founder effect is one example of genetic drift. Another is the bottleneck effect.

(22) **(D).** The classic example of this can be seen in the whale and the shark. The two animals are unrelated; the whale is a mammal and the shark is a fish. However, they look alike because they experience the same environmental pressures. They both have a streamlined appearance with fins because that design is best for living in the ocean, not because they are related or have a recent common ancestor.

(23) **(B).** Pectoral fins of sharks and flippers of dolphins are analogous organs. Pectoral fins of sharks are not pentadactyle. The flippers of dolphins are pentadactyle. Thus basic structure of pectoral fins of sharks and flippers of dolphins are different but both are useful in swimming and perform the same function. **(24)** (A) **(25)** (A)

(26) **(C).** Mendel's laws of inheritance and Weismann's theory of continuity of germ plasm (1892) discarded Lamarck's concept of inheritance of acquired characters.

(27) **(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.

(28) **(A).** *Ginkgo biloba* is a living fossil because its ancestors are unchanged for the last many hundred years while its relative disappeared.

(29) **(B).** Primitive earth was devoid of oxygen so, only those organisms that were able to survive within anaerobic condition developed. All those were heterotrophic organisms (taking nutrient from outside). Then after autotrophic organisms were developed that used inorganic sources such as H_2S, NH_3, CH_4 as the principle sources of energy. These organism were called chemoautotrophs.

(30) **(B).** Coacervates and microspheres are believed to be the precursors of life. The coacervates contains mainly proteins, polydaccharides and some water. As coacervates do not have lipid outermembrane, hence they cannot reproduce.

(31) **(B).** Adaptation is an important features of animals by which they adopt different strategies to survive in hostile environment. The stick insect or praying mentis having green body colour exhibit close resemblance with wigs and foliages It is an adaptation known as protective mimicry.

(32) **(A).** Darwin believed that the small and useful variations make some species more adapted to the changing environment than others. Out of heterogenous population, nature selects the best adaptative individuals, while less fit or unfit individuals are rejected because the unfit ones fails to survive and reproduce.

(33) **(A).** It has been observed that the banding pattern of individual human chromosomes is very similar to the banding pattern of the corresponding chromosomes in apes. The banding pattern of human chromosomes number 3 and 6 were compared with those of particular autosomes in the chimpanzee. It shows a common origin for man and chimpanzee.

EXERCISE-4

(1) **(C).** According to Darwin the organic evolution is due to Intraspecific competition.

(2) **(B).** According to Hardy-Weinberg principle, allele frequencies in a population are stable and is constant from generation to generation when there is random and non-selective mating.

(3) **(D).** Variation in gene frequencies within populations can occur by chance is called as genetic drift.

(4) **(D).** Convergent evolution occurs in unrelated group of organisms. It is the development of similar functional structures but in unrelated groups.

(5) **(A).** The eye of octopus and the eye of cat (mammal) are example of analogous organs because they differ in the position of retina. In the eye of mammal, retina is inverted in position.

(6) **(C).** According to Hardy Weinberg principle.
$p^2 + 2pq + q^2 = 1$; $(p + q)^2 = 1$
(AA) $p^2 = 360$ out of 1000 individual
or $p^2 = 36$ out of 100
$q^2 = 160$ out of 1000 or $q^2 = 16$ out of 100
$q = \sqrt{0.16} = 0.4$. As $p + q = 1$ so, p is 0.6.

(7) **(C).** Forelimbs of cat, lizard used in walking, forelimbs of whale used in swimming and forelimbs of bats used in flying are the examples of homologous. All are modified forelimbs, with the same types of bones, they have become different due to adaptation to habitat.

(8) **(A).** Bat wings and bird wings are Analogous as flight strictures. Their structure and function have evolved by different routes from a flightless reptilian ancestor.

(9) **(C).** Hardy Weinberg equillibrium is applicable for randomly mating populations only.

(10) **(B).** Chromosomal abberations, genetic drift & recombination all play role in bringing genetic variations but recombination is more common.

(11) **(B).** 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.

(12) **(D).** The wings of a bird and an insect are analogous structure which differ in structure and origin but perform similar functions and represent convergent evolution.

(13) **(D).** Industrial melanism is an example of natural selection.

(14) **(D).** Wings of bird and flipper of whale are modified fore limbs but wings help in flying and flippers help in swimming.

(15) **(C).** The earliest organisms that appeared on earth were anaerobic chemoheterotrophs. Chemoautotrophs were the first autotrophic organisms unable to perform photolysis of water and never released oxygen.

(16) **(B).** Analogous structures are a result of convergent evolution.

(17) **(A).** Genetic drift operates in small isolated inbreeding population.

(18) **(B).** p^2 = Homozygous dominant individuals
$2pq$ = Heterozygous individuals
q^2 = Homozygous recessive individuals

(19) **(B).**

(20) **(C).** Correct sequence of events in the origin of life is
Synthesis of organic monomers → Synthesis of organic polymers → Formation of protobionts → Formation of DNA-based genetic systems.

(21) **(B).** As per mutation theory given by Hugo de Vries, the evolution is a discontinuous phenomenon or saltatory phenomenon/ saltation.

(22) **(D).** Divergent evolution occurs in the same structure, example - forelimbs, heart, brain of vertebrates which have developed along different directions due to adaptation to different needs whereas eye of octopus, bat and man are examples of analogous organs showing convergent evolution.

(23) **(C).** In different vertebrates, bones of forelimbs are similar but their forelimbs are adapted in different way as per their adaptation, hence example of homology.

(24) **(C).** Correct match of hominids and their brain sizes are
Homo habilis — 650-800 cc
Homo neanderthalensis — 1400 cc
Homo erectus — 900 cc
Homo sapiens — 1350 cc

(25) **(B).** According to Hugo de Vries, mutations are random and directionless.
Devries believed mutation caused speciation and hence called saltation (single step large mutation).