

# ***Virtual Paleobotany Laboratory***

## **GLOSSARY**

### **abaxial**

on the lower surface; situated or directed away from an [axis](#)

### **adaxial**

on the upper surface; situated or directed toward an [axis](#)

### **actinostele**

a type of [protostele](#) that looks like a star in cross section

### **allochthonous**

something that has been transported

### **amphiphloic**

having [phloem](#) on both sides of the [xylem](#)

### **analogous, analogy**

opposite to [homologous](#): correspondence in function between anatomical parts of different structure and origin; analogous: exhibit analogy (synonym: similar)

### **annulus**

specialized of some fern [sporangia](#) that are involved in the opening of the sporangium: on drying out the cells of the annulus contract and the sporangium ruptures, releasing the [spores](#)

### **antheridia**

reproductive structure that produces male gametes (sperm)

### **anthracite**

see [coal](#)

### **apical meristem**

embryonic, totipotent tissue in the tips of the roots and shoots of plants

### **apomorphy**

same as [derived trait](#)

### **archegonia**

reproductive structure that produces female gametes (egg)

### **ataxonomic**

an approach in which interpretations are not based on taxonomic assignment; for example: if a fossil taxon has the same generic name as an extant taxon, interpretations about the ecology of the fossil taxon are not based on the ecology of the extant taxon

### **autapomorphy**

[derived trait](#) or **apomorphy** that is unique to only one group or OTU

**autochthonous**

something that has not been transported

**axis**

see [stem](#)

**basal taxon / group**

a group near the root of a [clade](#)

**bifacial (vascular cambium)**

having two "faces", i.e. a [vascular cambium](#) that produces cells on both sides; in seed plants [phloem](#) is produced to the outside and [xylem](#) to the inside; compare to [unifacial \(vascular cambium\)](#); see [cambium](#)

**biocoenosis**

life assemblage; an assemblage of fossils that reflects associations characteristic of the community when it was living

**bisaccate**

a pollen grain with two [sacci](#)

**biseriate**

in two ranks or rows in the same plane

**bituminous coal**

see [coal](#)

**cambium**

a lateral [meristem](#) that produces [secondary growth](#)

**carbonate**

a salt or ester of carbonic acid ( $\text{H}_2\text{CO}_3$ ); carbonates can combine with other elements to form minerals, for example with calcium (calcium carbonate) or with iron (iron carbonate)

**carinal canal**

a canal in the [xylem](#) of some sphenophytes, for example Equisetum, that results from extension and rupture of the [protoxylem](#) elements

**carpel**

the female reproductive organ of a [flower](#), consisting of [stigma](#), [style](#) and [ovary](#)

**cast**

opposite of [mold](#); a preservation type that forms within a mold; casts are usually three-dimensional and therefore preserve form

**cellulose**

polysaccharide that consists of a long unbrached chain of glucose units; cellulose is the main constituent of the cell walls of most land plants

**character**

heritable trait possessed by an organism; characters are usually described in terms of their states, for example: blue and red as [character states](#) for the character flower color

**character reversal**

character that reverses to a more ancestral state

**character state**

the state or value of a character; for example some character states for the character 'color' are red, green and blue

**chert**

a type of rock; chert can form as a primary deposit preserving fossils within it, or replace organic materials in fossils embedded in different rock material

**clade**

a group of organisms that share a common ancestor; lineage; a [monophyletic](#) group

**cladistics**

same as [phylogenetic systematics](#)

**cladogram**

a dichotomous phylogenetic tree that branches repeatedly, suggesting a classification of organisms based on the sequence in which evolutionary branches arise; a nested diagram of [synapomorphies](#) indicating relations between groups; each point of branching represents divergence from a common ancestor

**coal**

a general name given to stratified accumulations of carbon-rich material derived from vegetation. The starting point for coal formation is usually peat or some similar accumulation of partially decayed plant matter. By the process of compaction, heating, and chemical alteration, the peat is converted by a series of stages into coal. The type of coalification corresponds to the amount of heating that a peat has undergone:

- Peat
- Lignite (brown coal)
- Bituminous coal
- Anthracite

**coal balls**

a type of preservation known from Carboniferous and Permian coal seams, in which plants are preserved by calcium [carbonate](#) and other minerals; see [petrification](#) and [permineralization](#).

**collenchyma**

tissue composed of unevenly thickened cell walls; collenchyma cells are flexible and support young parts of the plant without hindering growth; collenchyma cells are composed of [cellulose](#)

**compaction**

in sedimentation: the formation of massive rock from loose sediment, normally brought about by the weight of the overlying sediments; in preservation: organic preservation in three dimensions, for example in peat or clay

**companion cell**

a specialized cell of [phloem](#), derived from the same parent cell as the closely associated [sieve-tube element](#) immediately adjacent to it; the nucleus of the companion cell supports both its own cell and the cell of its associated sieve-tube element

**complex tissue**

tissue that consists of more than one cell type, e.g. [phloem](#)

**compression**

a fossil preservation type in which a thin film of organic matter is preserved; compare to [impression](#)

**cone**

see [strobilus](#)

**convergent evolution, convergence**

the [independent](#) development of similar ([analogous](#)) structures in different groups; convergent evolution is thought to be the result of similar environmental selection pressures on different groups

**cork**

a plant tissue composed of cells whose walls are impregnated with suberin and are non-living at maturity; cork is produced by the [cork cambium](#)

**cork cambium**

a narrow cylindrical sheath of [meristematic](#) cells that produces [cork](#) cells to replace the epidermis during [secondary growth](#) (growth in width)

**cortex**

a primary tissue composed mainly of [parenchyma](#) cells, which extends between the [epidermis](#) and the [vascular tissue](#)

**cotyledon**

the embryo leaf or leaves of seed plants that usually stores or absorbs food in a young seedling; in angiosperms (flowering plants) the following distinction is made with respect to the cotyledons: dicots have two cotyledons and monocots have one cotyledon

**cross-section**

see [transverse section](#)

**crozier**

the spirally coiled "fiddlehead" of an immature fern leaf

**cupule**

structures that surround one or more [ovules](#) or [seeds](#); the cupule lobes may be free or united

**cuticle**

an impermeable layer of [cutin](#) on the outer walls of [epidermal](#) cells

**cutin**

the waxy substance of which a [cuticle](#) is composed

**deciduous**

falling off; in plants: shedding leaves annually

**decussate branching**

a type of branching in which the appendages are attached in pairs either alternately (alternate decussate) or at right angles (opposite decussate) to one another; the result are four ranks or rows of appendages

**derived trait**

same as **apomorphy**; a derived character / trait is inferred to be a modified version of a more primitive condition of that character and therefore inferred to have arisen later in the evolution of the [clade](#)

**determinate growth**

a type of growth in which the axis ceases growing, usually after the [apical meristem](#) differentiates into a reproductive organ, such as a [flower](#) or a [cone](#)

**dichotomous branching**

a type of branching in which the [apical meristem](#) divides into two more-or-less equal apices; by repetition of this type of branching in various planes distinctive shoot systems may be produced; for example see [decussate branching](#)

**dictyostele**

a dissected [siphonostele](#) with two or more overlapping leaf bases

**dioecious**

having unisexual reproductive structures confined to [separate](#) plants, i.e. female plants have only female reproductive structures, and male plants will have only male reproductive structures; compare with [monoecious](#)

**disjunct distribution**

discontinuous distribution of a species

**disparity**

distinct in morphological characters; morphological variation; compare to [diversity](#)

**dispersal**

to disperse: to dispel or scatter; in plants dispersal refers to mechanism of dispersing reproductive propagules like seeds or pollen

**diversity**

a terms used to describe number of taxa (species, genera etc.) and their relative abundance; also species richness; compare to [disparity](#)

**double fertilization**

in flowering plants: the more or less simultaneous union of one sperm and one egg to form a zygote ( $N=2$ ) and another sperm with two polar nuclei to form triploid ( $N=3$ ) [endosperm](#) in the ovule; in the Gnetales: the fusion of two sperm with two eggs to produce two zygotes, only one of which will mature into an embryo

**double integument**

the two outermost layers of an [ovule](#) in angiosperms, one of which will differentiate into the seed coat; see [integument](#)

**ectophloic**

having [phloem](#) only on the outer side of the stele; compare to [amphiophloic](#)

**embryophyte**

the group of all organisms that retain the zygote on the parent to form an embryo

**enation**

a non-vascularized, [epidermal](#) outgrowth found in some early land plants

**endarch**

a type of [xylem](#) maturation in which [protoxylem](#) is internal to [metaxylem](#) and development proceeds centrifugally (from the inside out); for comparison see [exarch](#) and [mesarch](#)

**endemic**

belonging or native to a particular region or area and found only in that area, for example a plant endemic to California is native to California, i.e. in the wild it occurs only in California

**endosperm**

the triploid ( $N=3$ ) product of [double fertilization](#) in angiosperms; during [seed](#) maturation the endosperm will develop into a storage tissue that will provide nutrients to the seedling as it emerges (in monocots) or that will be digested and stored by the cotyledons before germination (in dicots)

**endosporic**

[gametophyte](#) develops within the spores wall; compare with [exosporic](#)

**endotesta**

the delicate, innermost layer of the [integument](#) in some [seeds](#); compare to [sarcotesta](#) and [sclerotesta](#)

**entire margin (leaves)**

margin forming a smooth line or arc without noticeable serrations; note that lobed leaves can also have entire margins; compare to [lobed margin](#) and [toothed margin](#)

**epidermis**

the exterior tissue, usually one cell thick, of leaves and young stems and roots

**Euphyllophytina**

clade comprising the [seed plants](#), sphenopsids, ferns and *Psilophyton*; synapomorphies for the clade include among others a basically helical arrangement of small, pinnule-like vegetative branches, recurvation of branch apices and paired sporangia grouped into terminal branches

**eusporangium, eusporangiate**

eusporangium: sporangium that arise from a group of superficial cells; this is the primitive [character state](#) in vascular plants; compare to [leptosporangium](#)

**eustele**

a [stele](#) type, in which the vascular bundles are organized into strands of [xylem](#) flanked by strands of [phloem](#) on the outside; in [transverse section](#) the eustele appears as a ring of discrete [vascular bundles](#);

**evergreen**

opposite of [deciduous](#), i.e. evergreen plants do not shed all their leaves annually, but shed and grow new leaves continually; most conifers are evergreen, but the evergreen habit is not restricted to conifers

**evolutionary grade**

same as [paraphyletic group](#) showing similarities in morphology, ecology or life history

**evolutionary systematics**

same as synthetic systematics; a way to determine natural relationships of organisms by studying a group in detail and comparing degree of similarity; evolutionary systematics does not have an explicit methodology, but rather relies on the expertise of authorities very familiar with the group in question; compare to [phenetics](#) or [numerical taxonomy](#) and [phylogenetic systematics](#) or [cladistics](#)

**exarch**

a type of [xylem](#) maturation in which [protoxylem](#) is external to [metaxylem](#) and development proceeds centripetally (from the outside in); for comparison see [endarch](#) and [mesarch](#)

**exine**

the outermost layer of the wall of [pollen](#) and [spores](#); made of [sporopollenin](#); compare to [intine](#)

**exosporic**

[gametophyte](#) development outside the [spore](#) wall, i.e. the development of a free-living, multicellular gametophyte

**extant**

currently existing; living now

**extinct**

no longer existing; not living anymore

**fiber**

a long-walled plant cell which is often dead at maturity; fibers impart elasticity, flexibility and tensile strength to plant structure

**flower**

condensed reproductive shoot of flowering plants, generally consisting of four whorls from the outside in: [sepal](#), [petal](#), [stamen](#), and [carpel](#); the diversity of flower form comes from variation of the general four-whorled structure

**form taxon**

binomial name (genus and species) given to a fossilized plant organ when it is found in isolation, i.e. when the taxonomic affinities of the organ are not known with certainty; for example [spore](#) and [pollen](#) taxa have their own binomial names, since it is rarely known which fossil genus may have produced them

**fossil**

any evidence of past life; any remains of any once living organism preserved in the Earth's rocks

**frond**

[leaf](#) of a fern

**fusain**

fossil charcoal; a component of coal and sedimentary rocks characterized by black color, silky luster and fibrous texture

**fusiform**

tapering towards each end; football-shaped

**gametophyte**

the haploid phase ( $n=1$ ) of a life cycle on which gametes are produced

**grade**

see [evolutionary grade](#)

**ground tissue**



a tissue consisting mostly of [parenchyma](#) cells that makes up the bulk of a young plant

**growth form**

general description of the type of growth exhibited by a plant, such as herbaceous, shrubby (bush-like) and arborescent (tree-like)

**heterochrony**

an evolutionary change in phenotype based on an alteration in timing of developmental events

**heterosporous**

having two types of spores: [megaspores](#) and [microspores](#)

**homologous, homology**

homology: likeness and correspondence in structure between parts of different organisms, due to common ancestry of the organisms; compare to [analogy](#);

**homoplasy**

same as [convergence](#);

**homosporous**

having one type of spore

**hydroid**

the water conducting cells of bryophytes; compare to [leptoid](#)

**impression**

a type of preservation that represents the negative imprint of an organism; compare to [compression](#)

**index fossil**

a geographically widespread fossil, that is diagnostic of a particular time period and therefore useful in correlating the age of rock formations from different geographic areas

**integument**

the outermost layer(s) of an ovule which will develop into the [seed](#) coat; most seed plant [ovules](#) have one integument, angiosperm ovules have two integuments (see [double integument](#))

**internode**

the segment of a plant [stem](#) between the points where leaves are attached

**intine**

the innermost layer of the wall of [pollen](#) and [spores](#); made of [cellulose](#) and pectates; compare to [exine](#)

**leaf**

a flattened, photosynthetic structure of a plant arranged on a [stem](#)

**leaf gap**

a parenchyma filled interruption in a stem's cylinder of vascular tissue immediately above the point at which a branch of [vascular tissue](#) (**leaf trace**) leading to a leaf occurs

**leaf trace**

a branch of vascular tissue leading from the main vascular cylinder of the [stem](#) to a **leaf**

**leptoid**

photosynthate conducting cells of bryophytes; compare to [hydroid](#)

**leptosporangium, leptosporangiate**

leptosporangium: sporangium developed from a single superficial cell; leptosporangiate: having leptosporangia; this is a derived [character state](#) in the fern clade; compare to [eusporangium](#)

**lignite**

see [coal](#)

**ligule**

a tiny, tongue-like appendage on the [adaxial](#) surface of leaves of some members of the lycopods

**lobed margin (leaves)**

margin indented one quarter or more of the distance from the margin to the midvein or (where this is lacking) to the long axis of the leaf; compare [entire margin](#) and [toothed margin](#) leaves

**long shoot**

shoots that are distinguished by their widely separated nodes and internodes; compare with [short shoot](#)

**lumen**

intercellular space

**manoxylic wood**

wood type that contains abundant [parenchyma](#); typical of cycads; compare with [pycnoxylic](#)

**massule**

a large mass of mucilaginous material that encloses the microspores of water ferns like *Azolla*

**megagametophyte**

in [heterosporous](#) plants and in [seed plants](#): the female [gametophyte](#) produced by a [megaspore](#)

**megaphyll**

a **leaf** with more than one vein and a [leaf trace](#) associated with a [leaf gap](#) in the stele; compare to [microphyll](#)

**megasporangium**

a [sporangium](#) that produces [megaspores](#); see also [heterosporous](#)

**megaspore**

a large, haploid ( $N=1$ ) spore of a [heterosporous](#) plant that produces a [megagametophyte](#) (female gametophyte)

**meiotic**

pertaining to meiosis: a two stage type of cell division in sexually reproducing organisms that produces gametes with half the chromosome number of the original cell

**meristem**

region of totipotent cells in which cell division and initiation of tissues and organs takes place; see [apical meristem](#), [vascular cambium](#) and [cork cambium](#)

**mesarch**

a type of [xylem](#) maturation in which the [protoxylem](#) is embedded in the [metaxylem](#) and development proceeds both centripetally (from the outside in) and centrifugally (from the inside out); compare to [endarch](#) and [exarch](#)

**mesophyll**

[parenchyma](#) tissue between the upper and lower [epidermis](#) of a **leaf**

**metaxylem**

a type of primary [xylem](#) that differentiates and matures later than the [protoxylem](#); generally metaxylem tracheids are longer than protoxylem

**microgametophyte**

in [heterosporous](#) plants and in [seed plants](#): the male [gametophyte](#) produced by a [microspore](#)

**microphyll**

a **leaf** vascularized by a single [vascular bundle](#) that is not associated with a [leaf gap](#) in the [stele](#); this type of leaf is typical of the lycopods; compare to [megaphyll](#)

**micropyle**

a small opening in the [integument](#) at the apex of a [seed](#) through which either pollen (gymnosperms) or the pollentube (angiosperms) enters

**microsporangium**

a sporangium that produces [microspores](#); also see [heterosporous](#)

**microspore**

a small, haploid ( $N=1$ ) spore of a [heterosporous](#) plant that produces a [microgametophyte](#) (male gametophyte)

**midden, pack-rat midden**

midden: garbage or refuse heap; packrats (*Neotoma* sp.) collect and store plant and animal parts in middens; plant material is preserved and cemented together by urine and feces from the packrats; packrat middens are only found from the

later part of the Pleistocene through the present, but their fossils have been instrumental in reconstructing Pleistocene and Holocene vegetational changes in the North American southwest and have also been important in archeological studies

**mold**

a three-dimensional preservation type that represents a negative image of the plant; compare to [cast](#)

**molecular fossil**

non-structural compounds, for example break-down products of pigments or lignins

**monocarpic**

a plant that produces reproductive propagules only once in its lifetime

**monoecious**

having female and male reproductive structures on the same plant; the reproductive structures can be either unisexual or bisexual; compare to [dioecious](#)

**monophyly, monophyletic group**

terms applied to a group of organisms that include an ancestor and all of its descendants; compare to [paraphyly](#), [paraphyletic groups](#) and [polyphyly](#), and [polyphyletic groups](#)

**monosaccate**

a pollen grain with one [saccus](#) or buoyant bladder

**monostelic**

having one [stele](#); compare to [polystelic](#)

**morphometrics**

method to define and describe morphological characters and character states based on quantifiable measurements; morphometrics can also help define form taxa by evaluating ranges of variation within and between groups

**node**

1. region of a stem where one or more leaves are attached; compare to [internode](#); 2. the branching points on a [cladogram](#), which are supported by synapomorphies

**nucellus**

[ovule](#) tissue within which an embryo develops (embryo sac); homologous with the [megasporangium](#) of a seed plant

**numerical taxonomy**

same as [phenetics](#); a method of generating phylogenies that is based on large numbers of quantifiable (measurable) [characters](#) which groups organisms with respect to [overall similarity](#)

**ontogeny**

the course of development of an individual organism

**Operational Taxonomic Unit**

see [OTU](#)

**order**

or evolutionary order; which character state that must follow another in a character transformation series - without any implication as to what characters are primitive versus derived. For example, the order of the character states "grey", "white", and "black" could be hypothesized to be white-grey-black (or black-grey-white).

**OTU**

or **Operational Taxonomic Unit**; definitions or names of the taxa included in a phylogenetic analysis

**overall similarity**

a method by which organisms that share the most similarities are grouped together; [characters](#) are not distinguished as to whether they are [primitive](#) or [derived](#) or whether they are evolutionary meaningful; also see [numerical taxonomy \(phenetics\)](#); compare with [phylogenetic systematics \(cladistics\)](#)

**ovary**

the enlarged basal portion of a [carpel](#), where the [ovules](#) are borne; the ovary differentiates into the fruit

**ovule**

unfertilized [seed](#); the ovule contains the [megasporangium](#) with the [megagametophyte](#), surrounded by one or two integuments [integument](#)

**palynomorph**

fossil spores and pollen; also dinoflagellates

**parallel evolution**

see [convergent evolution](#)

**paraphyly, paraphyletic group**

terms applied to a group of organisms that include an ancestor and some, but not all of its descendants; compare to [monophyly](#), [monophyletic groups](#) and [polyphyly](#), and [polyphyletic groups](#)

**parenchyma**

the most common type of plant cell; thin-walled cells varying in size, shape, and function

**parichnos**

an interconnected system of parenchymatous strands with many air spaces that extend throughout the vegetative organs of some arborescent lycopsids

**parichnos scars**

small scars that marks the position of the [parichnos](#) strands on stem fossils of the some arborescent lycopsids

**peat**

see [coal](#) accumulations of terrestrial organic material with little associated mineral sediment

**periderm**

a tissue primarily consisting of [cork](#) cells; outer bark

**permineralization**

a preservation type in which mineral matter has infilled intercellular and intracellular spaces, but has not replaced the cell walls; compare to [petrification](#) and [silification](#)

**petal**

one of the whorls of a flower; petals may be brightly colored

**petiole**

the stalk of a leaf

**petrification**

a type of preservation in which mineral matter infills intercellular spaces and replaces the cell walls; compare to [permineralization](#) and [silification](#)

**phenetics, phenetic systematics**

same as [numerical taxonomy](#)

**phenetic similarity**

same as [overall similarity](#)

**phloem**

photosynthate conducting tissue of vascular plants

**phosphate**

$\text{PO}_3^{4-}$ ; a mineral that often participates in permineralization

**phylogenetic character**

see [character](#)

**phylogenetic systematics**

same as [cladistics](#); a method of grouping organisms that is based [synapomorphies](#) or shared [derived traits](#) or characters; compare to [numerical taxonomy](#)

**phylogeny**

an hypothesis of evolutionary relationships among organisms; the pattern of lineage branching produced by the evolutionary history of the organisms considered

**physiognomy, foliar physiognomy**

analysis of leaf features that are sensitive to environment

**pinnae**

plural: (primary) pinna; first order of subdivision of a compound [leaf](#) or fern [frond](#)

**pinnule**

the second order of segments of a compound or dissected leaf  
**leaf** or **frond**

**pith**

the central parenchymatous tissue in a vascular plant axis

**platyspermic**

a flattened [seed](#) with bilateral symmetry

**plesiomorphy, plesiomorphic trait**

same as [primitive trait](#)

**polarity**

direction of evolutionary change; evolutionary order, i.e which [character state](#) follows another in a character transformation series

**pollen**

the microspore of [seed plants](#) that contains the microgametophyte (male gametophyte)

**pollination**

the transfer of [pollen](#) from the pollen organ to the ovule; for example in flowering plants from [stamens](#) to the stigmatic surface of the [carpel](#)

**polyphyly, polyphyletic group**

a group of organisms with different most recent ancestors

**polystelic**

having more than one [stele](#)

**primary growth**

growth in length, controlled by the [apical meristem](#)

**primary pinnae**

leaflet of first subdivision of a fern **frond** or compound leaf

**primitive trait**

same as **plesiomorphy**; a character that is present in the common ancestor of a clade; a primitive trait is inferred to be the original character state of that character within the clade under consideration; compare to [derived trait](#)

**procambium**

the primary [meristematic](#) tissue that gives rise to primary [xylem](#) and primary [phloem](#); procambia are found in apical as well as intercalary meristems

**protostele**

a type of stele with a solid core of primary [xylem](#)

**protoxylem**

the first primary [xylem](#) to differentiate and mature, usually before and during elongation of the axis; protoxylem cells are generally smaller in diameter than metaxylem

**pychnoxylic wood**

dense wood that contains little parenchyma; typical of *Archeopteris* conifers; compare to [manoxylic](#)

**pyrite**

FeS<sub>2</sub> a common mineral that participates in permineralization

**quadriseriate**

in four ranks or rows; for example see [branching](#)

**radiospermic**

a round [seed](#); a seed with radial symmetry

**rhizome**

a (usually) underground stem that is horizontally oriented; rhizomes may appear like roots, but have a definite [node](#) and [internode](#) architecture

**root**

a plant organ that functions in anchorage and absorption; in seed plants derived from a bipolar embryo

**saccate pollen**

pollen with a [saccus](#) or [sacci](#); characteristic of many conifers

**saccus/sacci**

a winglike or bladderlike extension on a pollen grain;

**sarcotesta**

the usually parenchymatous outer layer of the [integument](#) in some [seeds](#); see also [endotesta](#) and [sclerotesta](#)

**sclereid**

a short, irregular [sclerenchyma](#) cell with pits; sclereids function as tissue support

**sclerenchyma**

tissue composed of cells with walls thickened with lignin; sclerenchyma tissue functions primarily in strengthening and support

**sclerotesta**

the middle, fibrous layer of the [integument](#) in some [seeds](#); see [endotesta](#) and [sclerotesta](#)

**secondary growth**

growth in width initiated and maintained by the [vascular cambium](#) and [cork cambium](#)

**secondary xylem**

xylem produced by the [vascular cambium](#), see also [xylem](#), and compare with [primary](#) and [secondary growth](#)

**seed plants**

a monophyletic clade of plants that reproduces by [seeds](#); megagametophyte is retained on the parent sporophyte and enclosed in an integument; microgametophyte is transferred to the megametophyte

**seed**

a fertilized [ovule](#); [megasporangium](#) that contains an embryo enclosed in an integument

**segment**

individual divisions on a [pinnule](#)



**sepal**

a whorl of a [flower](#); sepals often resemble reduced leaves and function in the protection of the bud; sepals may be modified to function more like a petal

**short shoot**

shoots that are characterized by short internodes giving the shoot a crowded appearance; compare with long shoot

**sieve cell**

a [phloem](#) conducting cell type in all vascular plants except angiosperms

**sieve plate**

area of the wall of a sieve tube element that contains several to many perforations that permit cytoplasmic connections between [sieve tube cells](#)

**sieve tube cell**

(in angiosperms) a specialized cell derived from the same parent cell as the closely associated [companion cell](#) immediately adjacent to it; sieve tube cells are elongated cells with sieve plates; sieve tube cells form sieve tubes through which photosynthate is transported

**silification**

a type of fossilization in which silica ( $\text{SiO}_2$ ) infills intercellular spaces ([permineralization](#)) or replaces the cell walls ([petrification](#))

**silica**

$\text{SiO}_2$ ; occurring in crystalline (quartz), cryptocrystalline (very finely crystalline; crystals are very, very small) (opal) and non-crystalline (chert) forms; one of the most common minerals in the crust of the earth; an important mineral in the process of silification; also see permineralization

**simple tissue**

tissue composed of only one cell type

**siphonostele**

a type of [stele](#) that consists of a ring of [vascular tissue](#) surrounding a [pith](#)

**sinus**

the indentations of a lobed [pinna](#) / [segment](#) of a fern or of a dicot **leaf**

**sister group**

two clades that resulted from the splitting of a single lineage; sister groups share a common ancestor

**sorus, sori**

a cluster or group of [sporangia](#); most frequently applied to clusters of fern sporangia

**sporangiophore**

the stalk which terminates in a [sporangium is](#) produced

**sporangium, sporangia**

structure in which [spores](#) are produced

**spore**

a haploid (1N) reproductive cell capable of developing directly into a [gametophyte](#) without uniting with another cell

**sporophyll**

a modified leaf bearing [sporangia](#)

**sporophyte**

the [spore](#) producing, diploid (2N) phase of the life cycle; compare to [gametophyte](#)

**sporopollenin**

an organic polymer that makes up the coat of a pollen grain or spore; sporopollenin is extremely resistant to degradation

**stele**

the central vascular cylinder in stems and roots where the [vascular tissue](#) is located

**stem**

same as **axis**; a plant axis with [leaves](#) or [enations](#)

**stoma, stomata**

a minute pore or opening in the epidermis of leaves; stomata are flanked by two guard cells that regulate opening and closing of the pore and thus regulate gas exchange and transpiration

**strict consensus**

a method for choosing among several most parsimonious trees generated by a phylogenetic analysis; strict consensus means that only clades that show up in all the most parsimonious trees are recognized

**strobilus, strobili**

cone; an aggregation of [sporophylls](#) on a common axis

**symplesiomorphy, symplesiomorphic trait**

*shared* [primitive trait](#) ([plesiomorphy](#))

**synangium, synangia**

a reproductive unit composed of fused [sporangia](#)

**synapomorphy**

*shared* [derived trait](#) ([apomorphy](#)); a derived character that is shared between organisms; compare to [autapomorphy](#)

**systematics**

field of biology that deals with the grouping and organizing of organisms

**taxic homology**

correspondence in structure between [sister groups](#); for example [fronds](#) of ferns and leaves of dicots are taxic

homologies, i.e. they are derived structures from the same primitive structure of the common ancestor of these two groups

**taxonomy**

the naming of organisms and groups of organisms

**toothed margin (leaves)**

margin having projections or serrations with pointed apices, indented less than one quarter of the distance to the midvein or long axis of the leaf; compare entire margin and lobed margin leaves

**tracheid**

a water conducting and supportive cell type of [xylem](#) composed of long, thin cells with tapered ends and walls hardened with [lignin](#)

**tracheophyte**

plants with true vascular tissue, i.e. [xylem](#) and [phloem](#); compare to [leptoids](#) and [hydroids](#)

**transformational homology**

an evolutionary series of character states with no significant breaks (from the [plesiomorphic](#) ancestor to the [apomorphy](#) in the descendant)

**transverse section**

cross section; a section perpendicular to the longitudinal axis of the plant organ

**triarch**

consisting of three; for example a triarch [stele](#) has three lobes

**unifacial (vascular cambium)**

having one "face", i.e. a [cambium](#) that produces cells only on one side; a unifacial vascular cambium that produces only secondary xylem is found in some fossil non-seed plants; compare to [bifacial](#) vascular cambium and [vascular cambium](#);

**vallecular canal**

air-filled canals in the cortical ([cortex](#)) tissue of some sphenophytes that alternate with the [vascular bundles](#)

**vascular bundle**

a strand of tissue composed mostly of [xylem](#) and of [phloem](#);

**vascular cambium**

a lateral [meristem](#) that produces secondary vascular tissue in stems and roots; see [cambium](#) and [bifacial](#) and [unifacial](#) vascular cambium

**vascular tissue**

tissue composed of conducting cells, i.e. [xylem](#) and [phloem](#)

**vessel element**

a water conducting, specialized short, wide cell in angiosperms; vessel elements are arranged from end to end in a tube-like

fashion; the perforated or open ends of the vessel elements allow water to pass freely; a type of [xylem](#) tissue; compare to [tracheid](#)

**vicariance**

separation of a continuously distributed ancestral population or species into separate populations, due to the development of a topographic or ecological barrier

**wood ray**

a radially oriented tier of parenchyma cells that conducts food, water, waste products and other materials laterally in stems and roots of woody plants; rays are usually continuous across the vascular cambium between the secondary [phloem](#) and [xylem](#)

**xylem**

tissue through which most of the water and dissolved minerals utilized by a plant are transported; see [vessel elements](#) and [tracheids](#)