

Glossary - Botany-1

Aleuron: (Gk. aleuron, flour) A proteinous material usually in the form of small granules occurring in the outermost cell layer of the endoderm of wheat and other grains; if contacted with water release a plant hormone triggering germination of the seed.

Bark: The ruptured original cortex and epidermal layer of the seedling when secondary growth takes place; it consists mainly of periderm (underlying phloem and many layers of cork-cells that die but remain in place to make the outer protective bark).

Cambium: (L. *cambiare*, to exchange) A meristem that gives rise to parallel rows of cells (secondary growth - dilatation); commonly applied to the vascular cambium and to the cork cambium, or phellogen.

Cork C.: The outer part of the *lateral meristem* that forms the periderm, producing cork (phellem) and growth rings toward the surface (outside) of the plant and phelloderm toward the inside; common in stems and roots of gymnosperms and dicots.

Pericamb.: Ruptures epidermis during secondary growth, seals off the vascular cambium against loss of water and other nutrients taken up from the environment; common in root and stem.

Procamb.: A primary meristematic tissue, derived from the apical meristem, that gives rise to primary vascular tissues (primary phloem and xylem as well as fascicular cambium).

Vascular C.: The internal part of the *lateral meristem* in which secondary growth occurs (secondary xylem and phloem).

- **Fascicular- and C.:** The vascular cambium originating within a vascular, or fascicle i.e. between phloem and xylem in plants with secondary growth - alternating with the interfascicular cambium; both arise from the procambium.
- **Inter-Fascicular C.:** The portion of the cambium located in the interfascicular regions, or pith rays - alternating with the fascicular cambium; a derivative of the procambium as well.

Casparian Strip: (Caspary, german botanist) A bandlike region of primary wall containing suberin and lignin; found in anticline (radial and transverse) walls of endodermal cells (see endodermis).

Carotenoid: Certain yellow and orange pigments in plant plastids that can function as accessory pigments in photosynthesis (when too sunny absorb excess photons and convert them into heat); such pigments are responsible for the color in fruits and veggies and autumn leaves.

Carbohydrates: Generally contain C, H, O in a ratio of 1:2:1 (CH₂O); commonly considered as the universal cellular fuel, suffixed *-ose*;

1.Monosaccharides: Single sugars

- Fructose: C₆H₁₂O₆; sweet tasting fruit-sugar - pentagonal ring-shaped.
- Glucose: C₆H₁₂O₆; 6C+6OH₂-groups - hexagonal ring-shaped.
- Ribose: C₅H₁₀O₅; backbone of RNA - pentagonal ring-shaped.
- Deoxyribose: C₅H₁₀O₄; backbone of DNA - pentagonal ring-shaped.
- Glyceraldehyde: C₃H₆O₃ - a linear molecule.
- Galacturonic Acid: C₆H₁₀O₇; a derivative of glucose - hexagonal ring-shaped.
- Xylose: C₅H₁₀O₅; a derivative of glucose - hexagonal ring-shaped.
- Galactose: C₆H₁₂O₆; a derivative of glucose - hexagonal ring-shaped.
- Fucose: C₆H₁₂O₅; a derivative of glucose - hexagonal ring-shaped.
- N-Acetylglucosamine: C₈H₁₅O₅N; building block of chitin - hexagonal shape.

2.Disaccharides: Two monosaccharides (simple sugars) joined together by an endergonic process known as condensation - such joined molecules can be broken apart by hydrolysis (exergonic); e.g.

Sucrose: Table sugar (glucose + fructose), the form in which most sugar is transported in plants; found in two helical forms which tend to cluster into grains:

- Amylose: A single molecule of amylose contains up to 1000 glucose subunits in an unbranched chain wound to a helix.
- Amylopectin: A molecule of it may contain up to 6000 glucose subunits with periodically branching units every 24/36th glucose molecule; winds also into a form of helix.

Maltose: Two joined glucose molecules formed to a ring.

3. Polysaccharides: A multi glucose-molecule.

- Starch: The principle storage polysaccharide in plants and consists of many glucose molecules;
- Glycogen: The principle storage polysaccharide in animals and fungi, bacteria;

- Cellulose: The most abundant insoluble polysaccharide; the bonds linking the glucose molecules are different from those in starch which render them very rigid and difficult to be hydrolyzed by enzymes. Cellulose incorporated into cell walls is no longer available as an energy source.
- Pectin: Pectic polysaccharids; pectic compounds are built up of residues of galacturonic acid; polymers of this sugar are known as pectic acid; Ca- and Mg- salts make up the most of the middle lamella, which bind adjacent cells.
- Hemicellulose: The building block sugars of CH is xyloglycan (a xylose side chain attached to glucose chain).
- Chitin: Monomers of C6-sugars with an attached N-group (N-acetylglucosamine) are joined together to form a strong polysaccharide structure.

Cell: The basic unit of life; able to reproduce independently; a plant cell is distinguished from an animal cell by four unique components: vacuole, plastids, and an extra rigid cellulose bounded cell wall;

Protoplast: (Gk. protos, first) The protoplasm (living substance) of an individual cell, it consists of the nucleus (nuclear envelope, nucleoplasm, chromatin = DNA, nucleolus)

Cytoplasm: (Gk. cyto, cell) The groundsystem between the outer membrane and the nuclear envelope with the cytoplasmic matrix (skeleton of microtubuli and actin filaments - see cytoplasmic streaming), bilayered organelles (plastids and mitochondria), the endomembrane system (ER, dictyosomes, vesicles, plasma membrane), and ribosomes.

Optionals: Crystals, starch grains, tannins, fats, oils, waxes, protein bodies, anthocyanins.

Vacuole: A large compartment within the cytoplasm filled with a watery fluid, the cell sap; enclosed by the tonoplast (see there).

Cell Wall: The rigid cellulosic outer layer of cells found in plants, some protista, and most bacteria.

Middle Lamella: The region of union of the primary CW of adjacent cells, also known as intercellular substance which is made mostly of pectic substances.

Primary CW.: Made of cellulosic layers (plus hemicellulose, pectin, enzymes, and glycoproteins).

Secondary CW.: Innermost layer of the cell wall, formed in certain cells after cell elongation has ceased. The protoplast deposits additional cellulosic wall layers inside the primary CW, resulting in a growth from outside to inside (forming a three-layered matrix with different orientation, rendering it more stable - highly organized microfibrillar structure); secondary CW serve as reinforcement and are involved in water conduction after the protoplast has died.

Cellulose: A *carbohydrate*; the chief component of the cell wall in all plants and some protists (see fibril).

Chlorophyll: (Gk. chloros, green; phyllon, leaf) The green pigment of

plant cells, which is the receptor of light energy in photosynthesis; h , planck c. $6.63 \cdot 10^{-34}$ [J·s]

also found in algae and photosynthetic bacteria (see granum): f , frequency [1/s] [Hz]

$E = h \cdot f$ [N·m] = [J]

Chl.-a: In all photosynthetic eukaryotes and cyanobacteria; a large molecule with a central core consisting of a Mg-ion held in a porphyrin ring attached to it is a long insoluble hydrophobic carbohydrate tail (phytyl), which anchors it in the thylakoid membrane.

Chl.-b: An accessory pigment that serves to broaden the range of light that can be used in p.-synthesis.

Chl.-c: Takes the place of chlorophyll-b in some groups of algae.

Collenchyma: (Gk. kolla, glue) A supporting tissue composed of collenchyma cells; often found in regions of primary growth in stems (beneath the epidermis) and in some leaves (compare parenchyma, sclerenchyma).

C. Cells: Elongated living cells with irregularly thickened primary cell wall supporting stems and leaf ribs (shapes range from edge-, unilateral-, or gap-like reinforcements of the primary cell wall; alive at maturity).

Companion Cell: A specialized parenchyma cell associated with a *sieve-tube member* of the phloem by regulating its activities; a somewhat elongated cell with a primary cell wall, alive at maturity (see there).

Cortex: *Ground-tissue* or parenchymatic tissue of the *stem* bounded externally by the epidermis and internally by the phloem of the vascular system or by the pericycle in *roots*; (D=rindenparenchym).

Cotyledon: (Gk. kotyledon, cup-shaped, hollow) Seed leaf; generally stores food in dicotyledons and absorbs food in monocotyledons (D. keimblatt).

Dicot.: Dicotyledons - One of the two classes of angiosperms; are characterized by having two cotyledons, net-veined leaves often revealing secondary growth; vascular bundles are arranged along a circular pattern; usually taprooted; flower parts usually in multiples of fours or five's.

Monocot.: Monocotyledons - plant embryo has one cotyledon; flower parts usually in multiples of three; no true secondary growth; fibrous root system; widely distributed vascular cambium.

Epicotyl: The upper portion of the axis of an embryo or seedling, above the cotyledons (seed leaves) and below the next layer of leaves.

Hypocotyl: The portion of an embryo or seedling situated between (as well as under the soil) the cotyledons and the radicle, e.g. taproots.

Cuticle: Waxy or fatty layer on the outer wall of epidermal cells facing the surrounding environment, formed of cutin and wax - it is characterized by three distinct layers (from outside to inside): the epicuticular wax (lipid protective coat), the proper cuticle (cutin and cuticular wax), and cellular layer (cutin + cellulose + pectin) which generally is followed by a layer of pectin.

Cutin: (L. cutis, skin) Fatty, lipid substance deposited in many plant cell and walls on outer surface of epidermal cell walls, where it forms a protective layer known as a cuticle.

Cytochrome: (Gk. kytos, hollow vessel; chroma, color) Heme proteins serving as electron carriers in respiration and photosynthesis.

Cytoplasm: The living matter of a cell, exclusive of the nucleus, also known as protoplasm.

C. **Streaming:** Or cyclosis, the orderly sweeping along of suspended substances (plastids and other organelles) in circular movements between tonoplast and plasma membrane as long as the cell is alive; can be induced (due to external influences) or spontane (self triggered).

Dicot: see cotyledon.

Dilatation: see cambium and growth - secondary .

Dermal Tissue System: The epidermis or the periderm.

Endodermis: (Gk. endon, within; derma, skin) A single layer of cells forming a sheet around the vascular region in roots and some stems; the endodermal cells are (endo) form the casparian strip. In roots and stems of seed plants, the endodermis is the innermost layer of the cortex (D = prim. rinde) .

- **Primary E.:** Simple layer of cells only equipped with the casparian strip on its anteklinal walls.
- **Secondary E.:** Additional deposition of an internal suberin-lamella over all walls.
- **Tertiary E.:** Thick, often lignified material of cellulose sits on top of the suberin layer.

Epidermis: (Gk. epi, upon) The outermost layer of cells of the *leaf* (housing stomata, trichomes and, or spines) and of young *stems* and *roots* which protect and retard water loss; primary in origin - to be replaced by the periderm during secondary growth (see tissue).

Periderm: (Gk. peri, around; derma, skin) Outer protective tissue of roots that replaces epidermis (develops out of the pericycle) when it is ruptured during secondary growth of the pericycle; includes cork, cork cambium, and phelloderm.

Phelloderm: (GK. phellos, cork; derma, skin) A tissue formed inwardly by the cork cambium, opposite the cork; inner part from the periderm.

Protoderm: (Gk. protos, first; derma, skin) Primary meristematic tissues, derived from the apical meristem, that give rise to epidermis.

Rhizoderm: Outgrowths of the epidermal layer forming the root hair which increase the absorptive capacity of a root.

Diffusion. (L. diffundere, to pour out) The net movement of suspended or dissolved particles from a more concentrated region to a less concentrated region as a result of random movement (Brownian motion) of individual molecules resulting in a uniform distribution within the medium:

$D = d^2/t$ [m ² /s]	d, distance	[m]
	t, time	[s]
	(see osmosis)	

Endosymbiont Hypothesis: The idea that mitochondria and chloroplasts originated from prokaryotes that fused with a nucleated cell - this is sustained by the fact that mitochondria and chloroplasts still have their own DNA.

Fibril: Submicroscopic threads composed of cellulose molecules, which constitute the form in which cellulose occurs in the cell wall (see there).

Macro F.: A bundle of microfibrils make of a macrofibrille.

Micro F.: A cross-linked matrix of micelles wounded to a thread (like a steel cable).

Micelle: Fine threads of united cellulose molecule chains which form the microfibrille.

Fixation: Fixation of nutrients from soil or air.

Carbon-F.: The conversion of CO₂ into organic compounds during photosynthesis.

Nitrogen-F.: The incorporation of atmospheric nitrogen into nitrogen compounds; carried out by certain free-living and symbiotic soil bacteria. They enter the roots to form nodules, providing the plant with nutrients it can't generate itself: $N_2 + 8(H) \rightarrow$ (nitrogenase) $\rightarrow 2NH_3 + H_2$

Granum: Structures within chloroplasts, seen as green granules with a light microscope and as a series of stacked thylakoids with an electron microscope; the grana contain the chlorophylls and carotenoids and are the sites of the light reactions of photosynthesis.

Growth: In plants it is characterized by growth in height (primary G.) and thickness (secondary G.).

G. Layer: A layer in the secondary xylem or secondary phloem.

G. Ring: A growth layer in the secondary xylem or -phloem, as seen in transverse section; also called growth increment.

Primary G.: Growth originating in the apical meristem (tips of shoots and roots); primary growth results in increase in length (extension of plant body), due to apical meristems.

Secondary G.: Growth derived from secondary or lateral meristems (vascular- and cork cambiums); secondary growth results in an increase in girth (diameter by the growth of secondary xylem and -phloem); absent in annual and primitive plants.

Guard Cell: Pairs of specialized epidermal cells surrounding a pore, or stoma (see stomata).

Intercellular Substance: Middle lamella (see cell wall).

Kavitation: The fact in which water is "sucked" up from the roots to the top by evaporating water vapor from the leaves (see transpiration).

Lamella: (L. lamella, thin plate) Layer of cellular membranes, particularly photosynthetic, chlorophyll-containing membranes, the blade of the leaf.

Middle L.: The layer of intercellular material, rich in pectic compounds, cementing together the primary walls of adjacent cells.

Leaf: It is made of dermal tissue (upper and lower epidermis + stomata), ground tissue (mesophyll layer = palisade- and spongy parenchyma), and vascular tissue (venation by xylem and phloem).

L. Anatomy: A highly photosynthetic layer of palisade parenchyma beneath the upper epidermis; stomata are found beneath the lower epidermis followed by the spongy parenchyma which allows the exchange of gasses like H₂O-vapor and CO₂ (see also stomata).

- **Bifacial L.:** The upper section of the internal leaf houses the palisade parenchyma and xylem, whereas the lower part is occupied by the spongy parenchyma and phloem. Where in an *equifacial* leaf is made of palisade- and spongy parenchyma and the *dorsiventral* type is made up of palisade parenchyma only.
- **Unifacial L.:** The bifacial leaf is "rolled" into a cylindrical shape (with a central tubelike opening), where spongy parenchyma and phloem occupy the outer section of the cylinder, and palisade parenchyma along with xylem the inner section.

L. Architecture: Dicot leaves are laminated and broadly net-veined, and each leaf has a stalk or petiole and a blade; monocots such as corn plants have parallel venation and slender blades attached to the stem via a sheath not a petiole; gymnosperms have slender, axial, needle-like leaves and grow in clusters.

Legume: (L. legumen, leguminous plant) A member of the Fabaceae, the pea or bean family, rich in protein.

Leghemoglobin:

Lenticel: (L. lenticella, a small window) Spongy areas in the cork surface of the stem, roots, and other plant parts that allow interchange of gasses between internal tissues and the atmosphere through the periderm; and are tiny little bursts due to secondary growth of vascular plants.

Lignin: One of the most important constituents of the secondary wall of vascular plants, a stiffening material (used in the polymerization of cellulosic fibers) found in the secondary cell walls (between primary cell wall and plasma membrane); although not all secondary walls contain it; after cellulose, lignin is the most abundant plant polymer (see sclerenchyma).

Lipid: Biological molecules that consist mainly of hydrocarbon chains (fatty acids) and a glycerol head; do not dissolve readily in water (hydrophobic) .

Glycerol: A linear molecule of three carbons, each with a OH-group C₃H₈O₃.

Fatty acids: hydrophobic parts, soluble only in lipids and other hydrophobic solvents.

- **Saturated FA:** Do not have any double bonds within their CH-chain, hence are stiff, dense and straight - solid at room temperature; e.g.: palmitic acid CHO₂-14CH₂-CH₃.
- **Unsaturated FA.:** Do have one (monounsaturated) or more (polyunsaturated) double bonds in their CH-chain - liquid at room temperature e.g.: oleic acid CHO₂-14CH₂-2CH=CH₂-CH₃.

The four main groups of lipids are:

Triglycerides: A fat (solid) or oil (liquid) composed of 3 fatty acid tails joined to the three carbons of one glycerol; e.g.: C₃H₈O₃ + 3·(CHO₂-14CH₂-CH₃) → C₃H₅-3(CO₂-14CH₂-CH₃) + 3H₂O

Waxes: A sticky, solid, waterproof lipid which form the waterproofing of plants and fruits or the comb of beehives etc.

Cutin: An insoluble lipid polymer, commonly found on the outside of the epidermis.

• **Suberin:** An insoluble lipid polymer with an extra lignin-like component; it is the major component of cork cell walls of the secondary protective tissue, the Casparian strip and other endodermal cells.

Phospholipids: Similar like triglycerides but with only two fatty acid tails (diglyceride) attached to the glycerol backbone, with the third space occupied by a phosphorous-containing molecule. PS make up the bilayers in cell membranes, with their characteristic qualities - i.e.: a hydrophobic tail attached to a hydrophilic head, e.g.: $\text{organic-R-PO}_4^{+} \cdot \text{C}_3\text{H}_5 \cdot 3(\text{CO}_2 \cdot 14\text{CH}_2 \cdot \text{CH}_3) = (\text{P}_x + \text{glycerol} + \text{fatty acid})$.

Steroids: (Gk. steros, solid + L. oleum, oil) A major class of lipids based on a 17C-atom ring system and often a CH-tail - e.g.: cholesterol, sex-hormones.

Matrix: The cellulose framework (plus pectin, hemicellulose, and glycoproteins) of the primary cell wall (see there).

Cytoplasmic M.: The cellular soup (nucleus, membrane system and various entities) are suspended there; also known as ground substance or cytosol.

Meristem: (Gk. merizein, to divide) The undifferentiated, embryonic plant tissue from which new cells arise.

Apical M.: (L. apex, tip) The meristem at the tip of the root (incl. root cap) or shoot in a vascular plant, responsible for primary growth; it will be replaced by the protoderm, procambium and ground meristem.

Ground M.: The primary meristem, or meristematic tissue, derived from the apical meristem, that builds the ground tissues (pith, pith rays and cortex in stem and root).

Lateral M.: Meristems that give rise to secondary tissue; vascular- and cork cambium are responsible for secondary growth (absent in and annual plants like herbaceous).

Marginal M.: The meristem located along the margin of a leaf primordium and forming the blade.

Root M.: The apical and lateral meristem in roots, protected by the root cap.

Mesophyll: The ground tissue (palisade- and spongy parenchyma) of a leaf, located between the layers of epidermis (in conifers, the jig-saw cell wall projection); mesophyll cells contain chloroplasts.

Monocot: see cotyledon.

Mychorrhiza: A symbiotic association between certain fungi and plant roots; characteristic of most vascular plants; the fungi derives its resources from the outer dead bark-tissue, whereas the root extracts its nutrients (mainly phosphate products) from the fungi.

Endotrophic M.: Hyphae penetrates into the root system (w/o infection) increasing the contact zone.

Ectotrophic M.: The fungal hyphae surrounds the root hairs but does not penetrate into the root tissue.

Nutrients: Plants, like animals require certain chemical elements as nutrients, besides the basic resources (H_2O , CO_2 , light).

Macro-N.: C (45%), O_2 (45%), H_2 (6%), N_2 (1-4%) K (1%); 0.1%: Ca, Mg, P, S.

Micro-N.: 0.0001-0.01%: Fe, Cl, Mn, Br, Zn, Cu, Md.

Optional-N.: Si, Na, Co.

Osmosis: (Gk. osmos, impulse, thrust) The diffusion of water, or any solvent across a differentially semipermeable membrane; in the absence of other forces, the movement of water during osmosis will always be from region of greater water potential to one of less.

O. Pressure: The potential pressure that can be developed by a solution separated from pure water by a differently permeable or semipermeable membrane; it is an index of the solute concentration of the solution.

	ρ , density	[kg/m ³]
	g, accel. of gravity 9.81	[m/s ²]
	h, height	[m]

$$\Pi_0 = \rho \cdot g \cdot \Delta h \quad [\quad] = [\quad]$$

O. Solute Potential: Osmotic potential; the change in free energy or chemical potential of water produced by solutes; carries a negative (minus) sign:

	a, osmotic coeff.: sugar=1, NaCl = 2	
	c, concentration	[mole/kg]
	\mathfrak{R} , gas const 8.314	[J/(mole·K)]
	T, temperature	[K]

$$\Pi = a \cdot c \cdot \mathfrak{R} \cdot T \quad [\text{N} \cdot \text{m}/\text{kg}] = [\text{J}/\text{kg}]$$

O. Water Potential: (Ψ - psi) The algebraic sum of solute potential and the pressure potential or wall pressure - the potential energy of water:

$$\Delta \Psi = \Delta P - \Delta \Pi \quad [\quad]$$

	σ , reflex. coeff.: $\sigma_{\text{H}_2\text{O}}=0$, $\sigma_{\text{KCl}}=1$	
$= \Delta P - (\sigma \cdot \Pi + \tau)$	τ , source potential	[\quad]

Parasite: An organism that lives on or in an organism of a different species and derives nutrients from it; the association is beneficial to the parasite and harmful to the host.

Hemiparas.: A parasiting plant docks into the xylem (haustoria) to obtain water and minerals.

- Holoparas.:** The parasiting plant extracts all nutrients from the host by penetrating both xylem and phloem.
- Parenchyma:** (Gk. para, besides; en, in; chein, to pour) Living, generally thin-walled cell of variable size and form; the most abundant kind of cell in plants (compare sclerenchyma and collenchyma).
P. Cells: Many sided cells with thin primary walls; alive at maturity, found throughout the plant; serve mostly as photosynthetic storage sites, local conduction of materials and wound healing.
- Palisade P.:** A leaf tissue composed of columnar chloroplast-bearing parenchyma cells with their long axes at right angles to the leaf surface - this is the site of photosynthesis.
- Spongy P.:** A leaf tissue composed of loosely arranged, chloroplast-bearing cells (like lungs) in which the exchange of gases (CO₂ and H₂O) take place.
- Pathology:** The study of plant or animal diseases, their effects on the organism, and their treatment.
- Pectin:** A complex organic carbohydrate present in the intercellular layer and primary wall of plant cell walls; the basis of fruit jellies (see cuticle).
- Pericycle:** (Gk. peri, around; kykos, circle) A tissue, characteristic of *roots* that is bounded externally by the endodermis and internally by the phloem; the first layer behind the casparian strip facing the center; it develops into periderm (cork, cork cambium and phelloderm) and vascular tissue (secondary phloem and xylem).
- Periderm:** The outer protective bark, and cork cambium (cork and phelloderm); see dermal tissue.
- Peroxisome:** A microbody that plays an important role in glycolic acid metabolism associated with photosynthesis; the site of photorespiration.
- Phloem:** (Gk. phloos, bark) Food-conducting (alive) tissue of vascular plants, consisting of thin-walled sieve elements, along with companion cells (type of parenchyma), and sclerids (type of sclerenchyma).
 The phloem conducts photosynthetic products (sacharose and amino acids dissolved water - lower in viscosity than starch) down to the roots in summer and up to the developing leaves in spring.
- Primary P.:** The early food conducting tissue formed by the procambium.
Secondary P.: The late food conducting tissue formed by the vascular cambium.
- Photosynthesis:** (Gk photos, light; syn, together; tihenai, to place) The conversion of light energy to chemical energy; the production of carbohydrates from CO₂ and water in the presence of chlorophyll by using light energy to form saccharose, which is conveyed down to the roots where it will be converted into starch (storage site).
- Light Dependent Reaction: Occurs within the thylakoid-membrane (energy trapping reaction):

$$2 \text{H}_2\text{O} \rightarrow \text{photons} \rightarrow 4(\text{H}) + \text{O}_2, \quad (\text{H}) = \text{H}^+ + \text{e}^-$$
 - Light independent Reaction: Takes place in the stroma of the thylakoid - synthesis of glucose from CO₂, ATP and NADPH:

$$\text{CO}_2 + 4(\text{H}) \rightarrow \text{Calvin cycle} \rightarrow \text{CH}_2\text{O} + \text{H}_2\text{O}$$
- Photosystem I / II:** The discrete unit of organization of chlorophyll and other pigment molecules embedded in the thylakoids of chloroplasts and involved with the light requiring reactions of photosynthesis.
- Pit:** A recessed cavity in a cell wall of tracheids where the secondary wall does not form, allowing water to pass from one to the adjacent tracheid, - in *xylem* only.
P. Membrane: The middle lamella and two primary cell walls between two pits.
P. Pair.: Two opposite pits plus the pit membrane.
Bordered P.: A pit in which the secondary wall arches over the pit membrane.
Simple P.: A pit not surrounded by an overarching border of secondary wall;
- Pith:** Part of the stems ground tissue system; it is located at the center and serves as a reinforcing element increasing strength and stability (D=mark).
P. Ray: see ray, radial system.
- Plant:** The root and the shoot (stem and leaves); from the cell to tissue and organ (leaf) to the organism (plant).
C3-P.: Those in which the assimilation of atmospheric CO₂ is directly incorporated via the enzyme ribulose-1,5-biphosphate carboxylase in the cells of the leaf mesophyll (Calvin Benson Cycle)
C4-P.: Species of higher plants in which the assimilation of atmospheric CO₂ in photosynthesis is indirect - via the enzyme phosphoenol pyruvate carboxylase in the sheaths surrounding the veins of the leaves; the set of reactions through which CO₂ is fixed to a compound known as phosphoenolpyruvate PEP to yield oxaloacetate, a four -carbon compound).
CAM-P.: (Crassulacean acid metabolism) A variant of the C4 pathway; phosphoenolpyruvate fixes CO₂ in C4 compounds at night and then, during the day time, the fixed CO₂ is transferred to ribulose biphosphate of the Calvin cycle within the same cell. Characteristic of mot succulent plants, such as cacti.
Annual P.: A species with a life cycle which takes approximately 12 months or rather less to complete; whose life cycle is directly related to the annual cycle of weather; generations are discrete.

Flowering P.: The monocots and dicots (see cotyledon).

Perennial P.: (L. per, through; annus, year) The vegetative structures live year after year.

Deciduous P.: (L. decidere, to fall off) Shedding leaves at a certain season - acts as a water saving procedure when cold and icy winters limit the availability of liquid water.

Vascular P.: A root and shoot plant; consists of a protective outer covering (dermal tissue) and a vascular tissue (phloem, xylem - the internal transport system).

Plasmalemma: The outer boundary of the protoplast, next to the cell wall; consists of a single membrane; also called cell membrane and ectoplast.

Plasmodesma: (plasma, form; desma, bond) The minute cytoplasmic threads (desmotubules) that extend through openings in cell walls and connect the protoplasts of adjacent living cells.

Plasmolysis: (Gk. plasma, form; lysis a loosening) The separation of the protoplast from the cell wall because of the removal of water from the protoplast by osmosis, rendering the cell sap more dense and in some cases even darker.

Concave P.: Slight concave-shaped (diverging) contraction of the protoplast.

Convex P.: A further contraction of the protoplast resulting in a ball-shaped protoplast.

Plastid: (Gk. plastis, formed molded) Organelle in the cells of certain groups of eukaryotes that is the site of such activities as food manufacture and storage; plastids are bounded by two membranes.

Proplastid: Arise out of meristematic tissue and convert in the absence of light into leucoplasts, whereas with light become mature chloroplasts. Aging leuco- and chloroplasts finally will degenerate to chromoplasts.

- **Leucoplast:** (Gk. leuko, white) Colorless plastid; are commonly centers of starch formation.

Amyloplast: Formation and storage site of starch grains.

Elaioplast: Formation and storage site of lipids, oil-droplets.

Proteinoplast: Formation and storage site of proteins.

- **Chloroplast:** (Gk. chloros, green) A plastid in which chlorophylls are contained; the site of photosynthesis; it contains grana (stacks of thylakoids), starch grains and tiny lipid droplets.

- **Chromoplast:** (Gk. chroma, color) Final stage of the plant-plastid life cycle, containing pigments other than chlorophyll, usually yellow and orange carotenoid pigments.

Other plastids:

Apoplast: (Gk. apo, away from; plastos, molded) The cell wall continuum of a plant or organ; the movement of substances via the cell walls is called apoplastic movement or transport.

Ectoplast: Outer boundary of the protoplast, next to the cell wall; consists of a single membrane; also called cell or plasma membrane.

Phragmoplast:

Protoplast: The protoplasm or cytoplasm (living substance of cells) of an individual cell; in plants the unit of protoplasm inside the cell wall.

Synplast: The primary cells surrounding (outside) the casparian circle; water is conducted in-between the cells, whereas minerals follow the cytoplasmic pathway (via plasmodesmata).

Tonoplast: (Gk. tonos, stretching, tension) The cytoplasmic membrane surrounding the vacuole in plant cells; also called vacuolar membrane.

Trichoplast: Root tissue in direct contact with the soil, pumping ions through their cytoplasm.

Primordium: (L. primus, first; ordiri, to begin) A cell or organ in its earliest stage of differentiation.

Leaf P.: A lateral outgrowth from the apical meristem that will eventually become a leaf.

Pump: Transport proteins driven by either chemical energy (ATP) or light energy; in plant and fungal cells, they typically are proton pumps. In the absence of light, the cell must expend energy to pump ions into and out of the cell to maintain the correct internal concentration of each substance.

Ion P.:

Proton P.: Active pumping across a membrane-potential gradient of H⁺ ions.

Ray (or Radial System): In secondary xylem and -phloem, the term applied to all rays (propagate perpendicularly against phloem and xylem from inside to outside); the cells of which are derived from ray initials; also called the horizontal, or ray system. They excrete resins and other products to protect an open wound and speed up healing.

R. Initial: An initial in the vascular cambium that gives rise to the ray cells of secondary xylem and secondary phloem.

Primary R.: A radial ray protruding from the xylem to becoming a dilated phloem ray.

Secondary R.: Xylem rays not penetrating into the phloem.

Vascular R.: See vascular.

Reaction Center: The chlorophyll molecule of a photosystem capable of using energy in the photochemical reaction.

Resin: A chemical viscous fluid sap used to plug nearby xylem- and phloem tubes, once the outer layers of the stem are injured, preventing infection (see radial system).

R. **Duct:** A tubelike intercellular space lined with resin-secreting cells (epithelial cells); contain resin.

Rhizobia: (Gk. rhizom, root; bios, life) Bacteria of the genera *Rhizobium* or *Bradyrhizobium*, which may be involved with leguminous plants in a symbiotic relationship that results in nitrogen fixation.

Rhizome: A more or less horizontal underground stem.

Root: The usually descending axis of a plant, normally below ground, which serves to anchor the plant and to absorb and conduct water and minerals into it. Most of the minerals in roots follow the cytoplasmic pathways, while the water follows a cell-wall pathway through the cortex; at the endodermis both water and minerals have to pass through the cytoplasm (waxy casparian strip prevents uncontrolled influx). Since energy is spent to transport ions into the xylem (by active pumping), water follows by osmosis (low water potential).

R. **Anatomy:** Consists of dermal tissue (epidermis, root hairs), the ground system (cortex, epidermis) and the vascular system (pericycle, phloem, xylem, and piths in some plants).

R. **Architecture:** A root cap protects the underlying meristem, followed by a zone of elongation and a zone of maturation. Dicots usually are taprooted, whereas monocots tend to be fibrous.

R. **Cap:** A thumblike mass of cells that covers, protects and is made from the growing tip (meristem) of the root.

R. **Hairs:** Tubular outgrowths of epidermal cells of the root in the zone of maturation; they break off as the root penetrates deeper into the soil. typ. 400 [roothair/mm²]

R. **Pressure:** The pressure developed in roots as a result of osmosis, which causes guttation of water from leaves and exudation from cut stumps.

Types of roots:

Adventitious R.: Aerial roots that act as "fingers" e.g. strangler figs.

Aerial R.: The root system of mangroves grow upwards out of the mud to obtain adequate aeration.

Alburlizic R.: Protrude deep into the soil

Homoyrlizic R.: Do not reach deep into the soil, spread more or less vertically.

Prop R.: Aerial roots of plants increase mechanical support - as seen in tropical plants and palms.

Rubisco: RuBP carboxylase, the enzyme that catalyzes initial reaction of the Calvin cycle, involving the fixation of CO₂ to rubilose 1,5-biphospate (RuBP).

Sclereid: (Gk. skleros, hard) See sclerenchyma cell.

Sclerenchyma: (Gk. skleros, hard; L. enchyma, infusion) A supporting tissue of *stem* cortex and *vascular system*, composed of sclerenchyma cells, including fibers and sclereids. Dead at maturity with thick lignin-reinforced cell walls.

S. **Cell:** Or sclerid; a sclerenchyma cell with a thick, lignified secondary wall having many pits. Sclerids are variable in form but typically not very long; they may or may not be living at maturity.

S. **Fibers:** Very long and narrow with very thick primary and secondary walls - often dead at maturity; support the stem cortex and vascular system.

Secondary Plant Body: The part of the plant body produced by the vascular cambium and the cork cambium; consists of secondary xylem, secondary phloem, and periderm.

Shoot: The above-ground portions, such as the stem and leaves, of a vascular plant.

Sieve: A pore containing structure which allows fluids to pass in and out.

S. **Area:** A portion of the sieve-element wall containing clusters of pores through which the protoplasts of adjacent sieve elements are interconnected.

S. **Cell:** A long, slender sieve element with relatively unspecialized sieve areas and with tapering end walls that lack plates; found in the phloem of gymnosperms and seedless vascular plants.

S. **Element:** The cell of the phloem that is involved on the long-distance transport of food substance ; further classified into sieve cells and sieve-tube members.

S. **Plate:** One of the two perforated end walls of a sieve tube member.

S. **Tube:** A series of sieve-tuber members arranged end-to-end and interconnected by sieve plates.

- S. Tube Member:** Elongated cells, with a primary wall and sieve plates; alive at maturity, but lacks a functional nucleus (therefore always found in associated with a companion cell); stacked end to end to form sieve tubes; and serves as the main food-conducting cell in phloem of flowering plants.
- Starch:** (M.E. sterchen, to stiffen) A complex insoluble carbohydrate, the chief food storage substance of plants; composed of a thousand or more glucose units $C_6H_{10}O_5$.
- Stele:** (Gk. stele, a pillar) The central cylinder in young plants, inside the cortex (primary phloem and xylem), of roots and stems of vascular plants.
- Stem:** The part of the axis of vascular plants that is above ground, as well as anatomically similar portions below ground, such as rhizomes or corm.
- S. Anatomy:** It consists of apical meristems (leaf primordium and lateral buds - give rise to flowers and leaves, procambium - gives rise to the primary phloem and xylem), the dermal system (epidermis - cuticle prevents water loss), ground system (central pith and colenchyma - reinforcement structures), and the vascular system (vascular bundles of phloem and xylem, and cambium).
- S. Architecture:** Vascular cambium is widely distributed in monocots; dicots reveal a circular pattern.
- S. Bundle:** Vascular bundle belonging to the stem.
- Stipe:** A supporting stalk, such as the stalk of a gill fungus or leaf stalk of a fern.
- Stipule:** An appendage, often leaflike, that occurs on either side of the basal part of a leaf, or encircles the stem, in many kinds of flowering plants.
- Stroma:** (Gk. stroma, anything spread out) The ground substance (inner cavity) of plastids, outside the granum.
- Stomata:** (Gk. Stoma, mouth) A minute opening bordered by guard cells in the epidermis of leaves and stems through which gases pass; also used to refer to the entire stomatal apparatus - the guard cells plus their included pore; the higher the concentration of K^+ , Cl^- , and malat²⁻ ions the greater the pressure within the guard cell, followed by a net inflow of water (osmosis), resulting in open stomata.
- Amphistomatic Leaf:** Stomata are found on both sides of the leaf.
- Epistomatic Leaf:** Stomata are located on the upper side of the leaf, as in water plants.
- Hypostomatic Leaf:** Stomata located at the lower side of the leaf.
- Suberin:** (L. suber, the cork oak) Fatty, lipid material found in the cell walls of cork tissue and in the Casparian strip of the endodermis.
- Succulent:** A plant with fleshy, water-storing stems or leaves.
- Sucrose:** A carbohydrate-disaccharide (glucose + fructose) found in many plants; the primary form in which sugar is produced by photosynthesis is translocated.
- Taproot:** The primary root of a plant formed in direct continuation with the root tip or radicle of the embryo: forms a stout, tapering main root from which arise smaller, lateral branches.
- Texture:** Of wood, refers to the relative size and amount of variation in size of elements within the growth rings. It is the result of uniformity in cell dimensions - if uneven it is the results out of distinct differences between early and late growth rings.
- Thylakoid:** (Gk. thylakos, sac; oides, like) A saclike membranous structure in cyanobacteria and in the chloroplasts of eukaryotic organisms; in the stroma of chloroplasts, stacks of thylakoids form the grana; chlorophylls are found within the thylakoid membranes.
- Intrathylakoidal Space:** Internal compartment of the thylakoid; high in H^+ concentration ($pH \approx 5$) due to H_2O splitting; ion pumps convey them out of the stroma, generating ATP.
- Tissue:** A group of similar cells organized into a structural and functional unit
- Dermal T:** In young plants (primary growth) the *epidermis* and *cuticle*; in older plants (secondary growth) the outer protective bark replaces the epidermis.
- Ground T. System:** All tissues in the *stem* other than the epidermis (or periderm) and the vascular tissues; also called fundamental tissue system; it stores the starchy products of photosynthesis, keeps the plant from collapsing, etc.; It evolves into pith, pith rays and cortex; characterized by three distinct types of tissue (see coll-, par-, sclerenchyma):
- **Parenchyma:** Loosely packed thin-walled rounded cells - alive at maturity.
 - **Collenchyma:** Sticky quality, "glues" the plant together - alive at maturity.
 - **Sclerenchyma:** Surrounds and reinforces the tubes of the vascular system - often dead at maturity.
- Primary T.:** The tissue arising during primary growth (in roots: epidermis, vascular cylinder and cortex; in the stem: epidermis, primary phloem and xylem, and ground tissue).
- Secondary T.:** Tissues produced by the vascular- and cork cambium (in roots and stem: cork, phelloderm, secondary phloem and xylem).

- Vascular T.:** Xylem (water and mineral transport from soil, to root, stem, leaves); phloem (conveys sugars and proteins downwards from cells who store to those who need it in the summer and upwards in spring to the developing leaves).
- T. System:** A tissue or group of tissues organized into a structural and functional unit in a plant or plant organ: Dermal, vascular, and ground or fundamental tissue.
- Tracheid:** An elongated, thick-walled lignified water-conducting and supporting cell of xylem. It has tapering ends and pitted walls - dead at maturity. (compare vessel member).
- T. Element:** Water conducting cell in vascular plants; made of tracheids and vessel members
- Transpiration:** (L. *transpirare*, to perspire) The loss of water vapor by plant parts; most transpiration occurs through stomata. Water inside cells is drawn out, it is replaced by water molecules from the xylem. Because of the tendency of water molecules to form H-bonds, water molecules that evaporate from the leaf lift the following molecules constantly higher (transpiration-pull theory for water molecules).
Transpiration is highest when the on very sunny and hot days.
- Cuticular T.:** Cuticular transpiration can't be controlled, therefore kept low with a waxy cuticula.
- Stomatal T.:** Transpiration via stomata is the preferred way of gas metabolism.
- Trichomes:** (Gk. *trichos*, hair) An outgrowth of the epidermis, such as a hair, scale, spines, and water vesicle; also use to deter predators, and retard water loss.
- Turgor:** (L. *turgidus*, a swollen) Swollen, distended, referring to a cell that is firm due to water uptake.
- T. Pressure:** The pressure within the cell resulting from the osmotic movement of water into the cell.
- Vacuole:** (L. *vaccus*, empty) A large compartment within the cytoplasm filled with a watery fluid, the cell sap; part of the lysosomal compartment (hydrolysis - pH \approx 1) of the cell and is surrounded by the tonoplast. It can contain deposited crystals such as SiO₂, calciumoxalat, CaCO₃, Ba-sulfate, Ca-sulfate etc. which can deter predators by having toxic, lacrimogenic or other effects.
- Vascular:** (L. *vasculum*, a small vessel) Pertains to any plant tissue or region consisting of or giving rise to conducting tissue; e.g., xylem, phloem, vascular cambium.
- V. Bundle:** A strand of tissue containing primary xylem and -phloem (and procambium if still present) and frequently enclosed by a bundle sheath of parenchyma cells or -fibers.
- V. Cambium:** A cylindrical sheath of meristematic cells, the division which produces secondary phloem and -xylem (wood) - a type of lateral meristem.
- V. Rays:** Ribbonlike sheets of parenchyma that extend radially through the wood, across the cambium, and into the secondary phloem; they are always produced by the vascular cambium.
- V. System:** All the vascular tissues in their specific arrangement in a plant or plant organ.
- Vein:** A vascular bundle forming a part of the framework of the conducting and supporting tissue of a leaf or other expanded organ.
- Venation:** Arrangement of veins in leaf blade.
- Vessel:** (L. *vasculum*, a small vessel) A tubelike structure of the xylem composed of elongate cells (vessel member). Its function is to conduct water and minerals through the plant body. Found nearly in all angiosperms and flowering plants.
- V. Member:** Long and narrow, but generally shorter than tracheids; with primary and secondary cell walls dotted with pits and perforations; stacked and to end to form a long vessels - dead at maturity.
- Wall Pressure:** The pressure of the cell wall exerted against the turgid protoplast; opposite and equal to the turgor pressure.
- Water Potential:** The algebraic sum of the solute potential and the pressure potential, or wall pressure; the potential energy of water.
- Wood:** Secondary xylem.
- Heartwood:** Nonliving and commonly dark-colored wood in which no water transport occurs. Heartwood becomes infiltrated with oils, gums, resins and tannins, all of which render it dark, aromatic, and resistant to rot (older secondary xylem); it is surrounded by sapwood.
- Hardwood:** A name commonly applied to the wood of dicots.
- Sapwood:** Outer part of the wood of stem or trunk, usually distinguished from the heartwood by its lighter color, in which active conduction of water takes place (younger secondary xylem).
- Softwood:** A name commonly applied to the wood of a conifer.
- Tension W.:** The reaction wood of dicots; develops on the upper side of leaning trunks and limbs.
- Xylem:** (Gk. *xylon*, wood) Water and mineral transporting tissue of plants (from roots to the shoot and leaves), composed of thick-walled tracheids, vessels, parenchyma cells, and fibers; dead xylem cells form wood (see there).

Protoxyl.: The first of the primary xylem, which matures during elongation of the plant in which it is found.

Primary X.: The early water conducting tissue formed by the procambium.

Secondary X.: The late water conducting tissue formed by the vascular cambium.