In last class we started phylogeny of angiosperms, we discussed what is phylogeny, what are angiosperms and what are the general principles of angiosperm phylogeny. Before proceeding further, we first need to discuss some terms and concepts in detail, which are involved in understanding of the topic.

We are going to discuss about primitive and advanced characters, homology and analogy, clade in this class.

**What is clade?**

- A clade is a group which includes a common ancestor and all the descendants (living and extinct) of that ancestor.

Members of a clade will possess common characteristics as a result of their shared evolutionary lineage.

- Clades can be organized into branching diagrams (*cladograms*) in order to show evolutionary relationships.

**What are primitive and advanced characters?**

To determine the phylogenetic position of a group, knowledge of number of primitive (plesiomorphic) and advanced (apomorphic) characters that the group contain is must.

The first step in the determination of relative advancement of characters is to ascertain which characters are primitive and which are advanced. In the past, most conclusions on primitiveness were based on circular reasoning: ‘These families are primitive because they possess primitive characters, and primitive characters are those which are possessed by these primitive families’. With the advancement over the years a better understanding of these concepts has become possible and it is believed that evolution has proceeded at different rates in different groups of plants and because of which, among the present day organisms some are more advanced than others.

It is argued by Stebbins (1950) that it is wrong to consider the characters as separate entities, since it is through the summation of characters' peculiar to an individual that natural selection operates. His idea was also supported by Sporne (1974).

So comparative morphology has been largely used to decide the relative advancement of characters although there are insufficient fossil records of the earliest angiosperms.

The term “Primitive” simply means more like the original or less modified from previous and “advanced” means less like the original or more modified. A character being primitive does not mean that it is
necessarily inferior or backwards and a character being advanced does not make it superior in any absolute sense. To understand the primitiveness and advancement of characters, various doctrines have been proposed but unfortunately they are mostly based on the circular reasoning.

Some of the important doctrines are –

**Doctrine of conservative regions** – it states that certain regions of plants have been less susceptible to environmental influence than others and therefore exhibit primitive features.

**Doctrine of recapitulation** – it states that early phase in development are supposed to exhibit primitive features, i.e., ‘ontogeny repeats phylogeny’. Ontogeny means development of organism and phylogeny is the study of evolution. This concept was originally applied to animals but does not always hold well in plants because in plants ontogeny does not end with embryogeny but continues throughout the adult life.

There is a term known as **Neoteny** (persistence of juvenile features in mature organisms) is an example wherein a persistent embryonic form represents an advanced condition, it contradicts this doctrine.

**Doctrine of teratology** - Teratology is the study of abnormalities of physiological development, when normal equilibrium is disturbed, an adjustment is often made. Thus, teratology is seen as reminiscent of some remote ancestors.

**Doctrine of sequences** - it states that if organisms are arranged in a series in such a way as to show gradation of a particular organ or structure then two ends of the series represent apomorphy and plesiomorphy. But the crucial decision is from which end should the series be read.

**Doctrine of association** - it states that if one structure has evolved from another, then the primitive condition of the derived one will be similar to the ancestral structure.

**Doctrine of common ground plan** - it states that characters common to all members of a group, must have been possessed by the original ancestor and must therefore be primitive.

**Doctrine of character correlation** - it states that certain morphological characters are statistically correlated and this can be used to study the evolution. Frost (1930) believed that correlation between characters arises because rates of their evolution have been correlated.

Primitive members of group have retained high proportion of ancestral (plesiomorphic) characters, while advanced members have dispensed with relatively high proportion of these same characters either by loss or replacement with different (apomorphic) character.

The concept of apomorphic and plesiomorphic characters has been considerably advanced with recent development of cladistics methods.

Certain groups of angiosperms are reported to have a combination of both plesiomorphic and apomorphic characters, the situation is known as **heterobathmy**. For example, *Tetracentron* has primitive vesselless wood but the pollen grains are advanced being tricolpate.
**Homology and analogy**

Different organisms resemble one another in certain characters. Taxa are constructed based on overall resemblance. The resemblance due to homology are real, whereas those due to analogy are generally superficial. These two terms play a very important role in understanding evolutionary biology.

These terms were first used and defined by Owen (1848). He defined **Homology** as the occurrence of the same organ in different animals under every variety of forms and functions.

He defined **Analogy** as the occurrence of a part or an organ in one animal which has the same function as another part or organ in a different animal.

In simple words, Homology refers to the traits inherited by two different organisms from a common ancestry. For example, tendril of a pea plant and spines of a barberry plant are homologous organs showing similar functions. The tendril of a pea plant is a modified leaf used for providing mechanical support to the plant. But in the case of barberry plants, the spines are modified leaves meant for protection. The tendril of a pea plant and spines of a barberry though originated from leaves, are homologous organs performing different functions.

According to Wiley (1981) **two characters are homologous if one is directly derived from the other.** Such a series of characters is called evolutionary transformation series (also known as morphoclines or phenoclines).

Three or more characters can be homologous if they belong to the same evolutionary series (ovary superior to half inferior to inferior).

Moreover, two or more organisms may be known as homologous for a particular character if their immediate common ancestor also had this character. Such character is known as **shared homologue**.

If the character is present in the immediate common ancestor, but not in the earliest ancestor which means that character is the derived one, the situation is known as **synapomorphy**. If the character is present in immediate common ancestor as well as in earliest ancestor that means, it’s an original character and the situation is known as **symplesiomorphy**.

Analogy in simple words refers to the similarity in function of two different organisms due to convergent evolution (is the process whereby organisms not closely related (not monophyletic), independently evolve similar traits as a result of having to adapt to similar environments and not common ancestry). For example - The leaves of opuntia and peepal are analogous organs in plants. In opuntia the stem is modified into a broad succulent leaf like structure that performs photosynthesis like leaves. Peepal leaf is a normal leaf that performs photosynthesis. So both the opuntia and peepal leaves perform common function through photosynthesis, so they are analogous.

Potato and sweet potato also show similar characteristics, but have different origins. Potato is a modified stem meant for storage of food. Sweet potato is a modified root also meant for the storage of food, so they are analogous.