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Plant identification is about pattern recognition, and to do it well, it should be a blend of traditional imprinting (learning to recognize something because someone else has told you what it is) and character-based diagnosis (figuring out what something is based on its features). It is about training the eye to see differences and the brain to be able to articulate them. Incorporating an understanding of phylogeny (relationships between groups) can further strengthen ID skills since some features are reliable at different levels of universality, e.g., a characteristic that applies to a species may also apply to related species (in same genus, family, order, etc.). Plant identification is challenging for many people, but the more it can be holistically integrated with everything else we know, the easier it gets. The most important basics include:

-- habit; leaves simple vs. compound, alternate vs. opposite, entire vs. toothed (or lobed), with pellucid dots (or punctations or stellate hairs); stipules present or not; latex present or not; foliage with distinct smell or not; veins pinnate or palmate (or plinerved);

-- flowers sympetalous or apopetalous; floral symmetry; hypanthium present or not; stamen number & arrangement; carpel number; gynoecium syncarpous or apocarpous; ovary inferior or superior.

The basic growth module for vascular plants is a stem with nodes; at each node the first structure is a leaf, with an axillary bud (which will grow into a new stem, often highly modified). Most plants that are confusing to understand are because the leaves and stems can be highly modified (e.g., flowers, carpels, cones) or reduced (e.g., the stems can be very very short with nodes tightly clustered, making it almost impossible to understand basics such as leaf arrangement). Leaves and branches can fall off (and it is difficult to study the absence of something), but they leave scars. As my grandma used to say when I was struggling with something, KISS (keep it simple stupid), a phrase meant to express the importance of remembering the basics when dealing with something complicated or difficult. Understand these terms and be able to apply them to what your eyes see, and you can build a knowledge matrix for diagnosing plant families!

Plant Vegetative Characters

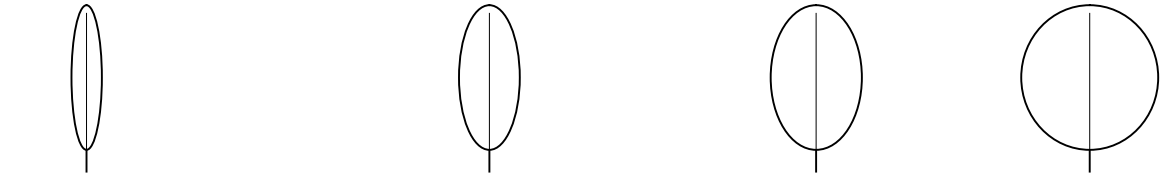
Node – point at which a leaf (bud or branch) arises from a stem; (not a structure but a point of reference).
Petiole – a structure (stalk) that attaches a leaf to a stem.
Blade – the usually flat broad photosynthetic portion of a leaf; abaxial (lower surface), adaxial (upper surface).
Stipule – a small flange of tissue at the base of the petiole, generally paired; only present in some plants.
Axil – the angle formed from a leaf attachment to a stem.
Axillary bud – precursor of a new stem arising in the leaf axil.

Shape:

Oblong – widest portion constituting a zone through the middle of the long axis of the leaf, margins parallel or nearly so within this zone.

linear narrow oblong oblong wide oblong

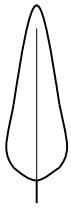
Elliptic – widest at the approximate midpoint of the blade axis.

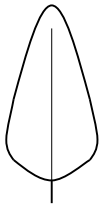


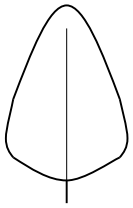
narrow elliptic elliptic wide elliptic orbicular

Ovate – widest below the midpoint of the blade axis.


lanceolate

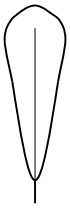

narrow ovate

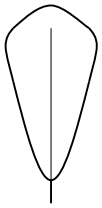

ovate

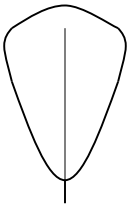

wide ovate

Obovate – widest above the midpoint of the blade axis.


narrow oblanceolate


oblanceolate


obovate


wide obovate

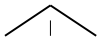
Leaf Apex (distal 1/3 or so of lamina)**:**

Acute – straight to convex margins forming an angle of less than 90°.
Acuminate – tip acute, margins markedly concave, either long or short acuminate.
Attenuate – margins straight or only slightly concave, gradually tapering to a narrow acute apex.
Obtuse – straight to convex margins forming an angle of more than 90°.
Rounded – margins forming a smooth arc across the apex.
Mucronate – apex terminating in a sharp point which is a continuation of the midrib.
Emarginate – apex broadly notched by the embayment of the leaf tissue.


acute


acuminate


attenuate


obtuse


rounded

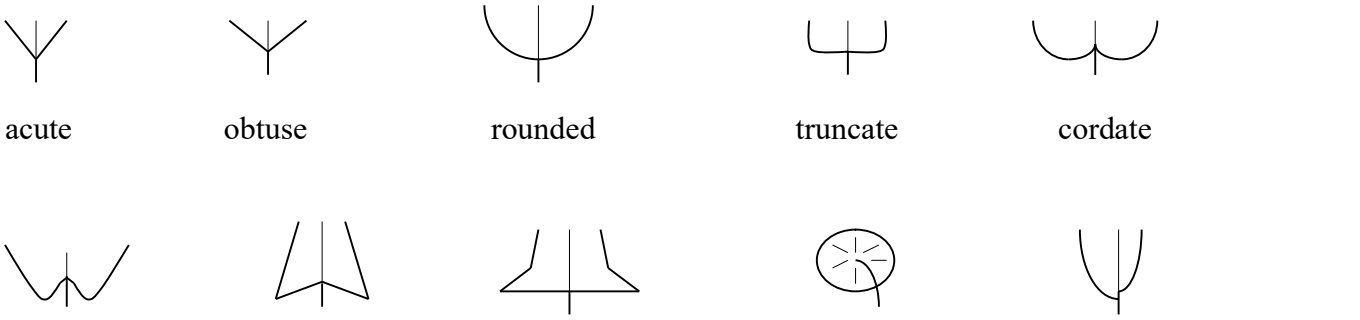

mucronate


emarginate

Leaf Base (proximal 1/3 or so of lamina)**:**

Acute – margins forming an angle of less than 90°; **cuneate** (wedge-shaped)
Obtuse – margins forming an angle of greater than 90°.
Rounded – margins forming a smooth arc across the base
Truncate – terminating abruptly as if cut, margin perpendicular to the midrib or nearly so.
Cordate – leaf base embayed in a sinus whose sides are straight or convex (heart-shaped)
Auriculate to **lobate** – small to large rounded projections whose inner margins (those toward the petiole) are in part concave.

Sagittate – with two large pointed lobes whose apices are directed downward, i.e., at an angle of 45° or less from the leaf axis.
Hastate – with two large pointed lobes whose apices are directed outward, i.e., at an angle of greater than 45° from the leaf axis.
Peltate – petiole attached inside the leaf margin.
Oblique – having unequal (asymmetrical) dimensions on either side of the midrib

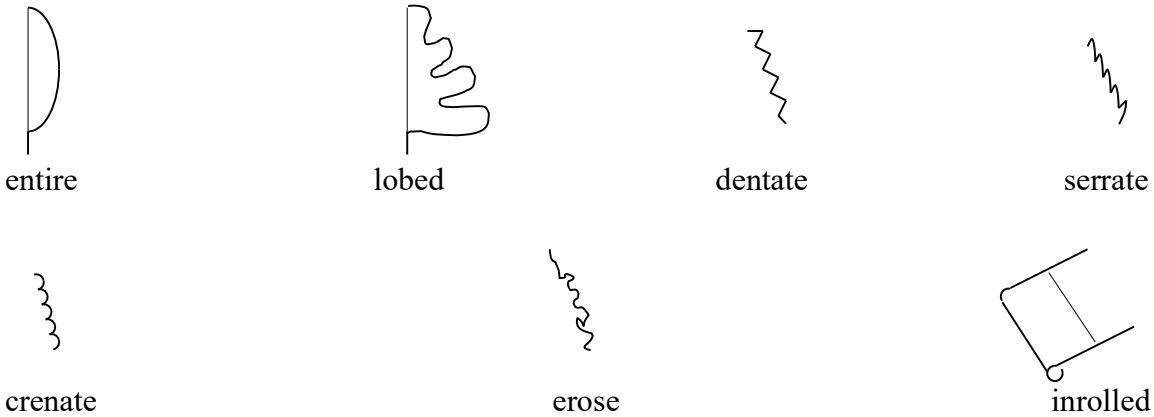


acute obtuse rounded truncate cordate

auriculate sagittate hastate peltate oblique (asymmetrical)

Leaf Margin:

Entire – margin forming a smooth line or arc without noticeable projections or indentations.
Lobed – margin indented ~¼ or more of the distance to the midrib.
Toothed – margin having projections with pointed apices, indented less than ¼ of the distance to the midrib.
Dentate – dentations are pointed with axes approximately perpendicular to the trend of the margin.
Serrate – serrations are pointed with their axes inclined (i.e., at an oblique angle) to the trend of the margin.
Crenate – crenations are smoothly rounded, without a pointed apex.
Erose – irregular, as if chewed.
Revolute or **inrolled** – margin turned under or rolled upon itself like a scroll.

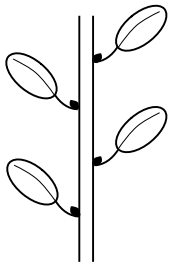


entire lobed dentate serrate

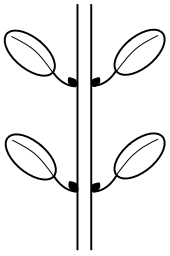
crenate erose inrolled

Leaf Arrangement/Position:

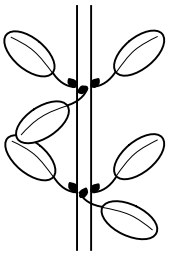
Alternate – a single leaf at each node along the stem.
Opposite – two leaves at each node along the stem (180° from each other).
Whorled – three or more leaves occurring at each node along the stem (= verticillate).



alternate



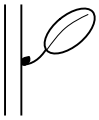
opposite



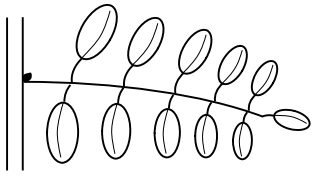
whorled

Leaf Composition/Divisions:

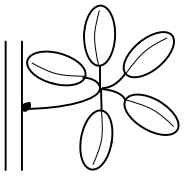
Simple – leaf has no divisions (maybe be deeply lobed, but blade tissue connects base of lobes).
Compound – leaf divided into smaller leaflets, each attached to a rachis (and not attached directly to the twig).
Compound leaves may be **pinnately** or **palmately** compound.



simple leaf



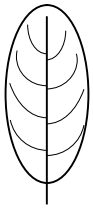
pinnately compound



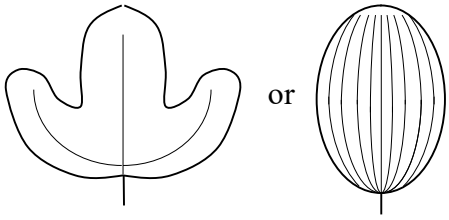
palmately compound

Types of Venation:

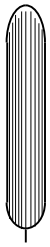
Reticulate - forming netlike pattern (2° & 3° veins interconnected)
Pinnate – veins arising at intervals along the midrib (midvein, 1° vein).
Palmate – all veins arising at the base of the blade. [**Plinerved** - palmate at base, pinnate above]
Parallel – prominent veins all running lengthwise and parallel to each other.



pinnate



palmate

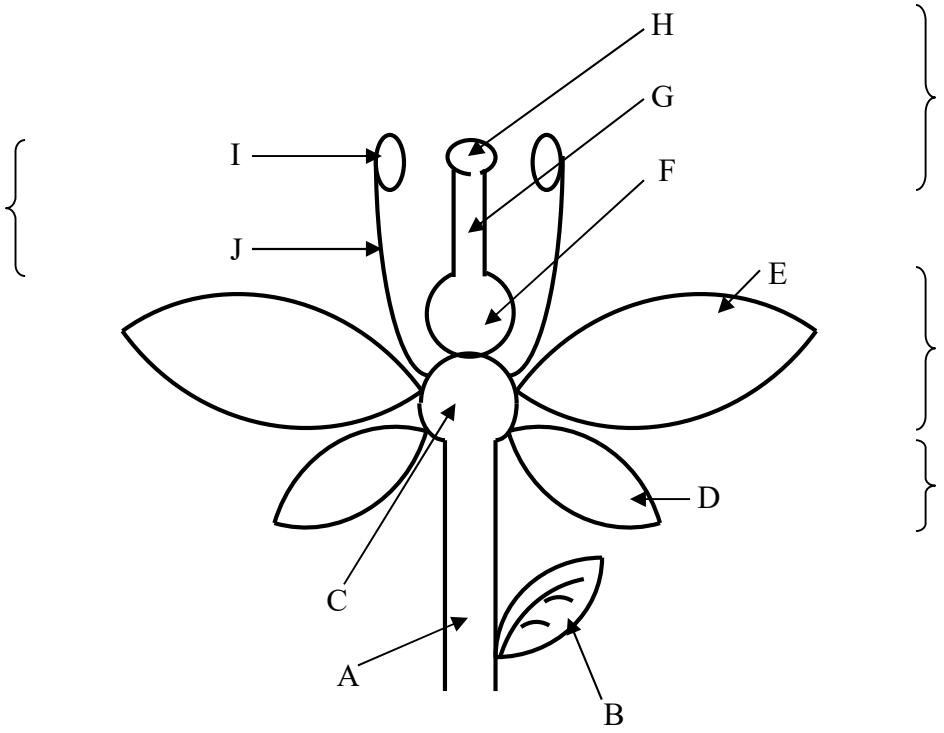


parallel

Pubescence and modifications:

Pubescent – having hair (on leaves, branches, floral parts, fruits, etc.)
Glabrous – lacking hair
Glaucous – covered with a bluish-whitish waxy coating that rubs off
Glandular – describes a surface or hairs containing glands that often appear shiny &/or swollen
Prickles – sharp extensions of the epidermas on stems or leaves
Spines – sharp structures on stems derived from modified leaves
Thorns – sharp structures on stems derived from modified stems (axillary branches)

Floral Characters

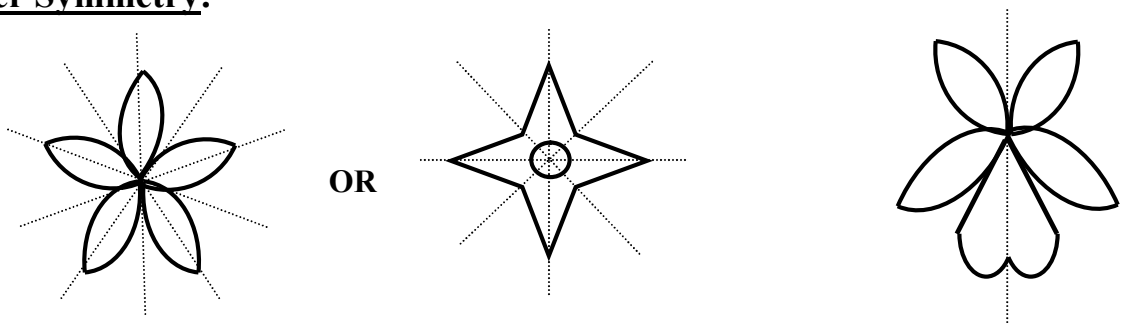


Parts of the Flower:

- **Peduncle** – The stalk to an inflorescence.
- **Pedicel** (A) – The stalk to a single flower.
- **Bract** (B) – A modified leaf situated near a flower or inflorescence; generally smaller and/or with a different shape or different color than the leaves.
- **Receptacle** (C) – The terminal portion of a pedicel bearing a flower.
- **Perianth** (all D & E) – The floral envelope consisting of the calyx and corolla.
- **Sepal** (D) – One of the parts of the outer whorl of the floral envelope or calyx, usually green in color. All of the sepals together are called the **calyx**.
- **Petal** (E) – One of the individual parts of the corolla; collectively called the **corolla**.
- **Stamen** (I & J) – The pollen-bearing organ of a flower; collectively called the **androecium**.
    - **Filament** (J) – Stalk of the stamen.
    - **Anther** (I) – **Pollen** bearing portion of the stamen.
- **Carpel** (F-H) – The female reproductive structure of a flower; collectively called the **gynoecium**.
    - **Stigma** (H) – That part of the carpel that receives the pollen, usually at or near the apex of the style and mostly hairy, papillose or sticky.
    - **Style** (G) – The usually stalk-like part of a carpel connecting the ovary and stigma.
    - **Ovary** (F) – The part of the carpel with ovules; at maturity called a **fruit**. **Locule**, **septum**, **exocarp**, **mesocarp**, **endocarp**.
        - **Ovule** – The structure that develops into the seed; **placentation** (**parietal**, **axile**).

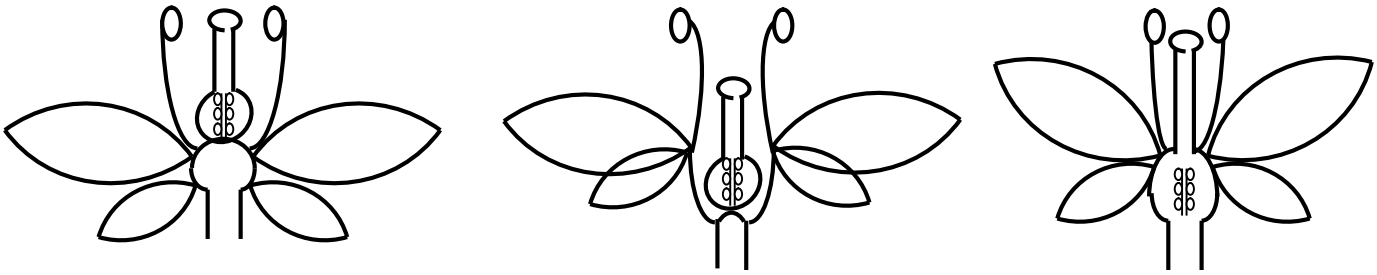
[*Pistil** – This is an older term that you may still see used in keys and textbooks. Pistil refers to a visually single female structure in a flower. This may be one of several separate carpels, or a fusion of carpels. Because of the ambiguity of this term, its usage is best avoided.]

Flower Symmetry:



- **Regular** or **actinomorphic** – A flower with multiple planes of symmetry = **radially symmetrical.**
- **Irregular** or **zygomorphic** – A flower with only one plane of symmetry = **bilaterally symmetrical.**

Ovary position:



- **Superior ovary** – An ovary with the perianth inserted below it. A flower with a superior ovary is called **hypogynous** (hypo = below, gynous = female), unless there is a **hypanthium** (cup-like structure composed of the fused bases of the perianth & androecium [rarely from receptacle]) that is NOT fused to the ovary, in which case the flower is **perigynous** (peri = around, about, surrounding).
- **Inferior ovary** – An ovary with the perianth and stamens attached above it. A flower with an inferior ovary is called **epigynous** (epi = on top of, on, above, over). Most inferior ovaries are the result of a hypanthium fused to the ovary.

More flower terms:

- **Connation** – The union of like parts, e.g., **sympetalous** (fused petals), **synsepalous** (fused stamens).
- **Adnation** – The union of unlike parts, e.g., **epipetalous** (stamens fused to petals).
- **Free** - Distinct, separate, unfused parts.
- **Complete** – A flower with sepals, petals, stamens, and carpels present.
- **Incomplete** – A flower lacking 1 or more of the series of sepals, petals, stamens, or carpels.
- **Perfect** – A flower with both functional stamens and carpels.
- **Imperfect** – A flower lacking either functional stamens or carpels.

Inflorescence types:

- Spike, Raceme, Catkin, Umbel, Head, Panicle, Cyme, Fascicle, Solitary; determinate vs. indeterminate.

Fruit Characters

What is a fruit?

A mature ovary along with fused accessory structures; contains seeds (fertilized ovules).

Terms:

- **dehiscent** – opens up or splits apart at maturity
- **indehiscent** – remains closed (doesn't split apart) at maturity
- **winged** – having a scale-like extension that may aid in wind dispersal
- **aggregate** – several tightly adherent fruits derived from unfused carpels of a single flower, e.g., blackberries, raspberries, strawberries
- **multiple** – a fused fruit derived from the adherent carpels of separate flowers, e.g., pineapples, figs
- **accessory fruit** – a fruit with tissues not derived from the gynoecium, e.g., strawberries (the fleshy red stuff is expanded receptacle), apples (much of the flesh is from hypanthium tissue), any inferior ovary fruit has outer layer of hypanthium (blueberry, kiwi, banana).
- **aril** – a structure associated with a seed; may be soft to hard, oily, or brightly colored; generally involved in dispersal

Major Fruit types (all arbitrary points along a continuum of variation):

- **achene** – a small, dry, indehiscent fruit containing a single seed, e.g., buttercups, sunflower "seeds"
- **berry** – a fleshy, indehiscent fruit, e.g., blueberries, oranges, cucumbers, apples
- **capsule** – a dry, dehiscent fruit from 2 or more carpels, usually with many seeds, e.g., hibiscus, catalpa
- **drupe** – a more or less fleshy, usually indehiscent fruit containing one (to several) seed(s) enclosed in a hard pit (to several pits; then called **pyrenes** by some), e.g., peaches, plums, avocado, hollies (several pits), hickories (dehiscent; also called a nut)
- **follicle** – a fruit derived from a single carpel that opens along a single longitudinal suture, e.g., milkweeds, magnolia
- **legume** – a dry fruit derived from a single carpel that opens along two sutures, restricted to the Fabaceae; sometimes these split transversely into indehiscent 1-seeded segments called **loments**, e.g., *Desmodium*
- **nut** – a relatively large, indehiscent fruit with a thick, tough wall surrounding a single seed, e.g., oaks; sometimes the term **nutlet** is used for small fruits (like mints & borages) that occur in clusters of 2-4
- **samara** – a winged, indehiscent, dry fruit containing a single seed, e.g., elms, ashes
- **schizocarp** – a multi-carpellate, dehiscent fruit that splits into 1-seeded segments, e.g., maples (the segments of which are samaroid), carrot & relatives (anise, carroway, dill, fennel, etc.), mints

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-- accrescent, aestivation, deciduous, equitant, marcescent, rosette (rosulate), undulate, vernation
-- native (indigenous), non-native (non-indigenous, exotic), cultivated, introduced, naturalized, invasive
-- population, community, ecosystem, biome, habitat, niche, biotic, abiotic
-- species name, scientific binomial, Genus + specific epithet
-- species, genus (genera), family [-aceae], order [-ales]
-- bulb, rhizome, stolon, tuber; hairs (glandular, peltate); tendril; woody (tree, shrub, liana), herb, vine; sporophyte, gametophyte

I SEEDLESS VASCULAR PLANTS ("Ferns and Fern-allies"). The following families do not represent a monophyletic group, but a paraphyletic grade of early land plants. Current interpretations of the evolutionary history indicate that there are two main clades which are monophyletic, the Lycopsids and the Monilophytes. The only extant lycopsids are the clubmosses (Lycopodiaceae), the spikemosses (Selaginellaceae), and the quillworts (Isoetaceae). Monilophytes include all other extant ferns and fern-allies.

a) Lycopsids
- Lycopodiaceae (clubmosses)
- Selaginellaceae (spikemosses)

b) Monilophytes
- Equisetaceae (horsetails)
- Psilotaceae (whiskferns)
- Osmundaceae (cinnamon fern, royal fern, interrupted fern)
- Cyatheaceae (tree ferns)
- Marsileaceae (water clover)
- Polypodiaceae (ferns)

III NON-FLOWERING SEED PLANTS (Gymnosperms). The term gymnosperm means 'naked seed,' referring to the fact that the seed is not enclosed within ovarian tissue. Extant seed plants can be classified into 5 major monophyletic groups: Cycads, Ginkgo, Gnetopsids, Conifers, and Angiosperms.

"Non-Conifers"

Cycads
- Cycadaceae
- Zamiaceae

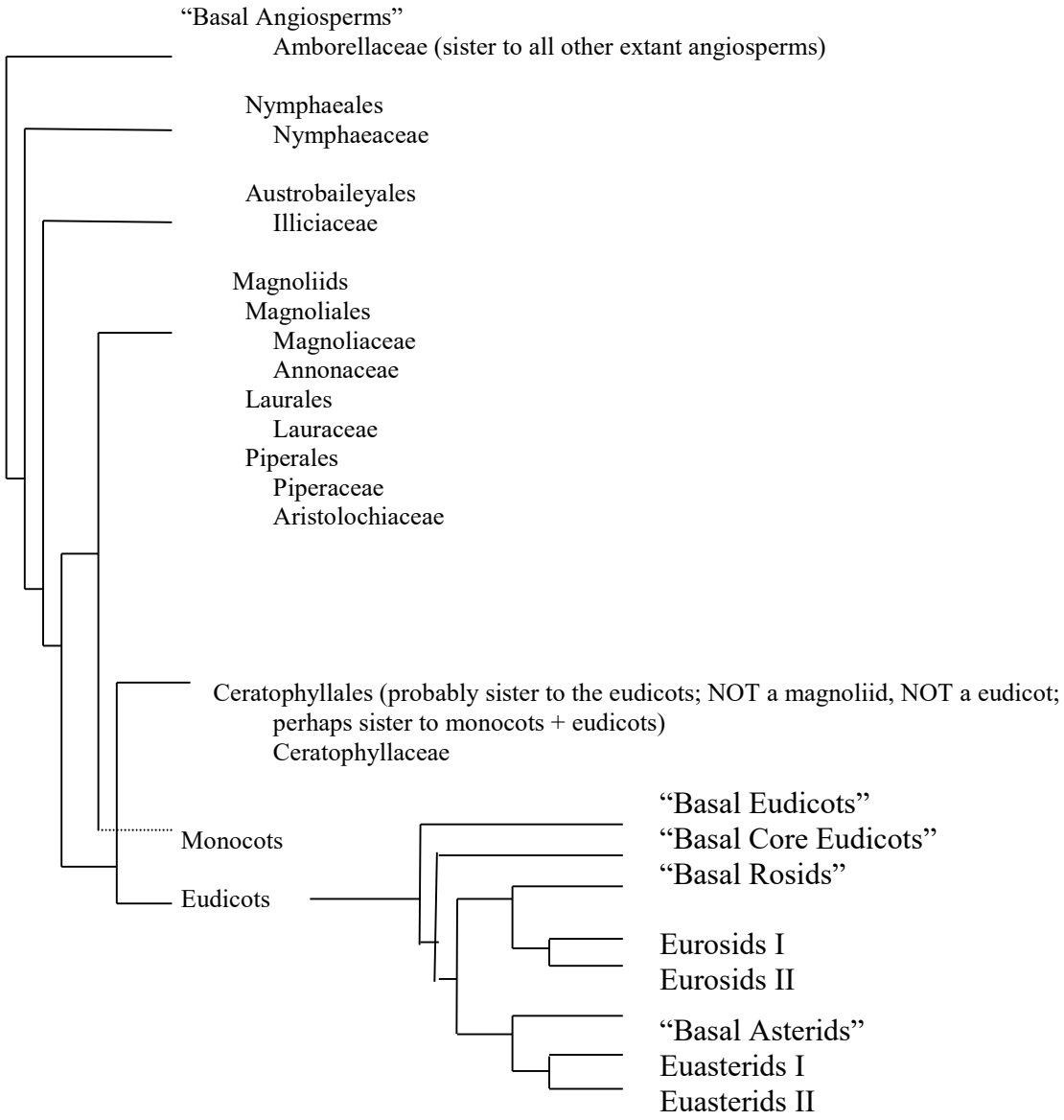
Ginkgo
- Ginkgoaceae

Gnetopsids
- Ephedraceae
- Gnetaceae
- Welwitschiaceae

Conifers
- Araucariaceae
- Cupressaceae
- Pinaceae
- Podocarpaceae
- Taxaceae

IV ANGIOSPERMS. Although angiosperms are strongly supported as a monophyletic group, diagnosable as flowering plants with seeds enclosed within a fruit (matured ovary). Current interpretations of the evolutionary history indicate that, for ease of discussion, angiosperms can be divided into 3 major groups, a paraphyletic assemblage of "basal angiosperms," monocots, and eudicots (not to be confused with the term for the polyphyletic group "dicots" which refers to all non-monocot angiosperms; the traditional features used to distinguish "dicots" from monocots do not work with most of the "basal angiosperms," but they do work with true dicots in a narrower sense, referred to as eudicots (or tricolpates, because of the tricolpate pollen) to avoid terminological confusion). Among the basalmost lineages, it seems that Amborellaceae (only one extant species from New Caledonia) are probably the sister to all other angiosperms, with the Nymphaeales (water-lilies and relatives) diverging next, followed by the Illiciales (Star-anise and relatives). *Amborella* and the Illiciales were traditionally considered to be part of the "magnoliid complex," an assemblage of primitive woody plants. The term Magnoliids can still be used to refer to a monophyletic clade of primitive angiosperms, but this clade is probably more closely related to monocots than it is to *Amborella* and the Illiciales, and this Magnoliid clade is now believed to include some soft-woody and herbaceous families (e.g., Piperaceae, Aristolochiaceae) which were briefly considered to be more closely related to monocots.

Ceratophyllaceae (hornworts; highly modified aquatics) are probably sister to the eudicots, and they illustrate the nomenclatural difficulties of trying to fit all families into a hierarchical classification system. That is, even though the criteria for higher-level ranks are arbitrary, adherence to the code of botanical nomenclature can sometimes lead to a forced redundancy in naming (e.g., Ginkgo, a monotypic genus must also be assigned to a family and an order, etc.). Many botanists are now using informal names for clades, reflecting a hybridization of the traditional hierarchical system of nested ranks with proposed rankless systems. Recognizing paraphyletic groups, such as "basal angiosperms" allows for conveniently talking about the flowering plants that are not monocots or true dicots, but is must be remembered that such a grouping is incomplete and that some of its members are actually more closely related to the monocots or true dicots than they are to each other. It is important to keep in mind that members of the "basal angiosperms" represent unique evolutionary lineages and not a single, natural, diagnosable group (even though they are mostly woody plants with alternate leaves, entire margins, no stipules, and ethereal oils producing a spicy smell).



Understanding phylogeny can be of great utility in plant identification. For instance, almost all plants with fused petals belong to the Asterids group, woody plants with alternate simple entire leaves with strong smell are usually "basal angiosperms," sympetalous plants with opposite simple entire leaves with colleters are probably Gentianales, etc., etc. Most higher level groups are not usually readily consistently macro-morphologically diagnosable, but most families usually are (although most also have their exceptions -- important to focus on norms), making family diagnosis a very useful skillset for plant identification. Provided below is a brief introduction to 16 of the families most commonly encountered as garden weeds in the eastern US. Such brief synopses based on standard norms do not usually apply to all species but can be a great starting point for identifying most members of the families involved. Important focal details can vary, depending on the groups being contrasted/compared...

brief plant family descriptions, with focus on characteristics in AR & brief list of local common garden weeds (* = edible)

Alliaceae (onion/garlic): bulb, scape, onion/garlic smell
-- *Allium vineale**

Apiaceae (carrot): lvs alternate, compound, sheathing base; umbel; inferior ovary; resinous smell
-- *Conium maculatum*, *Daucus carota**

Asteraceae (daisy, sunflower, dandelion): involucrate head; inferior ovary; [some smell resinous]
-- *Ambrosia* spp., *Artemisia* spp., *Erigeron* spp., *Lactuca* spp.*, *Matricaria* spp., *Taraxacum officinale**

Boraginaceae (borage): lvs scabrous; 4 nutlets
-- *Buglossoides arvense*

Brassicaceae (mustard): lvs alternate; fl 4-merous; stamens 4+2; mustard taste
-- *Capsella bursa-pastoris**, *Cardamine hirsuta*, Lepidium virginicum*, Planodes virginica, Thlaspi arvense*

Caryophyllaceae (chickweed): lvs opposite, basally fused across slightly swollen node; petals free
-- *Arenaria serpyllifolia, Cerastium* spp., *Stellaria media**

Fabaceae (legume): lvs alternate, compound, entire (toothed in clovers & relatives); stipules
-- *Lespedeza* spp., *Medicago lupulina, Melilotus* spp., *Trifolium pratense, Trifolium repens*

Geraniaceae (geranium): lvs palmate; petals free; fr with apical sterile portion
-- *Geranium carolinianum*

Lamiaceae (mint): lvs opposite; stems square; fl sympetalous, bilabiate; 4 nutlets
-- *Glechoma hederacea, Lamium amplexicaule, Lamium purpureum*

Oxalidaceae (wood sorrel): lvs trifoliate, entire, emarginate; fl radial, yellow in most (some pink); capsule
-- *Oxalis* spp.*

Plantaginaceae s.str. (plantain): scapose rosettes with spikes
-- *Plantago lanceolata, Plantago rugelii, Plantago virginica*

Poaceae (grass): sheath open; node swollen; stem round; caryopsis [vs. sedges with closed sheath; node not swollen; stem angled; achene; & vs. rushes with open sheath; non-swollen node; stem round; capsule]
-- *Bromus* spp., *Festuca elatior, Paspalum* spp., *Poa annua, Poa pratensis, Sclerochloa dura*

Polygonaceae (knotweed): ocrea (sheath above petiole on stem); [some edible, but have calcium oxalate]
-- *Persicaria* spp., *Polygonum* spp., *Rumex* spp.

Portulacaceae (purslane): succulent; 2 “sepals” with 5 petals
-- *Portulaca oleracea**

Rubiaceae (coffee): lvs opposite, entire; interpetiolar stipule; fl sympetalous, radial; inferior ovary
-- *Galium aparine, Sherardia arvensis*

"Scrophulariaceae" s.l. (snapdragon): stems usually round(ish); fl sympetalous; capsules
-- *Chaenorrhinum minus, Leucospora multifida, Veronica arvensis, Veronica peregrina, Veronica polita*

With ~1000 species in a county, ~3,000 in a state, and ~20,000 in North America, and with global estimates of up to 300,000 (-450 K) species, 16,000 genera, and 250-400(-600) families of plants, it is, clearly, not possible to know all species. Thus, recognizing a plant as a fern, gymnosperm, monocot, dicot, or basal angiosperm is an important first step in plant identification. Most plant families can then be diagnosed through careful application of a few morphological features, and such skills are then applicable to the entire global flora (keeping in mind that we're talking about norms & there are almost always exceptions). Asteraceae, Orchidaceae, & Fabaceae are the three largest plant families and together make up ~62,000 species (~1/4 of ALL plants globally), and in most parts of the world a dozen or so families make up roughly half (or more) of the vegetation. So, learning family characters is an empowering skill, enabling one to walk up to plants around the world and identify them to family, the starting point for further identification. Sometimes groups of families (orders) can be readily diagnosed, e.g., a woody plant with alternate compound exstipulate leaves is almost always a member of the Sapindales (or Juglandaceae in e N Am). Twenty-five or so families in e N Am total over 111,830 spp. globally, or nearly half of all currently described plant species! If practical, applied identification is the primary goal, it is also useful to think in terms of artificial groupings, e.g., which plants have opposite compound leaves, which are alternate, simple, and entire, etc.? And let's not forget that plants are an integral part of the landscape, generally found in specific habitats. Thus, understanding which species comprise dry uplands vs. intermediate mesic areas vs. wet bottomlands, is a critical component of learning to identify plants. All three of these approaches (family characters, artificial morpho-groupings, and in situ ecology) should be integrated with traditional sight-based recognition.

basal angiosperms: woody (usually); lvs alternate, simple, entire, exstipulate, fragrant

Magnoliaceae (2 G; ~227 spp.) ring around node (from sheathing stipules)

monocots: herbs; lvs linear, with sheath, parallel veins; fl parts in 3s

Alliaceae (13 G; ~795 spp.; now part of Amaryllidaceae): bulbs, umbels, scapose, onion/garlic smell

Cyperaceae (98 G; ~5430 spp.): stems triangular, lvs 3-ranked, sheaths closed, no jointed nodes; achene

Dioscoreaceae (4 G; ~870 spp.) [contrast with Convolvulaceae (57 G; ~1625 spp.) & Menispermaceae (70 G; ~442 spp.] -- vines, strong palmate veins, lowermost or some upper lvs opposite or whorled (in ours) [vs. convolvs with milky sap & menisperms with kinky petioles]

Iridaceae (66 G; ~2050 spp.): lvs equitant; 3 stamens; inferior ovary [vs. lilies with 6 stamens & superior ovary]

Juncaceae (7 G; ~430 spp.): stems rounded, lvs 2-ranked, sheaths open, nodes not jointed; capsule; tepals

Poaceae (707 G; ~11337 spp.): stems rounded (or compressed), lvs 2-ranked, sheaths open, nodes jointed; grain

Smilacaceae (1 G; 210 spp.); vines, paired stipular tendrils

-- graminoid: grass-like plants; some monocots (especially forest understory) have dicot-like lamina, e.g., Zingiberales (gingers/bananas) with inrolled vernation

dicots: herbs or woody; lvs usu broad, only rarely with sheathing petiole base, veins usu reticulate; fl parts in 4s or 5s

Apiaceae (434 G; ~3780 spp.): herbs; lvs alternate, usu compound, with sheathing lf base & carroty smell; umbels, inferior ovary with 2 carpels [vs. ranuncs which lack smell & usu have many free stamens & carpels; some rosacs have sheathing lf bases, but with stipules & hypanthium]

Aquifoliaceae (1 G; ~405 spp.): woody; small dark triangular stipules; dioecious, capitate stigma with no style [contrast with Rhamnaceae (52 G; ~925 spp.) also woody; small dark triangular stipules; stamens opposite petals]

Asteraceae (1620 G; ~23600 spp.): usu herbs (ours); involucrate head (otherwise super variable vegetatively); disk, ray, pappus; lettuce group (Lactuceae) has milky sap, ligulate flowers, leaves alternate & toothed; compound opp herb usu an asterac in e US [+ some polemoniacs, few mints/verbs, & ?]

Bignoniaceae (110 G; ~800 spp.): woody; lvs opposite, compound, vines (in ours, except Catalpa)

Brassicaceae (372 G; ~4060 spp.): herbs; lvs alt, no stipules; raceme with fls & frs at same time; mustard smell/taste

Caryophyllaceae (86 G; ~2200 spp.): herbs; lvs opposite, simple, entire, petiole bases fused across swollen node; ovary superior; petals free

Cornaceae (2 G; ~85 spp.); woody; lvs usu opposite, venation arcuate

Ericales - blueberries & relatives: woody, simple, alternate, no stipules; incl. persimmon (entire, ebony, cristate, dioecious); artificial entire "Bberry" look-alikes include blackgum, autumn olive, "basal angiosperms"

Euphorbiaceae (300 G; ~7500 spp.): separate male & female closely associated on same plant; ~40% with milky latex; [Phyllanthaceae (~60 G; ~2000 spp.): 2 ovules/locule, used to be euphorbs]

Fabaceae (745 G; ~19560 spp.): herbs or woody; lvs alternate, compound, stipulate, entire (except clovers & relatives with teeth; rarely with simple lvs); pulvinus, pulvinuli swollen & discolored with respect to adjacent midvein (best seen abaxially); "clovers" (trifoliate & toothed); vetch (terminal leaflet a tendril) -- contrast to Sapindales & Juglandaceae (both woody, compound, alt, no stips; juglandacs are finely evenly serrate and have golden to brownish glandular hairs with distinctive smell)

Hypericaceae (9 G; ~560 spp.): herbs or woody; lvs opposite, simple, entire, pellucid dots

Juglandaceae (~8 G; ~50 spp.): woody; lvs alternate, compound, exstipulate, with smell (glandular hairs), usually evenly regularly serrate; vs. Sapindales (if toothed, then often irregular or uneven, if has smell, not from glandular hairs)

Lamiaceae (236 G; ~7173 spp.): herbs (ours); lvs opposite, simple, usu toothed, usu with strong minty smell; fls zygomorphic with 2+3 pattern corolla, fr calyx strongly ribbed; 4 schizocarpic nutlets [Lamiales - relatives often also have square stems with opposite leaves & bilateral sympetalous flowers]

Malvaceae (243 G; 4225+ spp.): herbs (our rarely woody); lvs alternate, usu simple, palmate venation (often lvs also palmately lobed), stipulate, with slime canals (& often stellate hairs)

Moraceae (39 G; ~1125 spp.): woody (rarely herbs); milky sap; stipules (often with ring or nearly so around node)

Polygonaceae (43 G; ~1110 spp.): ocrea

"Portulacaceae" (20 G; ~500 spp., now just *Portulaca* ~115 spp.): 2 sepals, 5 petals; lvs often fleshy

Rosaceae (90 G; ~2520 spp.): collectively there is a group called the 'rosy motif' (woody; lvs alternate, toothed (usually), with stipules, usu simple; some rosacs are compound & some are herbs), rosacs are the default group (especially once you've ruled out the other groups), they have a hypanthium, usu with many stamens and often with many carpels, usu not doubly serrate; within the rose family, *Prunus* (cherries/plums) usu have petiolar glands & Maleae (tribe of apples & relatives) have an inferior ovary with apple-like fruits; other "rosy" include 1) hackberries (*Celtis*) with plinervy; 2) birches & elms are doubly serrate, elms usu scabrous & asymmetrical, birches usu soft pubescent (or glabrous) & symmetrical with the lateral veins usu more strongly even, straight, parallel (than in most elms); 3) oaks (*Quercus*) are usu lobed & clustered at tip of twigs; 4) hollies & buckthorns (see above); 5) willows (*Salix*, lanceolate lvs) -- many genera (e.g., other oak & birch relatives) have to be imprinted, as the vegetative characters are harder to characterize); [contrast with Betulaceae (6 G; ~145 spp.; birches), Cannabaceae (11 G; ~170 spp.; hackberries), Fagaceae (7 G; ~670 spp.; oaks), Ulmaceae (6 G; ~35 spp.; elms)]

Rubiaceae (611 G; ~13150 spp.): ours mostly herbs (1 woody); lvs opposite, simple, entire, with interpetiolar stipule; sympetalous; ovary inferior; part of Gentianales (lvs opp simple entire with colleters; sympetalous, radial, no plications)

Vitaceae (14 G; ~850 spp.): tendril attached opposite leaf, [Cucurbitaceae (98 G; ~975 spp.) tendrils are attached at right angle to leaves, Passifloraceae (27 G; ~975 spp.) tendrils are attached in axil (tendrils often curve to different angle, so look at the actual attachment point); all 3 are vines with tendrils at node]

-- Milky sap: fig/mulberry (woody), lettuce (Asteraceae), milkweed/dogbane (Apocynaceae; leaves simple, opposite, entire, so part of Gentianales), some Euphorbiaceae (monoecious, schizocarps), Convolvulaceae (vine, leaves alternate), [bellflower (Campanulaceae; leaves simple, alternate, toothed), Sapotaceae (woody, entire), Alismataceae (monocots, aquatic herbs), *Nelumbo* (aquatic herbs, peltate), sometimes *Rhus* (Sapindales)].

-- "(BE)MADCap" (woody & opposite; no stipules; deciduous): maples (palmately veined/lobed), ashes (trees, pinnately compound, not usually strongly serrate; part of the olive family, most with cuticular pits), dogwoods (arcuate veins), Caprifoliaceae (honeysuckles; default when above all not true); MA have superior ovary, while DCap have inferior ovary; [BE stands for buckeyes & elderberries; buckeyes (palmately compound) are related to maples, elderberries (shrubs, pinnately compound, sometimes twice; heavy lenticels, strongly serrate) are related to honeysuckles]

-- mistletoe (hemi-parasite, epiphyte, haustoria)

major identifiable angiosperm motifs

1) "basal angiosperms": woody, simple, alternate, entire, no stipules, strong smell

2) monocots: "graminoids" look like grasses (mostly grasses & sedges & rushes)

rest all dicots

3) sympetalae (fused petals): Gentianales (coffee, milkweed), Solanales (morning glory), Lamiales (mints & vervains & olives); blueberry, holly, carrot, asteracs

4) groups with 1-few species/families in se US: grape, squash, passionflower, mistletoe, mustard, mallow

5) the more complex (diverse/speciose) groups include legumes, roses, chickweeds/knotweed/purslane, etc., & other groups best addressed through "artificial" motifs:

6) "MADCap": woody, opposite (maple, ash/olive, dogwood, honeysuckle)

7) "VD": dicots with sheaths (carrot, herbaceous rose, buttercup), mostly alternate & compound; [many asteracs (involucrate heads) also have sheathing petiole bases, but they are often simple or opposite or have strong resiny smell; Geraniaceae can look similar and have stipules; Saxifragaceae, too, can be similar, and need to be imprinted vegetatively, have hypanthium in flower but usually no stipules]

8) "milky sap": lettuce, fig/mulberry, milkweed/dogbane, morning glory, bellflower, some spurges (& few others)

9) "TAN": vines with tendrils at node (grape, squash, passionflower)

10) "CoAl": compound alternate (legumes, juglandaceae, sapindales)

11) "rosy": woody, simple, alternate, toothed, stipules (but don't be confused by the fact that some Rosaceae can be herbs, sometimes compound, rarely opposite, sometimes entire, rarely no stipules; so this is an artificial motif that only includes some rosacs); includes oaks, birches, elms, hollies, willows, hackberries, & rosacs like *Prunus* (cherries & relatives) & Maleae (tribe of apples & relatives), and things with palmate veins (treated below as "mallows") can technically be treated here

12) "palmates" (mallows, sweetgum, & sycamore): alternate, palmate, stipules; sweetgum with smell & gumballs (multiple of capsules); sycamore with petiole surrounding axillary bud (& multiple of achenes)

13) "Bberry": woody, simple, alternate, no stipules, no strong smell; Ericales can have teeth or not, entire look-alikes include blackgum, autumn olive (peltate scales), "basal angiosperms" (smell)

-- Although there are roughly 3,000 plant species in most states and about 1,000 can be found in most counties, there are only a couple hundred species that dominate the landscape. Focus on the most abundant species to form a foundation, and then you can build on it later. It is not always easy to tell if a young plant will become woody, but most plant ID guides require an ability to distinguish woody plants from herbaceous ones. It gets easier with practice. Based on field work in western Kentucky, the following template is a rough guide to the commonest plants, organized by the basics of habit and then leaf arrangement and composition. I provide this list here as a starting point for you to make your own guide. The standard family ending (-aceae) is left off, but where you see '-cs' it refers to a family common name, e.g., vitacs = Vitaceae, fabacs = Fabaceae.

Woody (include lianas if you can't always tell them apart): gymnosperms; "basal angiosperms" (not Saururus); NOT monocots (except Arundinaria, Agave/Yucca, Smilax); Sapindales (aceracs, anacards, rutacs, simaroubs), adoxacs, altingiacs, aquifoliacs, araliacs (some herbs), [some cultivated berberidacs], betulacs, bignons, cannabacs, caprifoliacs, celastracs, cornacs, ebenacs, elaeagnacs, ericacs, some fabacs (Albizia, Amorpha, Cercis, Gleditsia, Gymnocladus, Robinia, Wisteria), fagacs, hippocastanacs, hydrangeacs, some Hypericum, juglandacs, Vitex, moracs, Nyssa, oleacs, Paulownia, Platanus, some Clematis, rhamnacs, some rosacs (Amelanchier, Prunus, Pyrus, Rosa, Rubus), Cephalanthus, salicacs, Staphylea, ulmacs, vitacs

-- Compound: Sapindales, Sambucus, Aralia, [some cultivated berberidacs], bignons (not Catalpa), [some cannabacs (Cannabis & Humulus) have palmately compound leaves, but they're not really woody, although they may seem so late in the growing season], most fabacs (not Cercis), hippocastanacs (palmate), juglandacs, Vitex (palmate), Fraxinus (& some other oleacs from other places), Clematis, some rosacs (Rosa, Rubus, Sorbus (only cultivated here)), Staphylea (trifoliate), some vitacs (Ampelopsis arborea (bipinnate), Parthenocissus quinquefolia (palmate))

-- Opposite: Juniperus (& Metasequoia, a cultivated gymnosperm); Acer, adoxacs (Sambucus, Viburnum), bignons, [some Cannabacs (Cannabis & Humulus)], some celastracs (Euonymus), Cornus, [some elaeagnacs elsewhere], [rarely some ericacs elsewhere], Aesculus (palmate), Hydrangea, Hypericum, Vitex (palmate), sometimes opposite in one introduced morac (Broussonetia), oleacs, Paulownia, Clematis, some rhamnacs from elsewhere, Cephalanthus, Staphylea

-- Alternate/simple/& entire: some gymnosperms (Pinus, Taxodium, Ginkgo (the latter sometimes lobed)); Arundinaria, Agave/Yucca; rarely some Ilex (mostly toothed), rarely Cornus (C. alternifolia & some cultivated species from Asia), Diospyros, Elaeagnus, some ericacs (some Vaccinium), Cercis, rarely some Quercus (Q. imbricaria, Q. phellos), Maclura, Nyssa, some Pyrus (sometimes with teeth; couple other cultivated genera of rosacs also lack teeth)

-- alternate/simple/toothed: 'rosy motif' (stipules): Liquidambar, most Ilex, betulacs (doubly serrate), Celtis (plinerved), fagacs, Morus (& some branches of introduced Broussonetia), Platanus (palmate), most rhamnacs, some rosacs (Amelanchier, Prunus, Pyrus (sometimes with no teeth); other rosacs may have compound leaves & some are actually herbs!), salicacs (Salix (lanceolate), Populus (most with laterally flattened petioles)), ulmacs; following are NOT rose motif because no stipules -- Hedera (liana; sometimes some leaves with no teeth nor lobes), Celastrus (liana), Oxydendrum, rarely Nyssa has a few teeth/lobes at apex of leaf

Herbaceous (include vines, if you can't always tell them apart): ferns; Saururus; most monocots (not Arundinaria); acanths, amaranths, apiacs, apocs, asteracs, balsaminacs, berberidacs (some woody), borages, brassicacs, campanulacs, caryophylls, [ceratophyllum], convolvs, crassulacs, cucurbits, many fabacs (Amphicarpaea, Apios, Chamaecrista, Coronilla, Desmodium, Lespedeza, Medicago, Melilotus, Stylosanthes, Trifolium), Geranium, some Hypericum (others woody), lamiacs (except Vitex), Utricularia, logans, malvacs, [one weedy morac, Fatoua], Nelumbo, onagracs, Oxalis, Passiflora, Phytolacca, plantaginacs, polemoniacs, polygalacs, polygonacs, ranunculacs, some rosacs (Duchesnea, Geum, Potentilla), most rubiacs (not Cephalanthus), scrophs, solanacs, urticacs, verbs, violacs [-- anything here not re-listed below can be assumed to be simple, alternate, & toothed (with or without stipules)]

-- Compound: most ferns (not Equisetum); Arisaema; apiacs; some asteracs (Ambrosia (some only deeply lobed), some Coreopsis), brassicacs (some very deeply lobed, rarely compound), fabacs, some Geranium (most just very deeply lobed), some malvacs (most just palmately lobed, rarely palmately compound), Oxalis, some polemoniacs, some ranunculacs (many just deeply lobed), most rosacs (Geum simple & compound on same plant often), rarely scrophs, rarely solanacs (tomato itself), some verbs (some Verbena/Glandularia), some violacs (usually just palmately lobed)

-- Opposite (including whorled): Dioscorea (some nodes on some plants); acanths, some amaranths (Alternanthera), most apocs (not Amsonia, not some nodes of Asclepias tuberosa), some asteracs (Ambrosia, Coreopsis, Eupatorium (some whorled), Helianthus, Mikania (vine), some Verbesina), caryophylls, crassulacs (some Sedum); some Geranium (some nodes on some plants), Hypericum, lamiacs, logans, polemoniacs (some Phlox), some polygalacs (rarely opposite or whorled), some ranunculacs (Clematis usually vines; bracteal leaves in many genera are opposite), rubiacs, many scrophs (often opposite below & alternate above), some

solanacs (not really opposite, but some genera/species have 2 leaves at one node with <90 degree angle between petioles), some urticacs (Boehmeria, Pilea, Urtica), verbs
-- Alternate/simple/&entire: most monocots (not Arisaema, not some nodes of Dioscorea with opposite or whorled leaves); Saururus; borages, convolvs (some lobed or compound), crassulacs (Sedum (also sometimes opposite)), Plantago (in rosettes so hard to see phyllotaxy), Polygonaceae, some Asteracs (Gnaphalium, some Erigeron, etc.)

Vines/Lianas: Dioscoreac, Smilacac; Toxicodendron radicans, some apocs (Cynanchum, Matelea, Vinca), Hedera, some asteracs (Mikania), bignons (not Catalpa), some caprifols (some Lonicera), some celastracs (Celastrus, some Euonymus), most convolvs, cucurbits, some fabacs (Amphicarpaea, Apios, some Desmodium, Pueraria, Vicia, Wisteria), [rare/cultivated hydrangeacs], menisperms, passifloracs, some polygonacs (ocrea), some ranunculacs (Clematis), [rare rhamnacs (Berchemia)], some rosacs (several stoloniferous so kinda viny; some Rosa & Rubus kinda viny), Cardiospermum, [rare solanac (an introduced weedy Solanum)], vitacs
-- Compound: Toxicodendron, bignons, fabacs, Clematis, rosacs (not usually good vines), [balloon vine], some vitacs (Ampelopsis arborea, Parthenocissus)
-- Opposite: some Dioscorea, apocs, Mikania, bignons, caprifols, Euonymus, Clematis
-- Alternate/simple/&entire: some Dioscorea, Smilax (some prickly margined but not toothed), some Hedera (usually shallowly lobed though), most convolvs (some lobed), some menisperms (almost always lobed), polygonacs