2. Paths of Evolution

Class 10 biology Notes by **Rasheed Odakkal**

- Theories of Evolution.
- Biodiversity through Speciation.
- Evidences of Evolution.
- Human Evolution.
- Nervous System: Neurons, Synapse, Nerves.
- Brain, Spinal cord, Autonomous Nervous System.
- Reflex Action.
- Nervous system in other organisms.

Unit Summary:

The ideas of Jean-Baptiste Lamarck were the main initial point for discussions on evolution. However, **Lamarckism** was rejected. The theory of natural selection (**Darwinism**), introduced by Charles Robert Darwin, following observations in the Galapagos Islands, laid the foundation for modern evolutionary perspectives. Darwinism explains that organisms develop variations that are favourable or harmful to nature for various reasons, and that due to overproduction, struggle for existence can occur among organisms, and then those with favourable variations survive, and in this way, natural selection takes place and some of them gradually develop into new species. With later studies and evidence, this theory has now been uncritically rationalised as Neo-Darwinism.

Biodiversity on Earth is originated from a common ancestral species through a process called speciation. Species are formed from the **MRCA** (Most Recent Common Ancestor) and the MRCA is formed from the **LUCA** (Last Universal Common Ancestor). Mutation, natural selection, genetic recombination etc. are the circumstances that lead to the formation of variations in organisms.

Molecular biology, the comparative study of anatomy of organisms and fossils provide evidence for evolution. The common ancestors of mammals such as monkeys, apes, and humans belonged to the group of primates, having a few common characteristics. Humans belong to the Hominoidea, a suborder of primates within the Anthropoidea.

Sahelanthropus tchadensis is considered the first link in the human evolutionary chain. Homo sapiens (modern man) appeared after the human lineages Australopithecus, Homo habilis, Homo erectus, and Homo neanderthalensis.

Human nervous system consists of the brain, spinal cord, nerves and receptors. Nerve cells or **neurons** are the basic building blocks of the nervous system. Nervous system also includes the neuroglial cells. A neuron mainly consists of a cell body or cyton, dendrons that receive impulses, axons that transmit impulses and synaptic knobs that release neurotransmitters when impulses reach there. In some neurons, the axon is covered by a layer called myelin sheath. In nerves, the myelin sheath is formed by Schwann cells and that in brain & spinal cord, by the oligodendrocytes.

Human nervous system is classified as the Central nervous system (brain, spinal cord) and the Peripheral nervous system Both the brain and spinal cord are covered and protected by a three layered meninges, having cerebrospinal fluid inside. The human brain consists of the cerebrum, cerebellum, thalamus, hypothalamus, and brain stem (midbrain, pons and medulla oblongata). Each performs certain functions.

Spinal cord transmits messages to and fro the different parts of the body and brain. 31 pairs of spinal nerves begin from spinal cord as dorsal roots and ventral roots.

When stimulated, positive ions from outside the cell membrane of neuron, enter the cell, causing a temporary charge variation in that region. This is transmitted as impulse. Synapse is the part where an impulse is transferred from one neuron to another. When the impulse reaches the presynaptic knob at the tip of the axon, neurotransmitters in synaptic vesicles are released into the synaptic cleft. These neurotransmitters bind with the receptors of post synaptic membrane and stimulates that neuron.

Compared to other mammals, the human cerebral cortex has evolved into a neocortex with 16 billion nerve cells and a large number of synapses. The presence of the neocortex sets humans levels different from other creatures.

Reflex actions are reactions that occur spontaneously and involuntarily in response to stimuli. These are controlled by the central nervous system. The pathway through which impulses are transmitted in a reflex action is called a reflex arc.

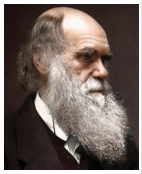
Autonomous nervous system is a part of the peripheral nervous system that regulates body activities by itself. It includes the sympathetic and the parasympathetic nervous systems. Peripheral nerves are classified as sensory, motor and mixed nerves.

Hydra has a neural network with out a controlling centre. In planaria, a pair of nerve ganglia in the head region coordinates the instructions. The nervous system in insects include a clear brain of united neurons in the head region and ganglia of paired nerve fibres in each segment.

Questions & Answers:

1. What is antimicrobial resistant bacteria? Example?
   Bacteria which aquired resistance against antimicrobial medicines, like the antibiotics are known as antimicrobial resistant bacteria.
   Eg:- Superbugs.
2. How did some bacteria acquire resistance to antibiotics?
   Because of genetic variation. (Due to the mutation in a specific gene in it)
3. The French biologist who initiated early discussions related to organic evolution? What was the idea put forward by him?

   Jean Baptiste Lamarck. (In 1809)
   His idea is known as : Lamarckism or the 'Theory of Inheritance of Acquired Characters'.
   According to this, *the acquired characters* (variations aquired by an organism in its life time) *are inherited to their offspring.*
   (For example, due to shortage of food, giraffes, whose necks were short, grew longer as they began to stretch their necks to higher treetops). In a changed environment, giraffes with longer necks survived.
4. Why did scientists rejected Lamarck's view ?
   Scientists proved that acquired characters (variation) do not impart change in the genetic structure of organisms and therefore, are not inherited.
5. What was the idea put forward by Charles Robert Darwin,related to organic evolution?



   Darwinism or the 'Theory of Natural Selection'.
   According to this, *organisms with certain characteristics favourable to the environment tend to survive, reproduce and produce more offspring.*

   Major ideas in the theory of Natural Selection:
   a. Overproduction:- Produce more offsprings than environment can support.
   b. Variations, whether beneficial or harmful, develop in organisms.
   c. Struggle for Existence:-Competition among organisms. when limitation of resources occur.
   d. Survival of the Fittest:- Organisms with favourable variations survive and they reproduce more effectively and create new generations.
   e. Natural selection occurs and a new species evolves. (Inherited and newly acquired favorable variations accumulate over time, resulting the formation ofnew species).
6. The book in which Charles Darwin presented his ideas?
   'On the Origin of Species' (In 1859)
7. What helped Darwin to formulate the theory of natural selection?
   The biodiversity observed during the exploration of areas such as South America, Australia, and the Galapagos Islands on the HMS Beagle, as well as Thomas Malthus's population theory and Alfred Russel Wallace's evolutionary ideas.
8. What types of finches did Darwin see on the Galapagos Islands? What was special about them?
   There were about 14 different species of finches in the Galapagos Islands, including seed eating ground finches, cactus-eating finches and insect-eating tree finches.
   Their beaks varied in shape and size depending on the availability of food resources around them. Darwin thought that those with beaks suited to each environment would survive and produce more offspring.

9. What would be the circumstances that might lead a new plant species to evolve from this plant after millions of years?
   The variations that have been passed from generation to generation and new ones that arise from that plant too accumulate and gradually it become a new species.

10. What is the Darwinist explanation for the evolution of long necks in giraffes, in contrast to Lamarckism?
    According to Darwin, among giraffes with necks of different lengths, only those with longer necks survived in the environment in competition for food and gradually evolved into new species.

11. Limitation of Darwinism?
    Darwin was unable to explain how variation occurs in organisms.
    Genetics had not yet developed at that time.

12. What is Neodarwinism?
    Later, it was recognised that the causes of variations that lead to evolution were genetic changes, genetic recombination during sexual reproduction and gene flow and more information from the fields of population genetics, palaeontology, environmental science, etc. were added to Darwinism to form an uncritically rationalised Neo Darwinism.

13. The areas where modern researches are being conducted, related to evolution?
    Evolutionary clinical medicine, DNA studies, artificial intelligence etc.

14. Explain with an example how evolutionary clinical medicine makes use of evolutionary ideas in healthcare.
    By studying how bacteria or viruses resist drugs, existing treatments are modified or new methods are created. Personalized medicine is designed by looking at his genes and his family genetic history.

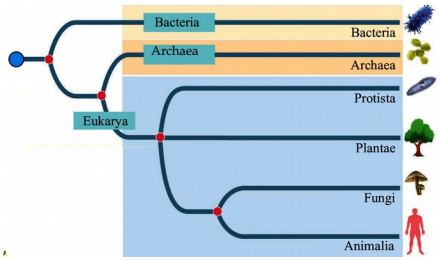
15. How did biodiversity form on Earth?
    Through a process called speciation.

16. The process by which new species arise from a common ancestral species?
    How does this happen?
    speciation.
    If the members of a population get isolated from each other by different reasons, several variations might accumulate over time and become unable to reproduce new offspring mutually, they will evolve into different species.
    (*ie*, the process of speciation begins when reproductive isolation occurs among members of a common ancestral species).

17. The circumstances that lead to the formation of variations in organisms?
    Mutation, natural selection, genetic recombination etc.

18. The closest common ancestor of different species can be called as -----.
    MRCA - (Most Recent Common ancestor).

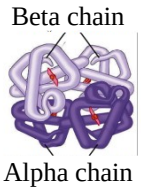
19. The last common ancestor of all living things?
    LUCA - (Last Universal Common ancestor).



20. Evidences of organic evolution?
    Molecular biology, the comparative study of anatomy of organisms, fossils etc.

21. The branch of science which compare and study the sequence of nucleotides in the DNA and the sequence of amino acids in proteins in an organism with those of other organisms, is -----?
    Molecular biology.

22. How does molecular biology justify the process of evolution?
    The evolutionary relationship of organisms can be find out by comparing the sequence of nucleotides in the DNA and the sequence of amino acids in proteins in an organism with those of other organisms.



23. According to molecular biology, which organism is closest to humans? Why?
Chimpanzee.
Because,no difference in the sequencing of amino acids in the beta chain of globin in both. Moreover, there is more than 98% similarity between human and chimpanzee DNA sequences.
24. What is the basis for saying that humans, cats, whales and bats have a common ancestor?
The bones in the forelimbs of humans and cats, the flippers of whales and the wings of bats are almost similar, though these organs differ in their external structure and function.
25. What conclusions can be reached through fossil studies?
The studies of fossils reveal that organic evolution is a gradual process from simple to complex. Fossils which are connecting links reveal the existence of evolutionary relationship between organisms and also reveal the extinction of many species from earth.
26. An example for fossils which are connecting links?
Archaeopteryx. (it possesses the characteristic features of both reptiles and birds).
27. Examples of organisms that are clearly extinct through fossil studies?
Dinosaurs, Mammoths.
28. What are primates? What are their common characteristics?
The common ancestors of mammals such as monkeys, apes, and humans belonged to the group of primates.
A thumb that can be opposed to other fingers, binocular vision, flat nails, relatively large and complicated brain are common characteristics of primates.
29. What are the two divisions of **Anthropoidea** in the human evolutionary tree? What are the organisms included in each division? Mention their common characteristics?
- **Cercopithecoidea** : Small sized brain, Having tail. (Eg:- Monkey)
- ഹൊമിനോയിഡിയ : Big sized brain, Without tail.. (Eg:- Gibbon, Orang-utan, Gorilla, Chimpanzee, Man)
30. Did humans evolve from monkeys?
No. Although humans and monkeys evolved from a common ancestor in the primate suborder Anthropoidea, monkeys are included in the order Cercopithecoidea, while humans are included in the order Hominoidea.
31. Correct order of hominoidea according to their origin?
Gibbon – Orang-utan – Gorilla – Chimpanzee – Man.
32. From available fossils, the first link considered in the human evolutionary series?
Sahelanthropus tchadensis.
33. Organisms and their characteristics in human evolutionary series:

	Cranial capacity	**Other characteristics**
Sahelanthropus tchadensis	350 cm^3	Fossil from Chad (Africa). The first link in the human evolutionary series.
Astralopethecus	450 cm^3	Fossils from Africa. Bipedalism.
Homo habilis	600 cm^3	Fossils from Africa. Large skull. Made tools with stones using hands. Began hunting. Lived in small groups.
Homo erectus	900 cm^3	Fossils from Africa, Asia and Europe. Able to walk upright on two legs. Large forehead, omnivores, used excellent stone weapons for hunting.
Homo neanderthalensis	1450 cm^3	Fossil from Germany. Contemporaries of modern man, small, sloping forehead and thick eye brows. Buried dead bodies.
Homo sapiens	1350 cm^3	Modern man. Acquired technology and agricultural methods. Domesticated animals and built cities. Culturally the most evolved category.