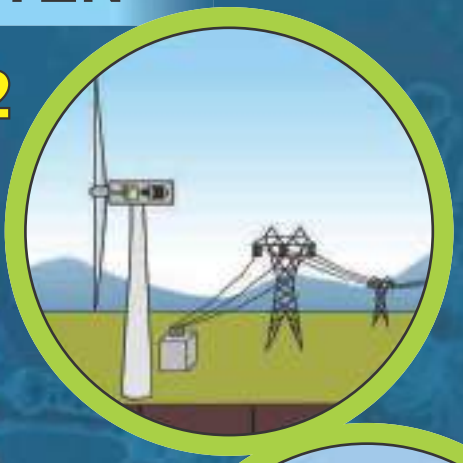
SCIENCE AND TECHNOLOGY

STANDARD TEN

PART – 2



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Academic Planning

Two separate books have been prepared for Science and technology. Science and technology part 2 contains ten chapters mainly related to Biology, Environment, Microbiology, Biotechnology. While thinking about science and technology, it is expected that an integrated approach will be taken while teaching and a connection will be made between different components of science and technology. In previous standards, we have studied various topics in science and technology together. For technical case two separate books science and technology part 1 and part 2 have been prepared, but it is necessary that an integrated perspective be taken while teaching.

Out of the ten chapters included in textbook science and technology part 2, the first five chapters are expected to be taught in the first five session while the next five chapters in the second session. At the end of a session, a written examination for 40 marks and a practical examination for ten marks should be conducted. Exercises and projects have been given an the end of every chapters in the text book.

In view of evaluation, representative questions similar to those in the activity sheets of language books are given in exercises. You may make similar other questions for your use. The students should be evaluated based on these questions detailed information above to this will be given in separate evaluation scheme.

1. Heredity and Evolution

- Heredity and Hereditary Changes
- Evolution
- Darwin's Theory of Natural Selection
- Speciation
- Transcription, Translation & Translocation
- Evidences of Evolution
- Lamarckism
- Human Evolution

Can you recall?

1. Which component of the cellular nucleus of living organisms carries hereditary characters?
2. What do we call to the process of transfer of physical and mental characters from parents to the progeny?
3. Which are the components the DNA molecule?

Heredity and hereditary changes

You know that here dity is the transfer of biological characters from one generation to another via genes. Johann Gregor Mendel is pioneer of the modern genetics. Around the period of 1886, it took a long time for him to understand the conclusions of his research about heredity. In 1901, the reasons behind the sudden changes were understood due to the mutational theory of Hugo de Vries. Meanwhile in 1902, Walter and Sutton observed the paired chromosomes in the cells of grasshopper; until then it was not known to anyone. Research started in the direction of finding the nature of genetic material when it was proved that genes are carried via chromosomes. Through which 1944, trio of scientists Ostwald Avery, Mclyn McCarthy and Colin MacLeod proved that except viruses, all living organisms have DNA as genetic material.

In 1961, the French geneticists Francois Jacob and Jack Monad proposed a model for process of protein synthesis with the help of DNA in bacterial cells. It helped to uncover the genetic codes hidden in DNA. Thereby, the technique of recombinant DNA technology emerged which has vast scope in the field of genetic engineering.

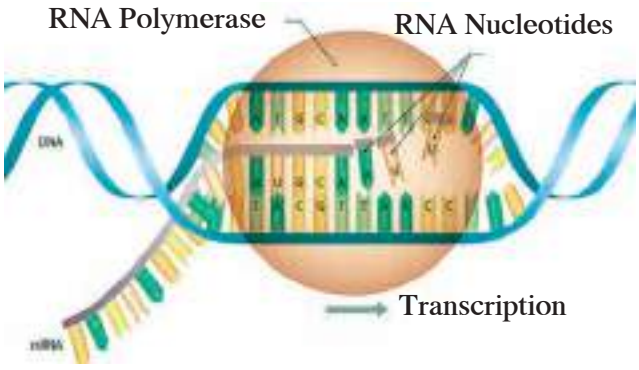
The science of heredity is useful for diagnosis, treatment and prevention of hereditary disorders, production of hybrid varieties of animals and plants and in industrial processes in which microbes are used.

Transcription, Translation and Translocation

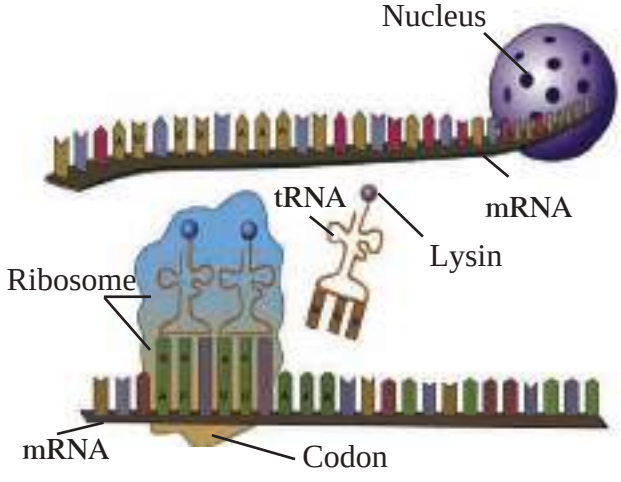
Can you tell?

1. Sketch and explain the structure of DNA and various types of RNA.
2. Explain the meaning of genetic disorders and give names of some disorders.

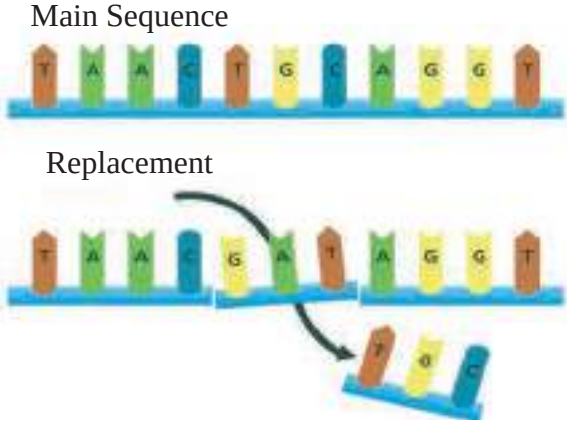
With the help of RNA, the genes present in the form of DNA participate in the functioning of cell and thereby control the structure and functioning of the body. Information about protein synthesis is stored in the DNA and synthesis of appropriate proteins as per requirement is necessary for body. These proteins are synthesized by DNA through the RNA. This is called as 'Central Dogma'. mRNA is produced as per the sequence of nucleotides on DNA. Only one of the two strands of DNA is used in this process. The sequence of nucleotides in mRNA being produced is always complementary to the DNA strand used for synthesis. Besides, there is uracil in RNA instead of thymine of DNA. This process of RNA synthesis is called as 'transcription'.



1.1 Transcription



1.2 Translation & Translocation



1.3 Mutation

` The mRNA formed in nucleus comes in cytoplasm. It brings in the coded message from DNA. The message contains the codes for amino acids. The code for each amino acid consists of three nucleotides. It is called as 'triplet codon'.

Dr Har Govind Khorana, a scientist of Indian origin has made an important contribution in discovery of triplet codons for 20 amino acids. For this work, he has been awarded with the Nobel Prize in 1968, along with two other scientists.

Each mRNA is made up of thousands of triplet codons. As per the message on mRNA, amino acids are supplied by the tRNA. For this purpose, tRNA has 'anticodon' having complementary sequence to the codon on mRNA. This is called as 'translation'. The amino acids brought in by tRNA are bonded together by peptide bonds with the help of rRNA. During this process, the ribosome keeps on moving from one end of mRNA to other end by the distance of one triplet codon. This is called as 'translocation'. Such many chains come together to form complex proteins. These proteins control various functions in the body of living organisms and their appearance too.

Living organisms can produce new individuals like themselves due to genes only and some of those genes are transmitted to the next generation without any changes. Due to this, some of the characters of parents are transmitted to their offsprings. However, sometimes sudden changes occur in those genes. Sometimes, any nucleotide of the gene changes its position that causes a minor change which is nothing but the 'mutation'.

Some mutations may be minor but some may be considerable. Ex. Mutation may cause the genetic disorders like sickle cell anemia. This is a everlasting process and it is one of the proof for Darwin's theory of natural selection.

Can you recall?

1. What is the function of the appendix of our digestive system?
2. Are our wisdom teeth really useful for chewing the food?
3. Why did the huge animals like dinosaur become extinct?
4. Why are many species of animals and birds getting extinct?

Evolution

Evolution is the gradual change occurring in living organisms over a long duration. This is a very slow-going process through which development of organisms is achieved. All the stages in changes occurred in various components ranging from stars and planets in space to the biosphere present on the Earth should be included in the study of evolution. Formation of new species due to changes in specific characters of several generations of living organisms as a response to natural selection, is called as evolution.

3.5 billion years ago, life had been non existent on the Earth. At the beginning, there may have been only simple elements in the ocean on the Earth and simple type of organic and inorganic compounds may have been formed from those. Complex compounds like proteins and nucleic acids may have formed over the long period from those simple compounds. First primitive type of cells may have been formed from the mixture of different types of organic and inorganic compounds. Number of those cells may have increased at the cost of surrounding chemicals. There may had been some differences among those cells and according to the principle of natural selection, some may have shown good growth and some may have perished which could not adjust with the surrounding.

At present, crores of species of plants and animals with huge diversity regarding shape and complexity are present on the Earth. Animal diversity ranges from the unicellular *Amoeba* and *Paramoecium* to man and giant whale. The plant diversity consists of various species ranging from unicellular *Chlorella* to the huge banyan tree. The life exists on Earth everywhere from equator to both the poles. Organisms are present at all the places like air, water, land, rock, etc. Humans have shown curiosity about origin of life and reasons for such a great diversity in life present on the Earth since ancient period. Different theories about origin and evolution of life have been proposed till today of which theory of 'Gradual development of living organisms is accepted

Internet is my friend

Collect the information from internet about Big-Bang theory related with the formation of stars and planets and present it in your class.

A peek into History

Many philosophers and religious scholars have written their views about formation of life. There seems to be a thorough discussion over the formation of Universe, in various cultures like Indian, Chinese, Roman, Greek, etc. Various cultures have noted different type of information about planets, stars, the 'panchmahabhuta', living organisms, etc. in the form of poetry, stories and religious / sacred books.

Theory of Evolution:

According to this theory, first living material (protoplasm) has been formed in ocean. In due course of time, unicellular organism was formed. Gradually, changes occurred in the unicellular organisms from which larger and more complex organisms were formed. All those changes were slow and gradual. Duration of all these changes is at must 300 crore years. Changes and development in living organisms had been all round and multi-dimensional and this led to evolution of different types of organisms. Hence, this overall process is called as evolution which is organizational. Progressive development of plants and animals from the ancestors having different structural and functional organization is called evolution.

Evidences of evolution

Collective thinking upon all above mentioned theories implies that evolution is everlasting process of changes. However, it needs proof to prove it. Following are various proofs available in support of the theories mentioned above.

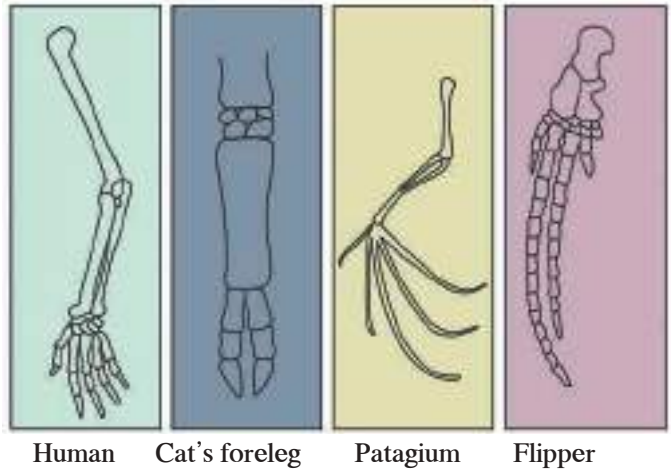
1. Morphological Evidences

Try this

Observe the following images and note the similarities between given animal images and plant images.

Various similarities like structure of mouth, position of eyes, structure of nostrils and ear pinnae and thickly distributed hairs on body are seen in animals whereas similarities in characters like leaf shape, leaf venation, leaf petiole, etc. occur in case of plants. This indicates that there are some similarities in those groups and hence it proves that their origin must be same and must have common ancestors

1.4 Morphological evidences



Human hand | Cat's foreleg | Patagium of Bat | Flipper of Whale

1.5 Structure of bones

2. Anatomical Evidances

If you carefully observe the pictures, there doesn't seem any superficial similarity between human hand, cat's foreleg, flipper of whale and patagium of bat. Similarly, use of each of those structures is different in respective animals. However, there is similarity in structure of bones and bony joints in organs of each of those animals. This similarity indicates that those animals may have common ancestor.

Can you tell?

1. Which are the different organs in body of organisms?
2. Is each of the organs useful to organism?

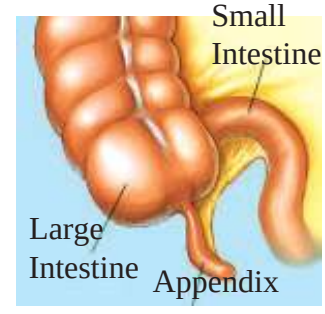
Use of ICT :

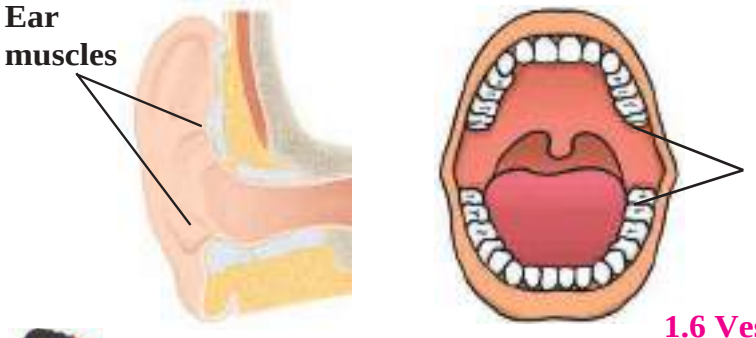
Collect the information of geological dating and Present it classroom.

3. Vestigial Organs

Degenerated or underdeveloped useless organs of organisms are called as vestigial organs. In living organisms, sudden development of new tissues or organs for living in changing environment is not possible. Instead, existing organs undergo gradual changes. Mostly, a specific structure in the body is useful under certain situation. However, same structure under different situation may become useless or even harmful. Such structure begins to degenerate under such situation as per the principle of natural selection. It takes thousands of years for a structure to disappear. Such organs are seen in different phases of disappearance in different animals. Such organ, though non-functional in certain organism, it may be functional in other organisms i.e. it is not vestigial in other organisms.

Appendix, which is useless to human, is useful and fully functional organ in ruminants. Similarly, muscles of ear pinna, which are useless to human, are useful in monkeys for movement of ear pinna. Various vestigial organs like tail-bone (coccyx), wisdom teeth, and body hairs are present in body of human being.





1.6 Vestigial organs

Observe and discuss. Observe the following pictures.

1.7 Some fossils

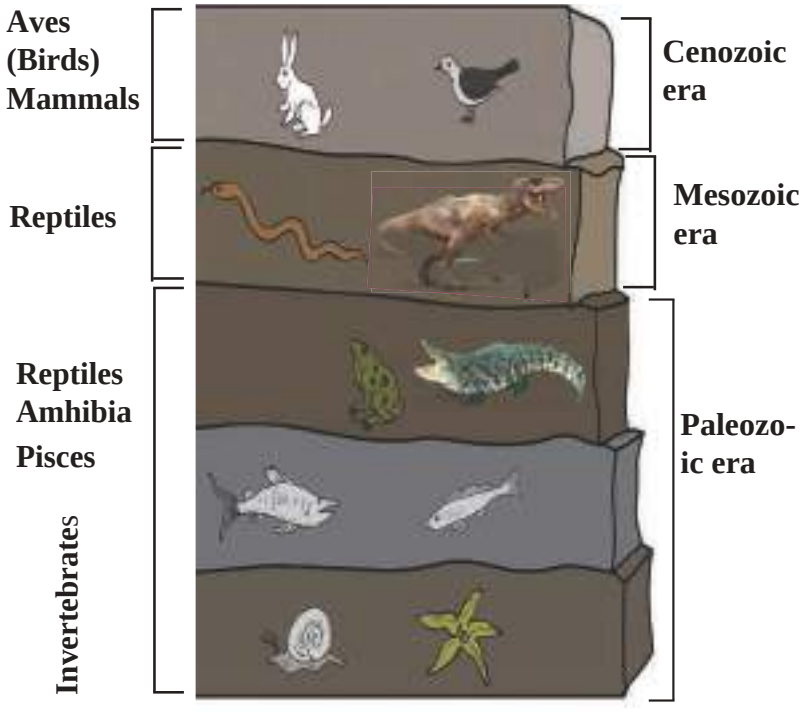
Use of ICT

Find how the vestigial organs in certain animals are functional in others. Present the information in your class and send it to others.

4. Paleontological Evidences

A question may arise in your mind that which organisms existed millions of years ago? How can we tell this? Now this secrete has been hidden in the Earth. Large number of organisms get buried due to disasters like flood, earthquake, volcano, etc. Remnants and impressions of such organisms remain preserved underground. These are called as fossils. Study of fossils is an important aspect of study of evolution.

Carbon consumption of animals and plants stops after death and since then, only the decaying process of C-14 occurs continuously. In case of dead bodies of plants and animals, instead of remaining constant, the ratio between C-14 and C-12 changes continuously as C-12 is non-radioactive. The time passed since the death of a plant or animal can be calculated by measuring the radioactivity of C-14 and ratio of C-14 to C-12 present in their body. This is 'carbon dating' method. It is used in paleontology and anthropology for determining the age of human fossils and manuscripts. Once the age of fossil been determined by such technique, it becomes easy to deduce the information about other erstwhile organisms. It seems that vertebrates have been slowly originated from invertebrates.



1.8 Structure of ground level and fossils

Intoduction to Scientists

Carbon dating method is based upon the radioactive decay of naturally occurring C-14 and it is developed by Willard Libby.

He has been awarded with Nobel Prize (1960) for this invention. The age of the materials determined by this method are published in the journal 'Radio Carbon'

5. Connecting Links

Observe and discuss.

Observe the following pictures and discuss the characters observed.

Duckbill Platipus **Lungfish** **Peripatus**

1.9 Some animals with special charactristics

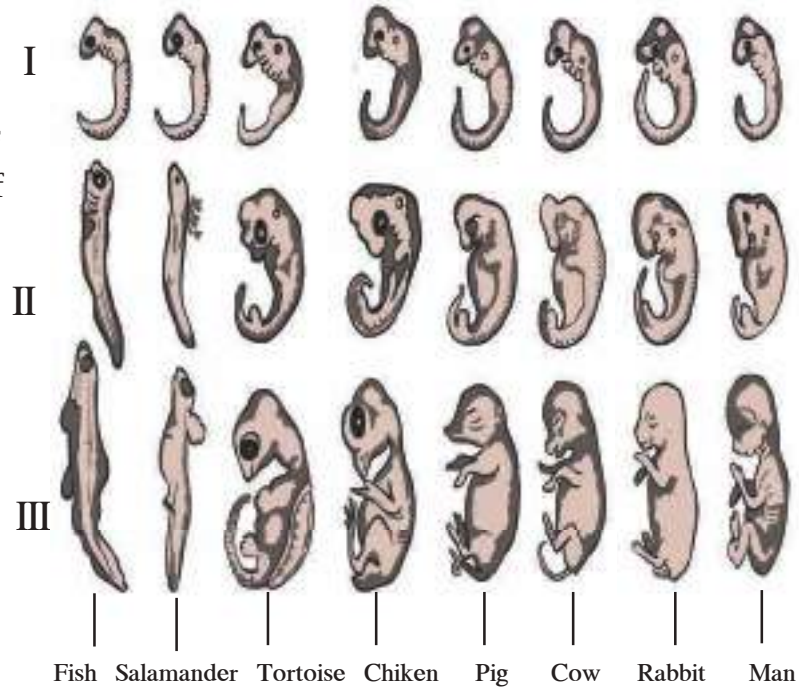
Some plants and animals show some morphological characters by which they can be related to two different groups; hence they are called as 'connecting links'. Ex. In *Peripatus*, characters like segmented body, thin cuticle, and parapodia-like organs are present. Similarly, these animals show tracheal respiration and open circulatory system similar to arthropods. This indicates that *Peripatus* is connecting link between annelida and arthropoda. Similarly, duck billed platypus lays eggs like reptiles but shows relationship with mammals too due to presence of mammary glands and hairs. Lung fish performs respiration with lungs irrespective of being fish. These examples indicate that mammals are evolved from reptiles and amphibians from fishes.

Observe and discuss.

Carefully observe the stages of embryonic development of some animals shown in fig. 1.10

6. Embryological Evidences:

Comparative study of embryonic developmental stages of various vertebrates given in the picture shows that all embryos show extreme similarities during initial stages and those similarities decrease gradually. Similarities in initial stages indicate the common origin of all these animals.



1.10 Embryos during different stages

Darwin's theory of natural selection

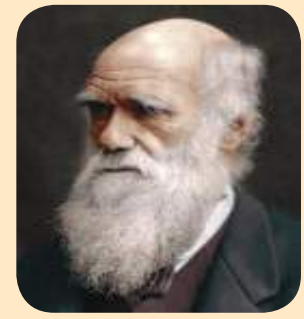
Charles Darwin had collected innumerable specimens of plants and animals and depending upon the observations of those specimens; he published the theory of natural selection which preaches the survival of fittest. For this purpose, Darwin had published a book titled **'Origin of Species'**. While explaining the concept, Darwin says that all the organisms reproduce prolifically. All the organisms compete with each other in a life--threatening manner. In this competition, only those organisms sustain which show the modifications essential for winning the competition. However, besides this, natural selection also plays important role because nature selects only those organisms which are fit to live and the rest perish. Sustaining and selected organisms can perform reproduction and thereby give rise to the new species with their own specific characters. Darwin's theory of natural selection was widely accepted for long duration. However, some objections were raised against the theory. Some of the main objections are-

1. Natural selection is not the only factor responsible for evolution.
2. Darwin did not mention any explanation about useful and useless modifications.
3. There is no explanation about slow changes and abrupt changes.

Irrespective of all these objections, Darwin's work on evolution has been a milestone.

Introduction to Scientists

Charles Robert Darwin (1809-1882)

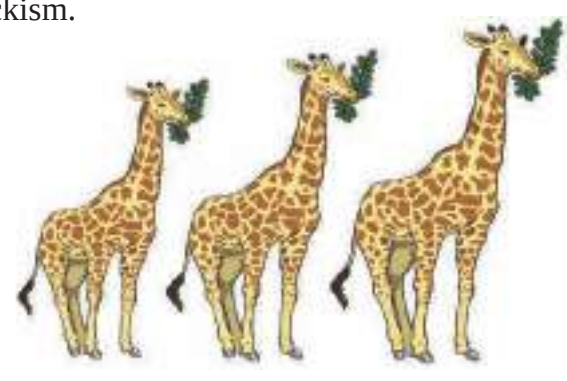


This English biologist proposed the theory of evolution. He showed that all the species of living organisms have been gradually evolved over the period of thousands of years from common ancestor. He proposed that principle of natural selection is responsible for this evolution.

Lamarckism

Jean-Baptiste Lamarck proposed that morphological changes occurring in living organisms are responsible for evolution and the reason behind those morphological changes is activities or laziness of that organism. He called this concept as principle of 'use or disuse of organs'.

Further, he said that the neck of giraffe has become too long due to browsing on leaves of tall plants by extending their neck for several generations; similarly, shoulders of the ironsmith have become very strong due to frequent hammering movements. Wings of birds like ostrich and emu have become weak due to no use. Legs of the birds like swan and duck have become useful for swimming due to living in water and snakes have lost their legs by modifications in their body for burrowing habit. All these examples are types of 'acquired characters' and are transferred from one to another generation. This is called as theory of inheritance of acquired characters or Lamarckism.



1.11 Giraffe

Development of organs due to specific activities or their degeneration due to no use at all was widely accepted but transfer of those characters from generation to generation was rejected. Because it had been verified many times that modifications brought in us are not transferred to next generation and thereby Lamarck's theory was disproved.

The living orgaism can transfer the characters which it has aquired, to the next generation. This is called ancestry of aquired characters.

Introduction to Scientists

Jean-Baptiste Lamarck (1744-1829)

Lamarck proposed that the activities of the organisms are responsible for their evolution. This French naturalist proposed that each animal or plant undergo some changes in its life span and those changes are transferred to the next generation and such changes occur in next subsequent generations too.

Internet is my friend

Collect the pictures and information of various species of monkeys from internet.

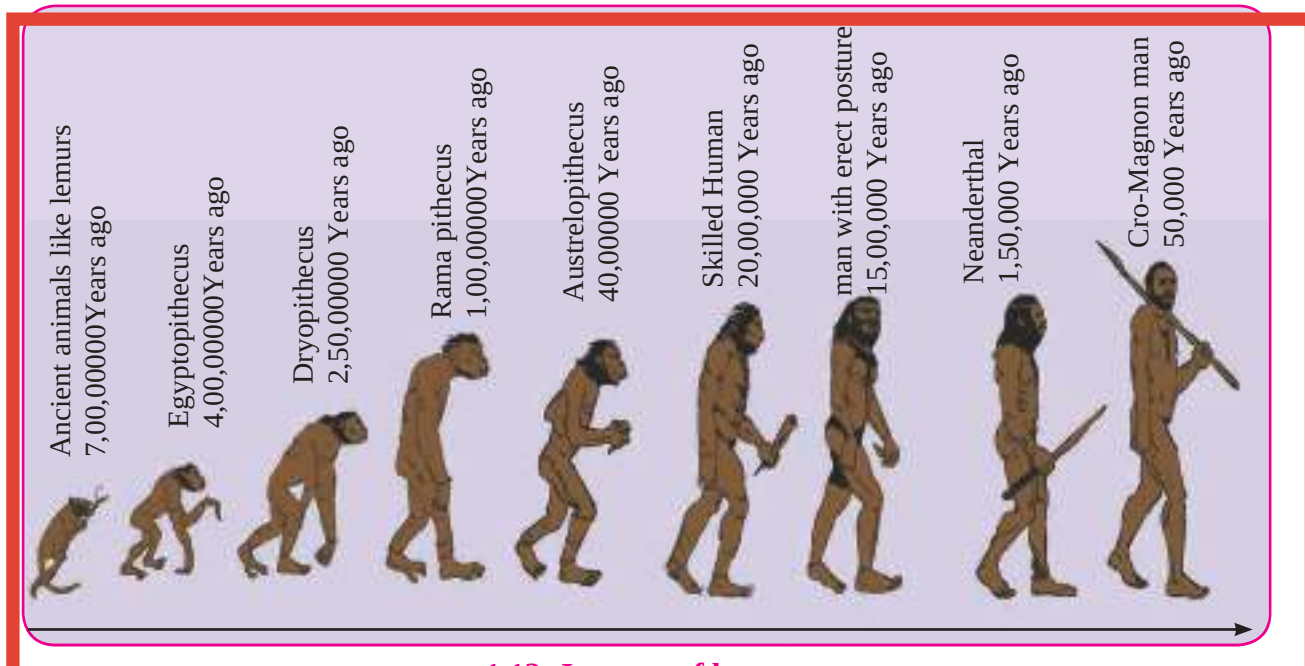
Speciation

Formation of new species of plants and animals is the effect of evolution. Species is the group of organisms that can produce fertile individuals through natural reproduction. Each species grows in specific geographical conditions. Their food, habitat, reproductive ability and period is different. However, genetic variation is responsible for formation of new species from earlier one. Besides, geographical and reproductive changes are also responsible. Similarly, geographical or reproductive isolation also leads to speciation

Human Evolution

The biodiversity that is known today has been said to be formed from very simple unicellular organism due to evolution. In this evolution, origin of human evolution can be shown as per the picture given below. Last dinosaurs disappeared approximately seven crore years ago. At that time, monkey-like animals are said to be evolved from some ancestors who were more or less similar to the modern lemurs. Tail of these monkey-like animals of Africa is said to be disappeared about 4 crore years ago. They developed due to enlargement in brain their hands were also improved and thus ape-like animals were evolved. Meanwhile, these ape-like animals reached the South and North-East Asia and finally evolved into gibbon and orangutan.

Remaining ape-like animals stayed in Africa and from them, gorilla and chimpanzee evolved about 2.5 crore years ago. Evolution of some of the 2 crore year old species of apes seems to be occurred in different way. They had to use their hands more for eating food and other work.

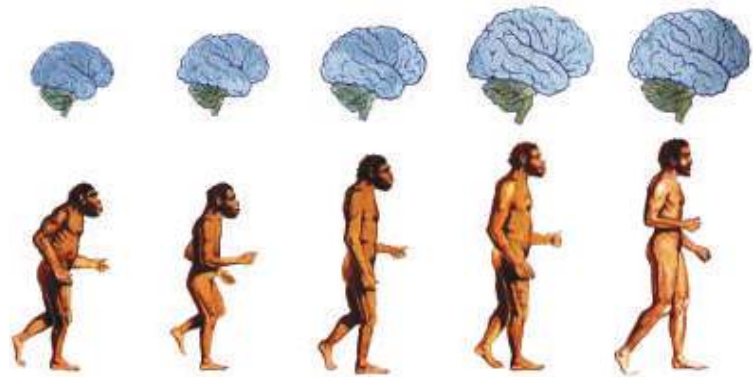


1.12 Journey of human

Those apes started to live on land as the forests started to decline due to dry environment. Their lumbar bones developed in such a way that they started to stand in erect posture in grasslands and thereby their hands became available for use, anytime. These first human--like animals with erect posture which were using their hands have evolved about 2 crore years ago.

First record of human-like animal is with us in the form of 'Ramapithecus' ape from East Africa. Afterwards, this ape grown up in size and became more intelligent and thus the ape of South Africa evolved about 40 lakh years ago.

The morphology of these human-like animals started to appear like to be the member of the genus *Homo*, about 20 lakh years ago and thus skilled human developed. About 15 lakh years ago, human walking with erect posture was evolved. It may have existed in China and Indonesia of Asian continent.



1.13 Development of human brain

Evolution of upright man continued in the direction of developing its brain for the period of about 1 lakh years and meanwhile it discovered the fire. Brain of 50 thousand year old man had been sufficiently evolved to the extent that it could be considered as member of the class- wise-man (*Homo sapiens*).

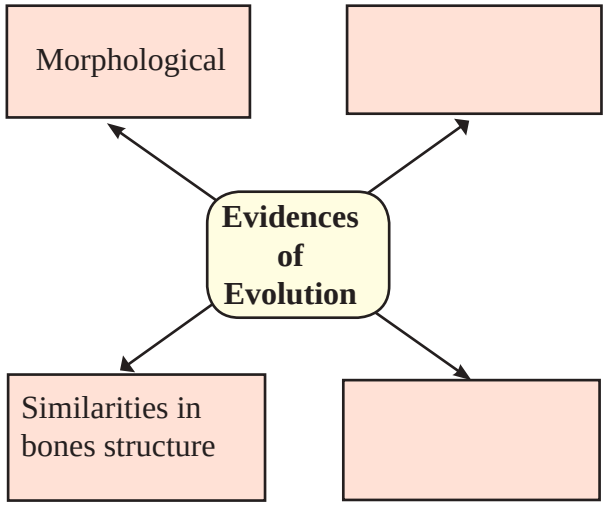
Neanderthal man can be considered as the first example of wise-man. The Cro-Magnon man evolved about 50 thousand years ago and afterwards, this evolution had been faster than the earlier.

1.14 Neanderthal man

About 10 thousand years ago, wise-man started to practice the agriculture. It started to rear the cattle-herds and established the cities. Cultural development took place. Art of writing was invented about 5000 years ago and thus the history had been started. Modern sciences emerged about 400 years ago and industrial society was established about 200 years ago and now we have reached at this stage, and still we are searching the details of roots of human ancestry.

Exercise

1. Complete the following diagram.



2. Read the following statements and justify same in your own words with the help of suitable examples.

a. Human evolution began approximately 7 crore years ago.
b. Geographical and reproductive isolation of organisms gradually leads to speciation.
c. Study of fossils is an important aspect of study of evolution.
d. There is evidences of fatal science among chordates.

3. Complete the statements by choosing correct options from bracket.

(Gene, Mutation, Translocation, Transcription, Gradual development, Appendix)

a. The causality behind the sudden changes was understood due to -- -- principle of Hugo de Vries.
b. The proof for the fact that protein synthesis occurs through -- --- was given by George Beadle and Edward Tatum.
c. Transfer of information from molecule of DNA to mRNA is called as -- -- -- process.
d. Evolution means -- -- -- --.
e. Vestigial organ -- -- -- present in human body is proof of evolution.

4. Write short notes based upon the information known to you.

a. Lamarckism
b. Darwin's theory of natural selection.
c. Embryology.
d. Evolution.
e. Connecting link.

5. Define heredity. Explain the mechanism of hereditary changes.

6. Define vestigial organs. Write names of some vestigial organs in human body and write the names of those animals in whom same organs are functional.

7. Answer the following questions.

a. How are the hereditary changes responsible for evolution?
b. Explain the process of formation of complex proteins.
c. Explain the theory of evolution and mention the proof supporting it.
d. Explain with suitable examples importance of anatomical evidences in evolution.
e. Define fossil. Explain importance of fossils as proof of evolution.
f. Write evolutionary history of modern man.

Project :

1. Make a presentation on human evolution using various computer softwares and arrange a group disscussion over it in the class room.
2. Read the book – 'Pruthvivar Manus Uparach' written by Late Dr. Sureshchandra Nadkarni and note your opinion on evolution.

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