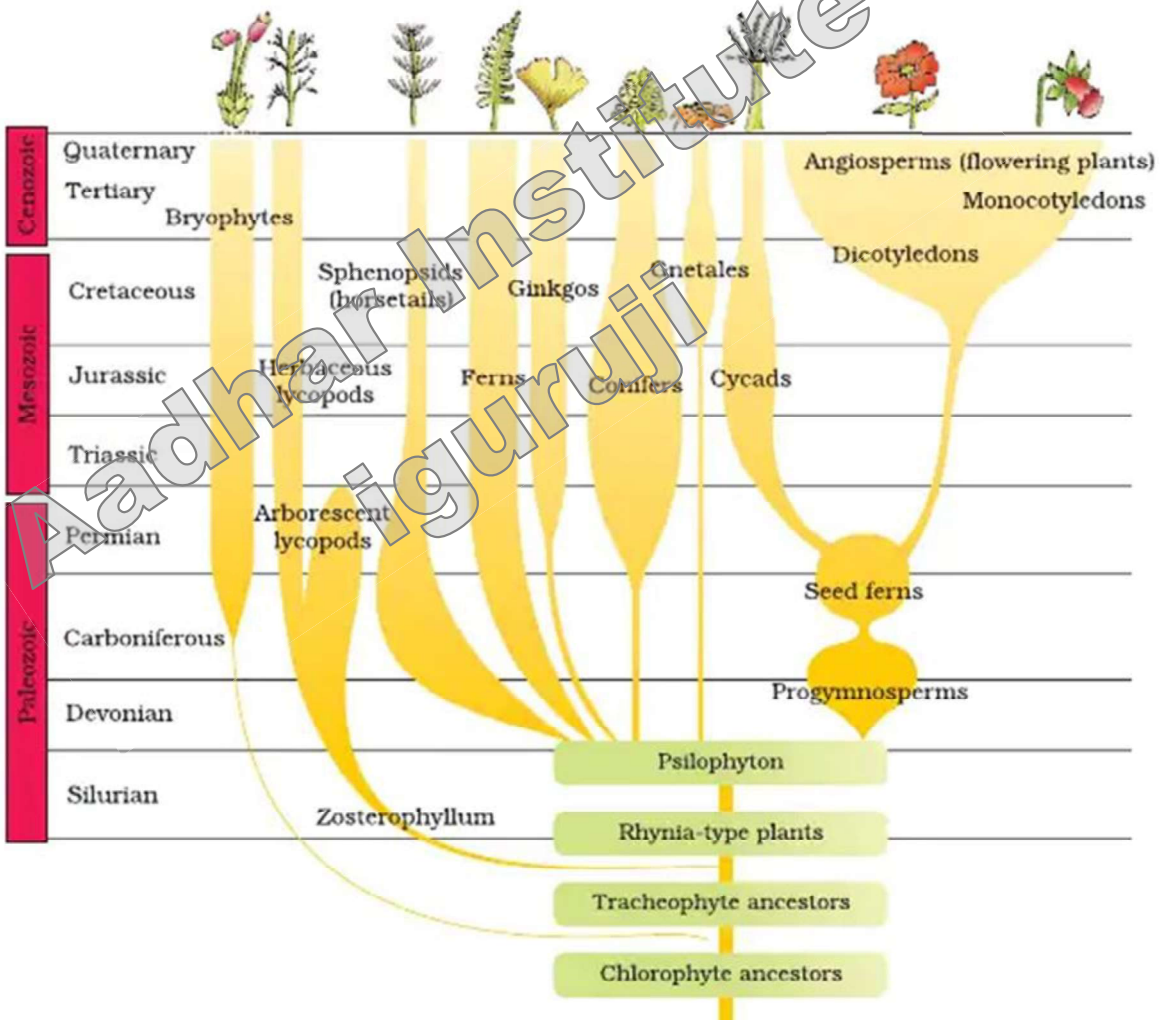
	Silurian		438	Diversity of lawless vertebrates; colonization of land by plants and arthropods; **origin of vascular plants**
	Ordovician		505	**First vertebrates (jawless fishes);** marine algae abundant
	Cambrian		544	Origin of most invertebrate phyla; diverse algae
Precambrian			700	**Origin of first animals**
			1500	Oldest eukaryotic fossils
			250	Oxygen beings accumulating in atomosphere
			3500	Oldest definite fossils known (prokaryotes)
			4600	Approximate origin of Earth



TOPIC: TYPES OF EVOLUTION

SEQUENTIAL AND DIVERGENT EVOLUTION

(i) Minor changes in the gene pool of a population from one generation to the next, with the result that no new populations are formed, but the descendent population is not genetically identical with its predecessor. This is known as sequential evolution.

(ii) The changes which result in the evolution of new populations, species, families, groups or classes represent as divergent evolution.

1. MICROEVOLUTION

The evolution, which results from the interaction of the elemental forces of evolution (i.e. mutation, variations, recombination, natural selection and the genetic drifts) to producer relatively small changes in the population or populations, is known as microevolution.

Microevolutionary forces operating for a shorter period produce sequential evolution, whereas when continued for generations together result in the evolution of new populations from the existing one. The origin of new populations can occur in two different ways-

(i) in a successional manner, and

(ii) in a divergent manner.

The successional microevolution is the evolution within a single population which results in the successional replacement of the pre-existing populations by the new once. This could be seen in successive strata of palaeontological series. It leads the micro-evolution to the formation of clines, when characters of a population seem to change gradually across its place of distribution. The formation of clines is an example of gradual changes in response to gradual changes in the climate.

The divergent microevolution results in the splitting of parental population into two or more new populations with the appearance of genetic divergence. Isolation is the additional factor operating to establish genetic divergence in the related populations.

2. MACROEVOLUTION (ADAPTIVE RADIATION)

The evolution, which results in the production of new adaptive types through a process of population fragmentation and genetic divergence, is known as macroevolution. It operates above the species level and results in the splitting of the population of species into several subgroups, each of which exhibits changes in a definite adaptive direction. These changes are known as adaptive trends and the phenomenon as the adaptive radiation or macroevolution. It means macroevolution is actually adaptive radiation.

►**Mechanism of macroevolution** - Macroevolution operates above species level and results in the establishment of new genera, families and orders. The changes in the organization occur on account of sudden mutations of large size, which are named “macro mutations” or “systematic mutation” by **Goldsehmidt. Macroevolution** occurs in a group of individuals which have entered a new adaptive zone free of competition.

3. MEGAEVOLUTION

Megaevolution has been described as the origin or evolution of new types of biological organization as a result of general adaptation from its predecessor, resulting in the formation of new classes, groups of phyta. Megaevolutionary changes are rare and have occurred only a few times in the evolutionary history of persist without extinction (with few exceptions).

MECHANISM OF MEGAEVOLUTION

During mega-evolution the organisms of the ancestral stock attempt to entera new zone, which is uninhabited by these forms and its devoid of competition. These exhibit varied modifications in different directions until one of these is found suitable to the new zone. It means a group of individuals of the parental stock develops certain generalized preadaptaions which unable them to enter the new zone. Therefore, these make a break - through into the new adaptive zone and start radiating into all the available habitats, thereby developing more specialized which are known as postadaptations.

►PATTERENS OF EVOLUTION

When morphological changes undergone by evolving higher taxa are plotted through time, distinctive patterns similar to those displayed in speciation are found. These are as follows-

1. Adaptive Divergence or Divergent evolution- When lineages split and evolve along separate adaptive pathways showing increased morphological differences in a given biospace, it is called adaptive divergence or divergent evolution. Divergent evolution is also seen when separate lineages follow different morphological solutions to the same problems.

2. Adaptive radiation or Radiation evolution- It shows splitting up of a number of lineages from some primitive group and these lineages modify and evolve to exploit a number of distinctive biospaces. This results in multiple divergence. Such evolutionary changes represent radiation evolution. Diversification of stegocephalian amphibians of various mammalian orders from their primitive ancestral forms represent adaptive radiation.

3. Parallel evolution- In parallel evolution two or more distinct lineages evolve along similar lines under the influence of similar environmental opportunities or requirements. As a result these exhibit similar morphological changes. best example of parallel evolution is found in arthropods. Arthropods are said to exhibit polyphyletic origin and it is presumed that 2 to 4 separate lineages of annelid - like worms have separately undergone arthropodization.

4. Iterative evolution- In iterative evolution similar sequences of morphological codification appear successively from the basic stock. For example, irregularly coiled ammonites (heterostrophic) have arisen three or more times from coiled ancestors.

5. Adaptive convergence or Convergence evolution- In this case separate lineages assumes similar morphology under the influence of similar environmental factors. For example, dolphins and whales (mammals) have fish-like appearance to lead a successful aquatic life.

►*Monophylectic And Polyphylectic Species*

Taxa whose members have descended from a common ancestor are called **monophylectic**. All members or species of monophylectic taxon descend either from the same parents or same population or same species i.e. the new species is the temporal extension of the parent species.

Taxa whose members are descended from diverse ancestral lineages are called **polyphylectic**.

►**ANAGENESIS** represent change in character of a lineage through time or linear succession of lineages through time i.e. succession of one species by other in due course of time. It is characterized by the replacement of one lineage by another.

Anagenesis creates organisms with novel characters and abilities, beyond those of their ancestors.

►**CLADOGENESIS** represents divergent evolution in which parental population of parental lineage splits or branches into several lineages. Lineage branches resulting from cladogenesis are called clades and are monophbylectic. This ensures rapid origin of new species.

►**STASIGENESIS** is a condition in which lineages neither split nor changes but persist unchanged. For example, turtles, Sphenodon, Coelacanths all represent stasigenesis.

George Gaylord Simpson noted two modes of evolution-

►**Bradytelic evolution**- (G. brady, means slow) - it includes evolution of new species rather slowly and gradually in relatively minor ways. This can also be called gradualism.

► **Tachytelic evolution** (G. tachy, means fast) - it includes origin of species by abrupt changes. As a result, the intermediate fossil forms are absent. This type of evolution is called punctuationism.