CHAPTER-7: EVOLUTION

Evolution: 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:

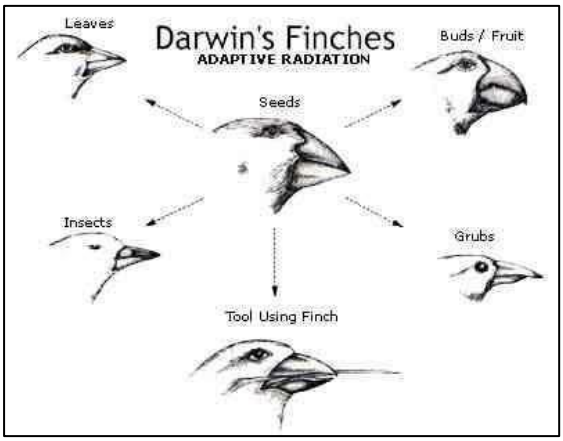
From comparative anatomy: Comparison of body structures amongst different species comes under comparative anatomy. Certain anatomical similarities among species bear witness to evolutionary history. eg. the same skeletal elements make up the forelimbs of man, horse, whale and bat, but each of them perform different functions. However, structural similarities in all mammals descended from a common ancestory with prototype forelimbs are common suggesting homology. Comparative anatomy confirms that evolution is a remodeling process. Ancestral structures that originally functioned in one capacity become modified as they take on new functions-***descent with modification'.***

Homologous organs	**Analogous organs**
Same basic structural plan and origin but different function	Different structure and origin but same function
It **suggests common ancestry**	It **do not suggests common** ancestry
Indicates Divergent evolution	***Indicates Convergent evolution***
Thorn of *Bougainvillea* Tendril of *Cucurbits*	Thorn of citrus and spine of *Opuntia* Tendril of cucumbers and tendril of pea
Flipper of seal, wing of bat, cats paw, human hand	Wing of insect and wing of bird

Divergent evolution	**Convergent evolution**
Origin of a variety of species from a common ancestral form Divergent evolution is the process of two or more related species becoming more and more dissimilar. As they adapted to different environments, the appearance of the two species diverged	Independent development of similar forms and features by unrelated organisms to adapt to a similar environment Unrelated species become more and more similar in appearance as they adapt to the same kind of environment
Homologous organs supports it	Analogous organs supports it

Adaptive radiation or mega evolution: Diversification, over evolutionary time, of a species or group of species into several different species or subspecies that are typically adapted to different ecological Group of organisms diversify greatly and take on new ecological roles. (for example, **Darwin's finches in the Galapagos Island and Marsupials in Australia**).

Darwin's finches: Divergent Evolution: Evolutionary pattern in which two species gradually become increasingly different. This type of evolution often occurs when closely related species diversify to new habitats. On a large scale, divergent evolution is responsible for the creation of the current diversity of life on earth from the first living cells. On a smaller scale, it is responsible for the evolution of humans and apes from a common primate ancestor. ***Adaptive radiation is one example of divergent evolution.***



Biological Evolution:

In the early 1800s French naturalist Jean Baptiste Lamarck suggested that evolution is a process of adaptation, the refinement of characteristics that equip organisms to perform successfully in their environment. However, unfortunately we remember Lamarck for his erroneous view of how adaptation evolved (the inheritance of acquired characters).

Branching descent and natural selection are the two key concepts of Darwinian Theory of evolution. According to him all the species inhabiting earth today descended from ancestral species (descent with modification) and natural selection is the mechanism for such descent with modification. Natural Selection states that a population of organisms can change over the generations if individuals having certain heritable traits leave more offspring than other individuals, resulting in a change in the populations genetic composition over time.

Directional selection shifts the overall makeup of the population by favoring variants of one extreme within a population. Natural selection may be directional: it may favor, for example, smaller individuals and will, if the character is inherited, produce a decrease in average body size. Directional selection could, of course, also produce an evolutionary increase in body size if larger individuals had higher fitness.

Disruptive selection, like directional selection, favors the variants of opposite extremes over intermediate individuals. Disruptive selection differs in that sudden changes in the environment creates

a sudden force favoring that. In nature, sexual dimorphism is probably a common example.

Stabilizing selection favors the norm, the common, average traits in a population .In nature, natural selection is most commonly stabilizing. The average members of the population, with intermediate body sizes, have higher fitness than the extremes. Stabilizing selection culls extreme variants from the population

Founder Effect: A cause of genetic drift attributable to colonization by a limited number of individuals from a parent population. When few individuals colonize a new habitat, genetic drift will more than likely occur.

The founder population is small and again the alleles present in this small population will not be representative of the original population. Saltation (from Latin, saltus, "leap") is a sudden change from one generation to the next, that is large, or very large, in comparison with the usual variation of an organism. The term is used for occasionally hypothesized, non gradual changes (especially single-step speciation) that are atypical of, or violate, standard concepts involved in neo-Darwinian evolution.

Genetic drift: Changes in the frequencies of alleles in a population that occur by chance, rather than because of natural selection.

Gene flow: movement of genes into or through a population by interbreeding or by migration.

Gene frequency: The frequency in the population of a particular gene relative to other genes at its locus.

Expressed as a proportion (between 0 and 1) or percentage (between 0 and 100 percent).

Gene pool: All the genes in a population at a particular time.

Geological time scale: Tabular record of the divisions of earth history. Major divisions are known as

_eras', these in turn are divided into _periods', which are further subdivided into _epochs'. Era → period → epoch → geographical time scale

Hardy-Weinberg principle: *In population genetics, the idea that if a population experienced no selection, no mutation, no migration, no genetic drift, and are randomly mating, then the frequency of each allele and the frequencies of genotype in the population would remain the same (constant) from one generation to the next generation.*

$p^2 + 2pq + q^2 = 1$

Recessive traits: If the frequency of a recessive trait such as cystic fibrosis or PKU is known, it is possible to calculate allele frequencies and genotype frequencies using the Hardy Weinberg equation and its assumptions are as follows:

i. say 1 in 1, 2500 Indian newborns have cystic fibrosis which means that the frequency of homozygotes for this recessive trait is

$q^2 = 1/2{,}500 = 0.0004$

ii. he square root of the frequency of recessives is equal to the allele frequency of the cystic fibrosis allele

$q = (0.0004)0.5 = 0.02$

iii. The frequency of the normal allele is equal to 1 - the frequency of the cystic fibrosis allele

$p = 1- q = 1 - 0.02 = 0.98105$

iv. The frequency of carriers (heterozygotes) for the cystic fibrosis allele is 2pq = 2 (0.98)(0.02) = 0.04 or 1/25

v. The frequency of homozygotes for the normal allele is $p^2 = (0.98)^2 = 0.96$vi.

Thus the population is composed of three genotypes at the calculated frequencies of homozygous normal = 0.96, heterozygous carriers = 0.04, homozygous affected = 0.0004

Natural Selection: states that a population of organisms can change over the generations if individuals having certain heritable traits leave more offspring than other individuals resulting in a change in the populations genetic composition over time.

Vestigial organs: functionless homologous organs that have no apparent function in certain organism. (supposed to be remnants of organs that had been well developed and functional in their ancestral state but had become modified during evolution)
E.g. 1. Vermiform appendix in man, 2. Pelvic girdle in python,3. Nictitating membrane, 4.Coccyx or tail vertebrae in man.

Time period	Name	Brain capacity	Remarks
10-15 Mya	*Dryopithecus (ape like)*		East Africa, Asia; closely related to chimpanzee
	Ramapithecus (man like)		Shivalik Hills; erect posture, small canine
2 mya	Australopithecines (cave dwellers)	500cc	African Ape Man ; height 1.5mts
	Homo habilis	700cc	Tool Maker, Community Life
1.2 mya	*Homo erectus*	800cc to 1300cc	Knew how to use fire, larger teeth
100,000-40,000 mya	Neanderthal man	1450cc	East and central Asia
25000mya	*Homo sapiens*	1650cc	Modern man ; height1.5 to 1.8 mts; flat face

Evolution can be summarized as a three step process-

- Mutations and genetic rearrangements caused by recombination occur at random.
- These random events then generate inherited differences in the characteristics of individuals in populations.

- Finally, mutation, gene flow, genetic drift and natural selection can cause allele frequencies to change
  over time.
- Of the four mechanisms of evolutionary change, mutation, gene flow and genetic drift are influenced by chance events, while, natural selection is a random process.

Synopsis of Human evolution Major Events during Geological Periods (Time scale):

PERIOD	EVENTS
Precambrian:	Origin of life, Oxygen evolution through photosynthesis
Cambrian	Flourishing of the invertebrates, increase in algal diversity, appearance of vertebrates.
Ordovician	Plants begin to colonize land.
Silurian	Increase in diversity of fish.
Devonian	Amphibians appear
Carboniferous	Extensive forest, dominance of amphibians, increase in diversity of insects, first reptiles appear.
Permian	Age of reptiles begin
Triassic	Dinosaurs evolve and spread, first mammal appear
Jurassic	First bird and first flowering plant appear.
Cretaceous	Dominance of flowering plants.
Tertiary	Age of mammals begin
Quaternary	Evolution of human, Large mammals and birds become extinct.

Questions

1. Define evolution.

2. What are homologous organs? What is homology? What do the homologous organs explain as an evidence of organic evolution?

3. What are analogous organs? What is analogy? What do analogous organs explain as an evidence of organic evolution?

4. What are vestigial organs? How do they support the organic evolution? Name any

5. four vestigial organs in human being.

6. Briefly explain the idea of natural selection taking **industrial melanism** or antibiotic resistance in bacteria as example.

7. Discuss the evidences from morphology and comparative anatomy in support of organic evolution.

8. Comparative embryology gives no less a significant evidence in support of evolution than any other branch of biology. Substantiate.

9. Fossils are the documentary evidences in support of evolution. Discuss.

10. Justify the statement" Galapagos islands are the living laboratories of Evolution".

11. What is Hardy-Weinberg equilibrium? Write the Hardy-Weinberg equation.

12. What is genetic drift?.

13. Define founder effect.

14. What is gene flow?

15. Discuss Darwin's theory of Natural Selection.

16. Discuss mechanisms of evolution.