

Unit 8: Phylogeny of Angiosperms

- Terms and concepts
 - ❖ primitive and advanced
 - ❖ homology and analogy
 - ❖ parallelism and convergence
 - ❖ monophyly, Paraphyly, polyphyly
 - ❖ clades
- origin & evolution of angiosperms;
- co-evolution of angiosperms and animals;
- methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).

TAXONOMY & SYSTEMATICS

- **Nomenclature** = the naming of organisms
- **Classification** = the assignment of taxa to groups of organisms
- **Phylogeny** = Evolutionary history of a group (Evolutionary patterns & relationships among organisms)

Taxonomy = Nomenclature + Classification

Systematics = Taxonomy + Phylogenetics

Phylogeny-Terms

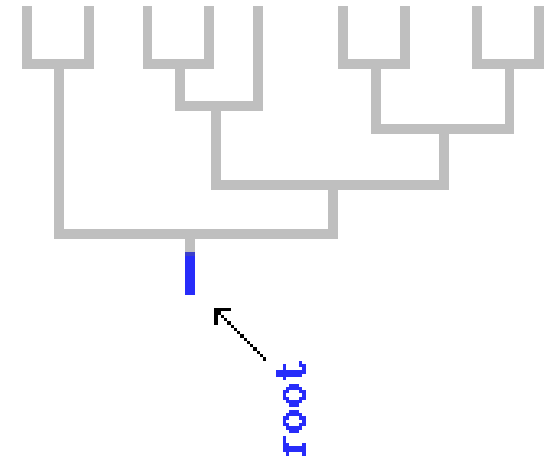
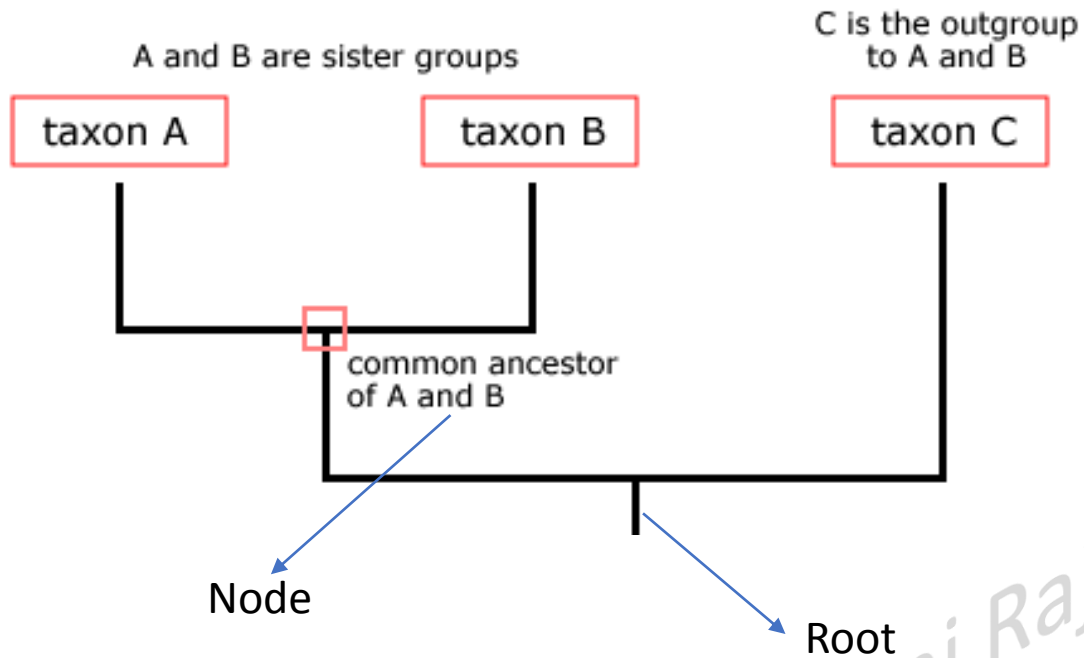
- **Phylogeny**- the evolutionary history of a group of organisms/ study of the genealogy and evolutionary history of a taxonomic group.
- **Genealogy**- study of ancestral relationships and lineages.
- **Lineage**- A continuous line of descent; a series of organisms or genes connected by ancestor/ descendent relationships.
- Relationships are depicted through a diagram better known as a **phylogram**

Evolution

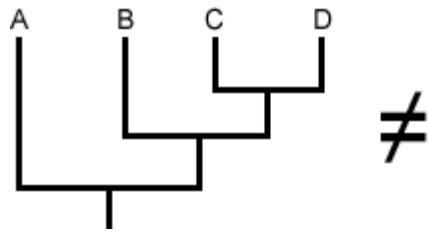
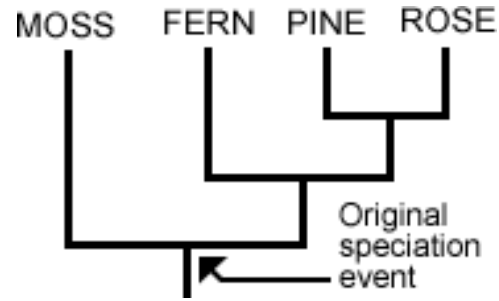
- Changes in the genetic makeup of populations- **evolution**, may occur in **lineages** over time.
- Descent with modification
- Evolution may be recognized as a change from a pre-existing or **ancestral character state (plesiomorphic)** to a new character state, **derived character state (apomorphy)**.
- 2 mechanisms of evolutionary change-
 1. **Natural selection** – non-random, directed by survival of the fittest and reproductive ability-through **Adaptation**
 2. **Genetic Drift**- random, directed by chance events

Cladistics

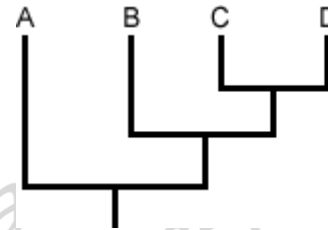
- Classification based on phylogeny
- Phylogenetic systematics- **Cladistics**
- **Lineage**- A continuous line of descent; a series of organisms or genes connected by ancestor/descendent relationships.
- Relationship is depicted as **phylogenetic tree/cladogram**
- A tree-like network that expresses such ancestor-descendant relationships (Cladistic relationship) is called a cladogram.
- **Cladogram** -Branching diagram shows the sequence of evolutionary change in characters, the number of changes associated with each lineage, and the sequence of lineage branching
- The branches of a cladogram represent time (unlike a phenogram).



- **Evolutionary tree** -evolutionary relationships among **taxa**
- **Phylogenies** trace patterns of shared ancestry between lineages.
- The **root** of the tree represents the ancestral lineage
- **Tips** of the tree represent groups of descendants of that ancestor -**descendent taxa** (often species)
- **Nodes** - common ancestors of those descendants.
- **As you move from the root to the tips, you are moving forward in time.**
- **Sister groups**- species A & B are sister groups — they are each other's closest relatives.
- An **outgroup** is a species or group of species that is closely related to the **ingroup** the various species being studied



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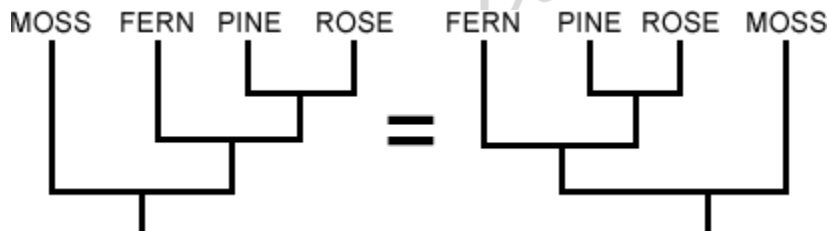


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A < B < C < D

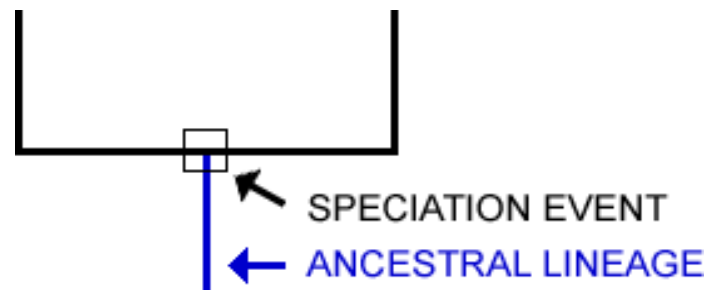
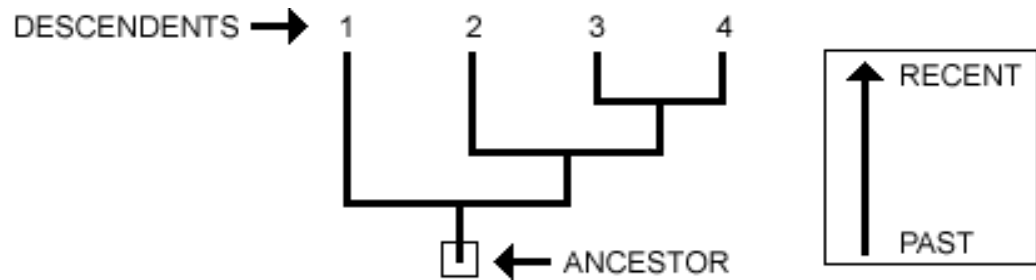
Evolution produces a pattern of relationships A B C D among lineages that is tree-like, not ladder-like

Just because we tend to read phylogenies from left to right, there is no correlation with level of "advancement."

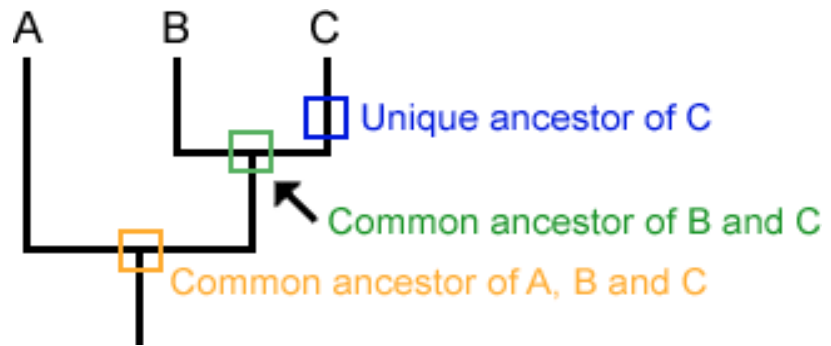
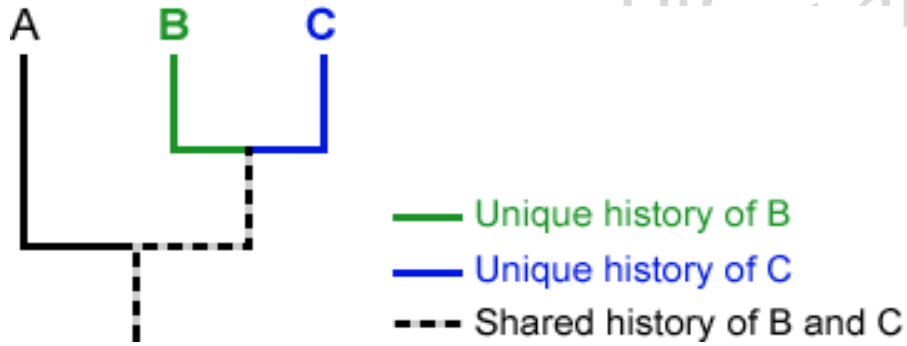


Order doesn't matter

For any speciation event on a phylogeny, the choice of which lineage goes to the right and which goes to the left is arbitrary. These phylogenies are equivalent



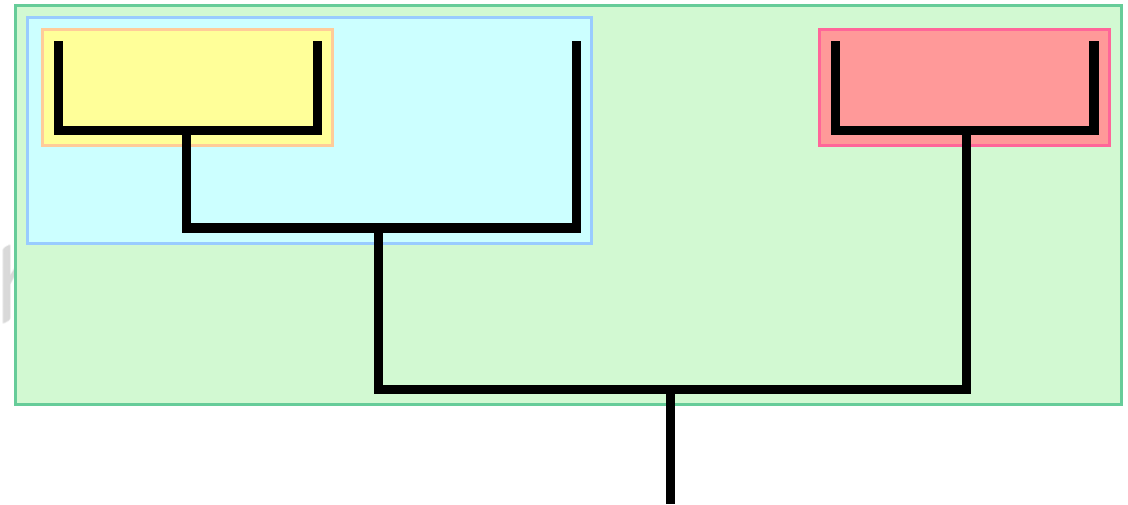
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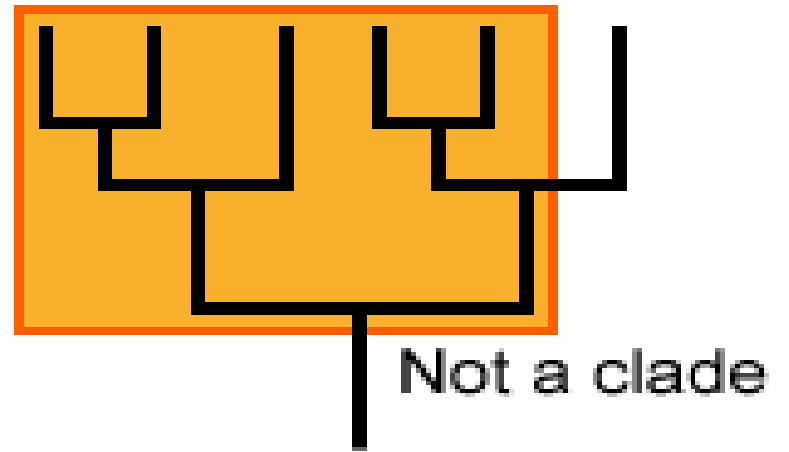
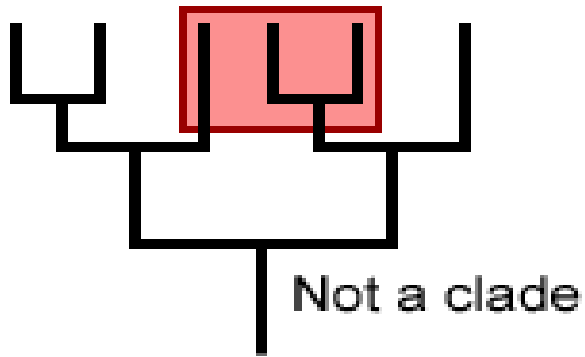
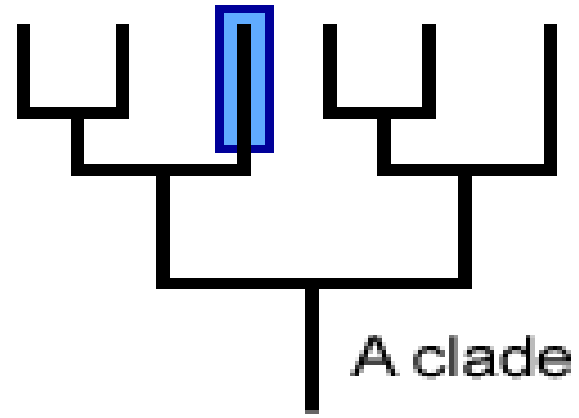
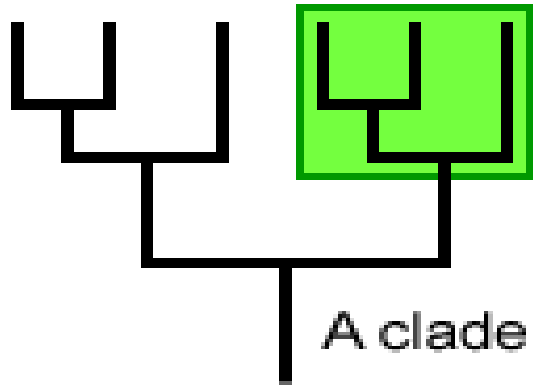


CLADE

- Evolutionary trees depict **clades**.
- A clade is like a branch on the tree of life.
- A clade is a group of organisms that includes **an ancestor and all descendants of that ancestor**.

Each colored rectangle below represents a clade:





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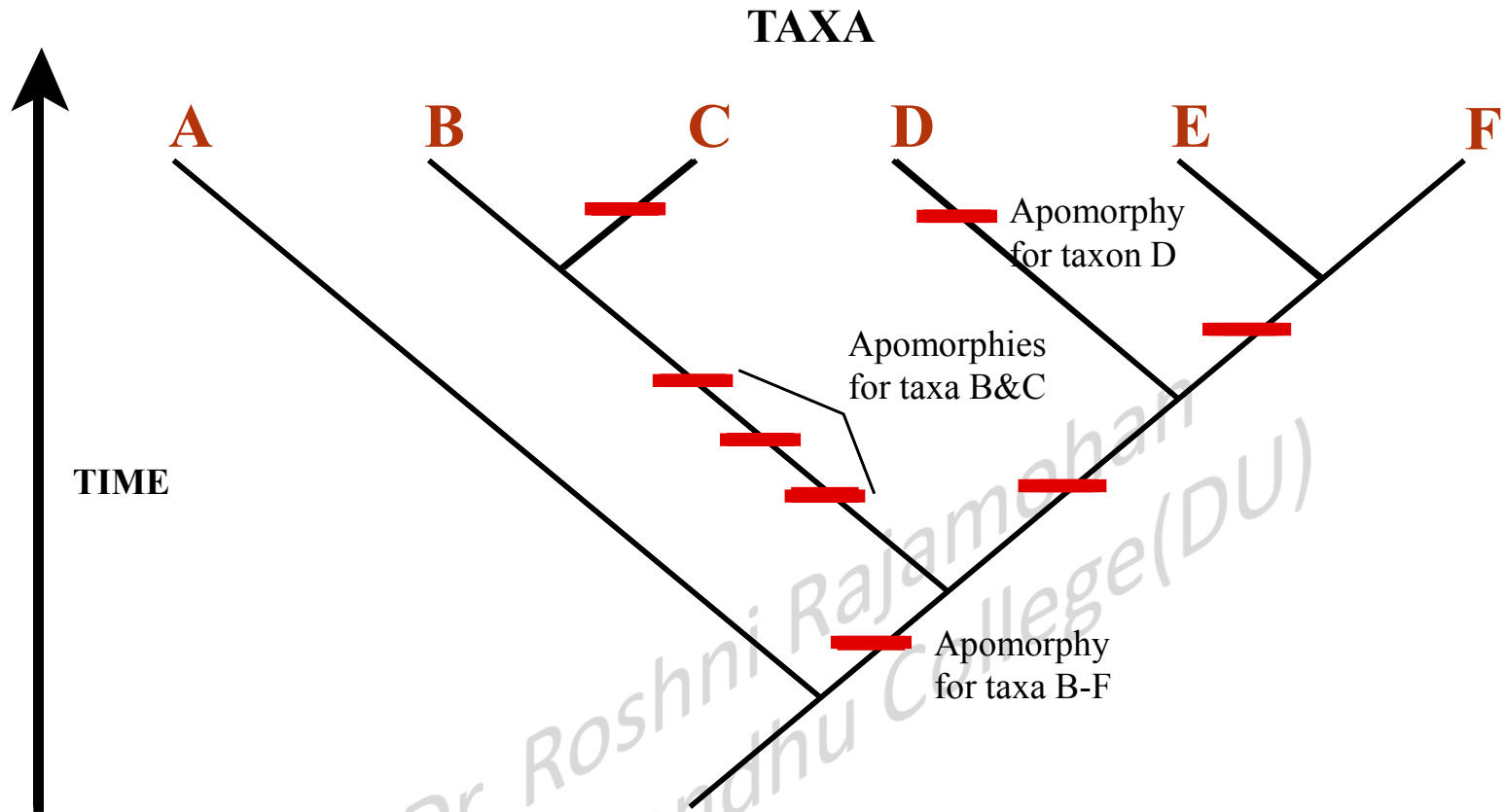
Apomorphy & Synapomorphy

APOMORPHY

- **Apomorphy** - The derived character state. It is an evolutionary novelty.
- The derived or **changed character state** for a particular clade under consideration.
- Apomorphies - the result of evolution.
- Taxa sharing apomorphies underwent same evolutionary history; should be grouped together.
- **Synapomorphies (shared derived characters)**- character states that have arisen in the ancestor of the group and is present in all the members of the group
- A derived or changed character state (i.e., an apomorphy) shared by two or more lineages in a particular clade. Synapomorphies are indicators of common ancestry.
- **Autapomorphy** is a derived trait that is unique to one group

PLESIOMORPHY

- **Plesiomorphy** - refers to a primitive / ancestral trait for a particular clade under consideration.
- This character state may change depending on the clade under consideration.
- **Symplesiomorphy** is a shared primitive trait.

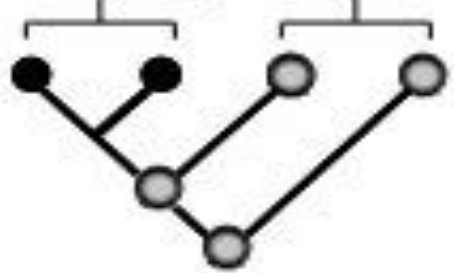


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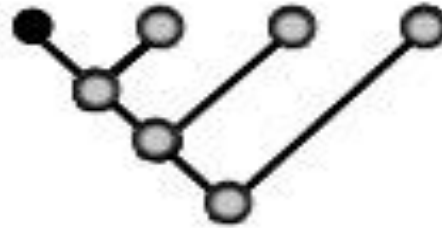
sporophyll -----> carpel (derived (new) feature)
 (ancestral feature) (apomorphy)

Presence of carpels - an **apomorphy** for flowering plants.

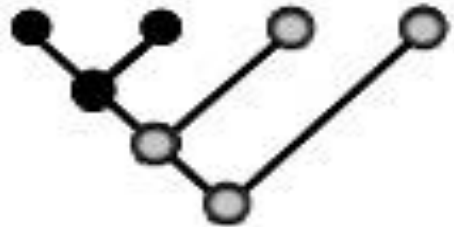
Apomorphy Plesiomorphy



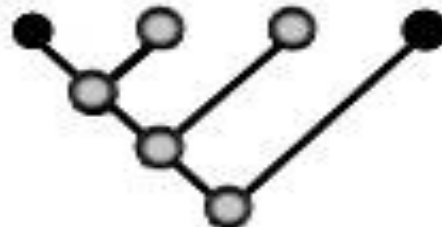
Autapomorphy



Synapomorphy



Homoplasy



Ancestral trait (○)
Derived trait (●)

(AUTAPOMORPHY-is a derived trait that is unique to one group (within a single lineage)

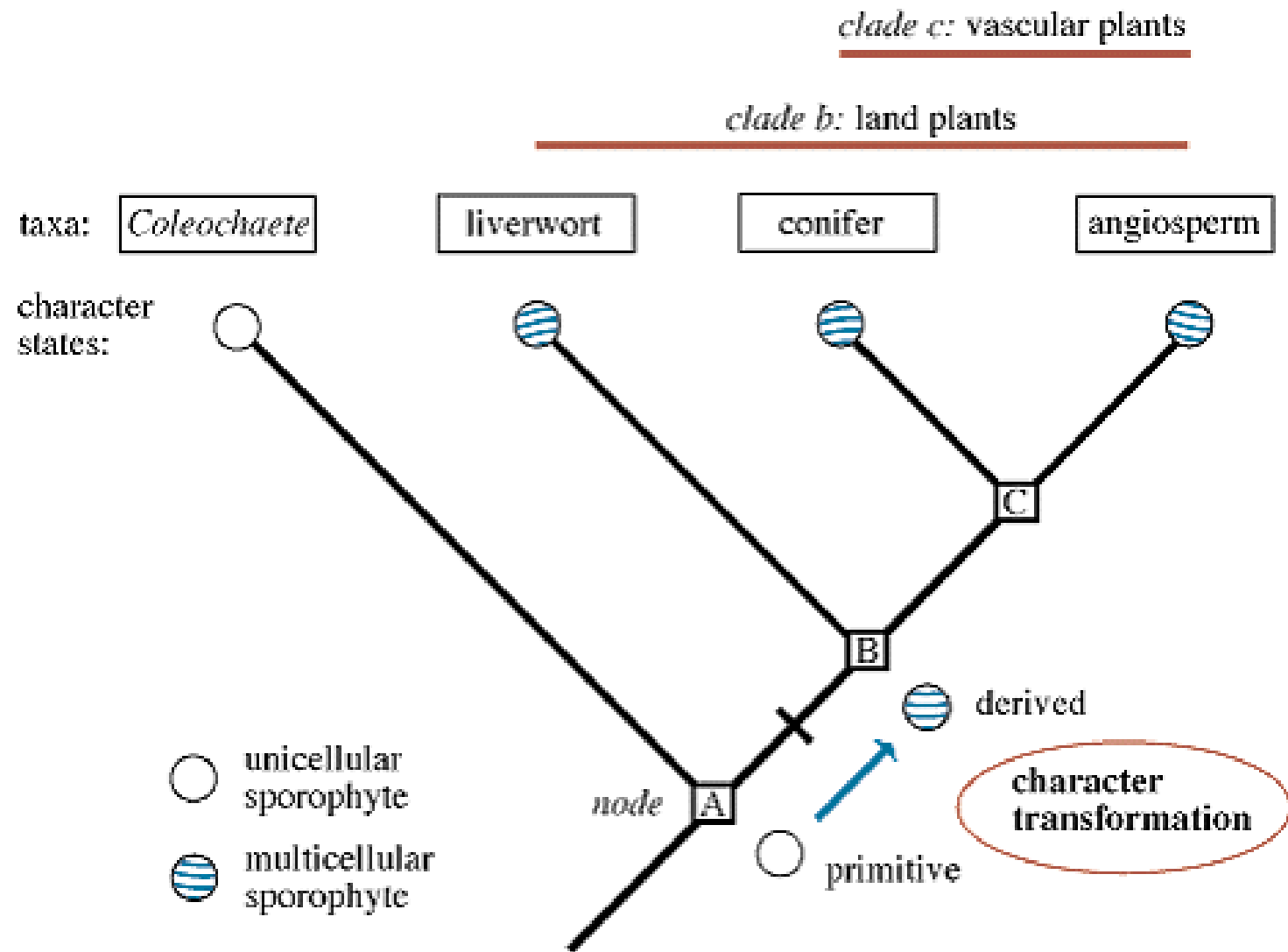
(SYNAPOMORPHY- an apomorphy that unites two or more lineages)

(HOMOPLASY - Similarity that is not the result of homology)

At node **B** (for liverworts) and clade *c* (vascular plants), "multicellular sporophyte" is a synapomorphy.

At node **B**, this trait is a symplesiomorphy for conifers and angiosperms.

At a node **A**, "multicellular sporophyte" is an automorphy for clade *b* (land plants).

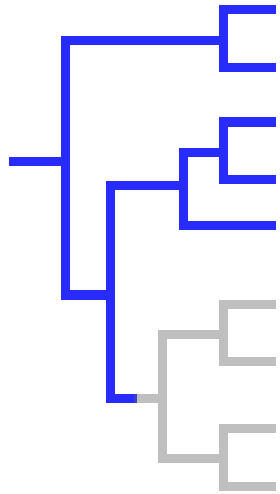


The multicellular sporophyte is an autapomorphy of the land plants, but a synapomorphy of the liverworts and all other land plants, and a symplesiomorphy for the conifers and the angiosperms.

Phylogenetic approach

- A phylogenetic approach demands the taxa to be **monophyletic**.
- **Monophyletic** groups, including all the descendants of a common ancestor, are recognized and form entities in a classification system.

Monophyletic group (clade)- a group composed of an ancestor and all its descendants.
a common ancestor + all descendants of that common ancestor

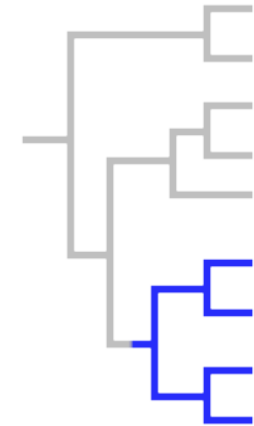


paraphyletic

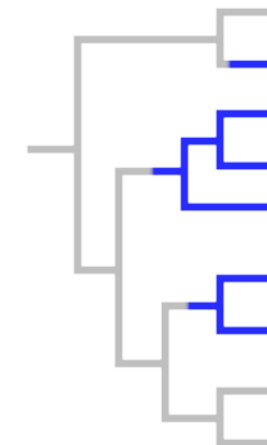
Paraphyletic groups, consist of common ancestor but not all descendants.

The descendants of a common ancestor that are left out are united to form monophyletic groups.

Polyphyletic groups, with more than one common ancestor. Common ancestor of components of group is not a member of the group.
Polyphyletic groups are split to form monophyletic groups.



monophyletic



polyphyletic