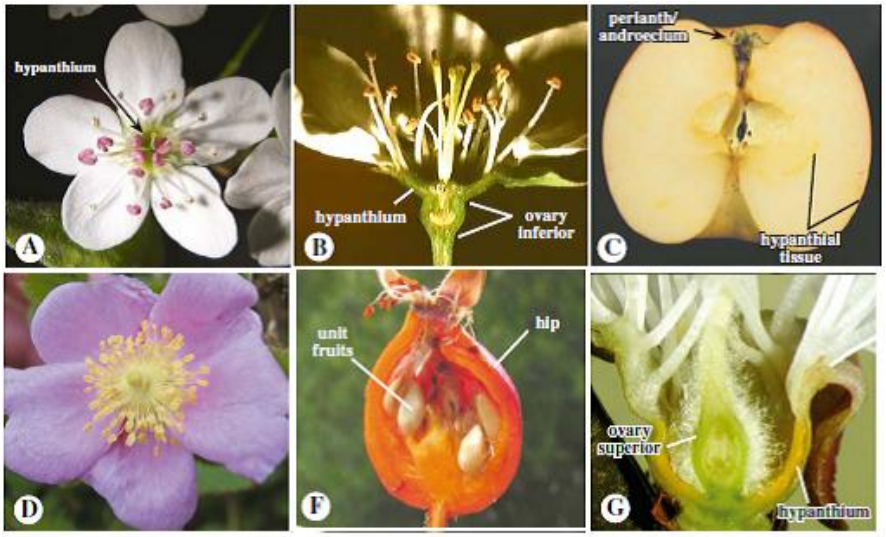
ornamental cultivars, such as *Cotoneaster*, *Photinia*, *Prunus* (cherries), *Pyracantha*, and *Rosa* (roses).

The Rosaceae are distinctive in having usually **stipulate** leaves (often adnate to petiole) and an actinomorphic, generally **pentamerous** flower with **hypanthium present**, variable in gynoecial fusion, ovary position, and fruit type.

K 5[3-10] **C** 5[0,3-10] **A** 20-∞[1,5] $\underline{\bar{G}}$ 1(-∞), hypanthium present.



Mulberry family (Moraceae)

Moraceae Latin name for mulberry. ca. 1100 species within 40 genera. The Moraceae consist of monoecious or dioecious trees, shrubs, lianas, and herbs, often with laticifers bearing milky latex. The **roots** are prop or buttress in some taxa. The **leaves** are simple [rarely compound], spiral or opposite, stipulate. The **inflorescence** is axillary and variable in morphology, consisting of a spike (catkinlike in *Morus*), raceme, head (in some taxa with flowers borne upon the surface of an invaginated compound receptacle), or in *Ficus* an enclosed hypanthodium. The **flowers** are unisexual, small, actinomorphic, hypogynous or epigynous. The **perianth** is uniseriate [rarely biseriate], 0-10, the perianth parts (often termed a calyx) connate, at least basally. The **stamens** are 1-6, opposite and usually as many as the perianth parts; anthers are dithecal or (in *Ficus* spp.) monothecal. The **gynoecium** is syncarpous, with a superior or inferior ovary, 2 [3] carpels, and 1 [2-3] locules. The **styles** are typically 2. **Placentation** is apical; **ovules** are solitary, bitegmic. The **fruit** is a multiple of achenes, each unit achene often surrounded by fleshy perianth (thus resembling a drupe) or borne on a fleshy compound receptacle, in *Ficus* borne on the inner surface of an enclosed syconium. The **seeds** are 1 per unit fruit, albuminous or exalbuminous. Plants are wind or insect pollinated, in *Ficus* spp. having an intricate pollination mechanism with wasps.

The Moraceae have a worldwide distribution, from tropical to temperate regions. Economic importance includes fruit trees, such as *Artocarpus altilis* (breadfruit), *Ficus carica* (edible fig), and *Morus* spp. (mulberry); paper, rubber, and timber trees; and some cultivated ornamentals, especially *Ficus* spp., figs; the leaves of *Morus alba* are the food source of silkworm moth larvae.

The Moraceae are distinctive in being **monoecious or dioecious** trees, shrubs, lianas, or herbs with a **milky latex**, **stipulate**, simple leaves, and **unisexual flowers**, the female with a usually **2-carpellate (2 styled) pistil** and a **single, apical to subapical ovule**, the fruit a **multiple of achenes**, in some taxa with an enlarged compound receptacle or syconium.

P (0-10) **A** 1-6 **G** (2) [(3)], superior or inferior.

BRASSICALES

The Brassicales are composed of ca. 15 - 17 families. Only the largest and most economically important family, the **Brassicaceae**, is described here. The order is generally united in having **glucosinolate** secondary compounds. Acceptable classification is to treat them as three separate families: Brassicaceae, Capparaceae, and Cleomaceae.

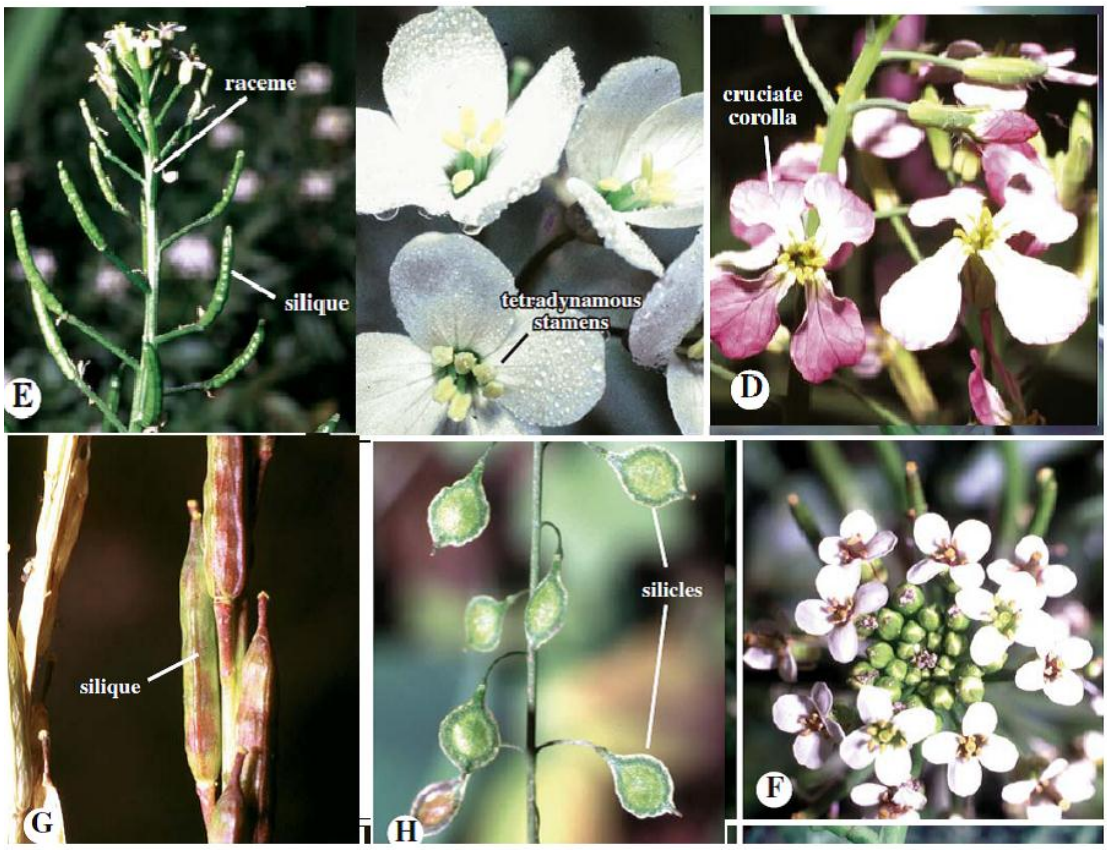
Mustard family (Brassicaceae):

The Brassicaceae have a worldwide distribution. Economic importance includes numerous vegetable plants (notably the crucifers or mustard plants), including broccoli, Brussels sprouts, cauliflower, cabbage, collards, kale (all cultivars of ***Brassica oleracea***), rutabaga and canola oil (***B. napus***), mustard (***B. nigra***), turnip (***B. rapa***), and many more, plus numerous cultivated ornamentals, dye plants (***Isatis tinctoria***), and some noxious weeds; ***Arabidopsis thalliana*** is noted as a model for detailed molecular studies.

The Brassicaceae as treated here are distinctive in being herbs, rarely shrubs, with **glucosinolates** (mustard oil glucosides), the **perianth cruciate** (petals usually clawed), the androecium with usually **2+4, tetradynamous stamens**, the gynoecium

with a superior, **2- carpellate/loculate ovary**, with **axile placentation** and a usually **2-valved, dehiscent fruit with a replum (silique or silicle).**

K 2+2 **C** 4 **A** 2+4 [2,4-16] **G** (2), superior.



Brassicales: Brassicaceae

MALVALES

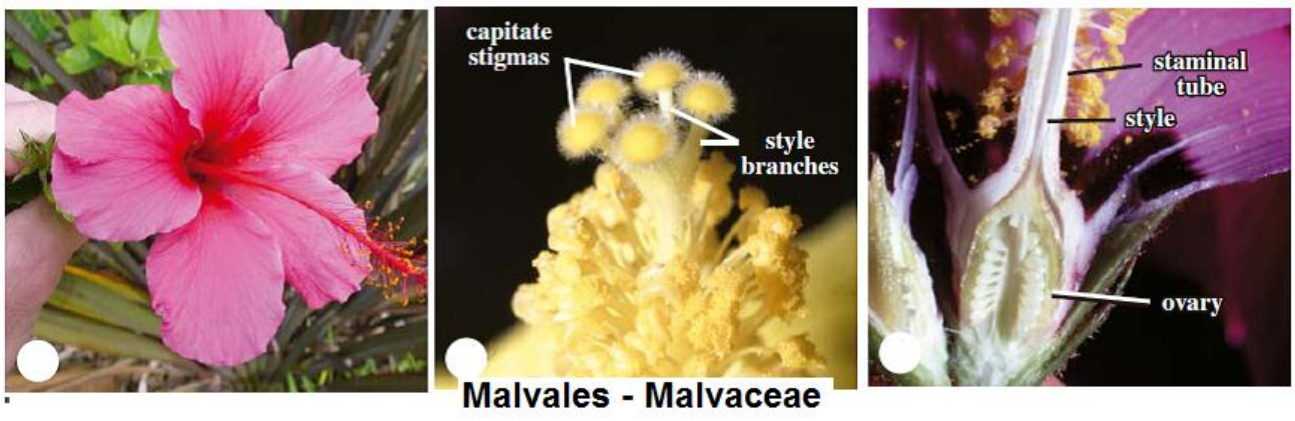
The Malvales, include nine families, only the **Malvaceae** will be covered here. More well-known among the others are the **Bixaceae** (containing *Bixa orellana*, anatto, commonly used as a natural food coloring), **Cistaceae** (the rock-rose family), **Dipterocarpaceae** (the dipterocarps of s.e. Asia, source of important hardwood timber trees and gum/resin plants), and **Thymelaeaceae**. The order as a whole may have chemical and anatomical apomorphies, including the presence of lysigenous mucilage canals in most members.

Mallow family (Malvaceae)

Including Bombaceae, Sterculiaceae, and Tiliaceae (**APG III**)], ca. 4230 species within 250 genera. The Malvaceae consist of usually hermaphroditic, rarely monoecious or polygamous trees, shrubs, or herbs, often with either stellate trichomes or peltate scales. The **leaves** are simple or palmately compound, sometimes lobed to divided, palmately or pinnately veined, usually spiral and stipulate, the stipules often caducous. The **inflorescence** is of solitary or paired flowers or

cymelike, sometimes complex. The **flowers** are bisexual [rarely unisexual], mostly actinomorphic, an epicalyx typically present, hypogynous, rarely perigynous. The **perianth** is biseriate, the petals alternating with the sepals. The **calyx** is aposepalous or basally synsepalous with 5, valvate sepals. The **corolla** is apopetalous [sometimes adnate to the base of an androecium tube; rarely absent], sometimes clawed, convolute, valvate, or imbricate petals. The **stamens** are 5 ∞, the filaments usually connate, as a tube surrounding the ovary. **Anthers** are longitudinal or poricidal in dehiscence. The **gynoecium** is syncarpous, rarely apocarpous or with carpels fused only apically, with a superior [rarely inferior] ovary, 2 ∞ carpels, and 2 ∞ [1] locules. The **style** is unlobed, lobed, or branched at the apex. **Placentation** is usually axile, rarely marginal; **ovules** are 2 ∞ [1] per carpel. **Nectaries** consist of glandular trichomes typically present at the adaxial base of the calyx. The **fruit** is a loculicidal, septicidal, or indehiscent capsule, a schizocarp of mericarps. The **seeds** are exalbuminous or endospermous. The Malvaceae as treated here were formerly (and still commonly) divided into four families: Malvaceae, Bombacaceae, the Bombax family, Sterculiaceae, the chocolate family, and Tiliaceae, the Linden family. Recent morphological The Malvaceae are distinctive in being herbs, shrubs, or trees, often with **stellate trichomes**, typically with an **epicalyx**, the **calyx valvate**, the **corolla often convolute** [sometimes valvate or imbricate] the **stamens connate** as a tube or 5 ∞ bundles, with **monothecal or dithecal anthers**, gynoecium syncarpous [rarely apocarpous], ovary superior [rarely inferior], ovules axile or marginal, the fruit a capsule, schizocarp of mericarps, berry, or samara.

K 3-5 or (3-5) **C** 3-5 [0] **A** 5-∞ **G** 2-∞ [1], superior [rarely inferior $\bar{G}$].



ASTERALES

The Asterales contain 11 families, are: Alseuosmiaceae, Argophyllaceae, **Asteraceae (Compositae)**, Calyceraceae, Campanulaceae, Goodeniaceae, Menyanthaceae, Pentaphragmataceae, Phellinaceae, Rousseaceae, and Stylidiaceae.

Sunflower family (Compositae ---- Asteraceae)

Asteraceae (after Aster, meaning star) represents the largest dicot family, comprising about **900 genera** and over **13000 species** distributed worldwide. It includes herbs, shrubs, trees, epiphytes, vines, and succulents, with laticifers or resin ducts present in some taxa. The **leaves** are simple or compound, spiral or opposite [rarely whorled], exstipulate. The **inflorescence** consists of one or more heads (capitula) arranged in various secondary inflorescences, each head consisting of a flat to conical compound receptacle that bears one to many flowers (developing centripetally) and is subtended by one or more series of bracts, the phyllaries (collectively termed the involucre); heads of five general types: (1) discoid, with only disk flowers, all bisexual; (2) disciform, with only disk flowers, a mixture of pistillate and sterile with bisexual and staminate, in the same or different heads; (3) radiate, with central (bisexual or male) disk flowers and peripheral (female or sterile) ray flowers; (4) ligulate, with all ray flowers (typically with 5-toothed corolla apices); and (5) bilabiate, with all bilabiate flowers. The **flowers** are epigynous, bisexual or unisexual, subtended in some taxa by bracts, known as chaff, or bristles (as in the thistles). The **perianth** is biseriate or uniseriate with hypanthium absent. The **calyx**, known as the **pappus**, is modified as 2 ∞ (sometimes connate) awns, scales, or capillary bristles (typically barbed or plumose), pappus absent in some. The **corolla** is sympetalous with 5 [rarely 4] lobes (reduced to 3 marginal teeth in some), of three structural types (also called flower types): (1) **bilabiate**, corolla zygomorphic with a short tube having upper and lower lips; (2) **disk**, corolla actinomorphic with short to elongate tube bearing 5 [4] teethlike or elongate lobes; or (3) **ray** or **ligulate**, corolla zygomorphic with generally short tube having elongate, flat, extension bearing 3-5 apical teeth. The **stamens** are 5 [4], whorled, alternipetalous, usually syngenesious, the anthers fused into a tube through which the style grows. **Anthers** are basifixed, with apical extensions and sometimes basal lobes, longitudinal and introrse in dehiscence. The **gynoecium** is syncarpous, with an inferior ovary, 2 carpels, and 1 locule. The **style** is solitary and apically two-branched; **stigmas** are two, occurring as stigmatic lines on the adaxial surface of style branches. **Placentation** is basal; **ovules** 1 per ovary. **Nectaries** are usually present at apex of ovary. The **fruit** is an achene (or cypsela, an achene derived from an inferior ovary), typically a multiple fruit of achenes, an elongate beak forming between fruit and pappus in some taxa. The **seeds** are exalbuminous.

The Asteraceae members have a worldwide distribution. Economic importance includes some food (e.g., *Cynara scolymus*, artichoke, and *Helianthus annuus*, sunflower), a number of ornamental cultivars, and various species used locally or industrially.

The Asteraceae are distinctive in being herbs, shrubs, vines, or trees, the inflorescence a **head** (**capitulum**) subtended by an **involucre** of **phyllaries**, flowers either **bilabiate**, **disk,** or **ray**/**ligulate** (heads of many taxa a mixture of central disk flowers and peripheral ray flowers), with the calyx, termed a **pappus**, modified as scales, awns, or capillary bristles (or absent), the androecium **syngenesious**, and with an **inferior ovary** with a **single, basal ovule**, the fruit a multiple of **achenes**.

K 0-∞ (pappus) **C** (5) [(4)] or (3) in some ray flowers **A** (5) [(4)] **G̅** (2), inferior.

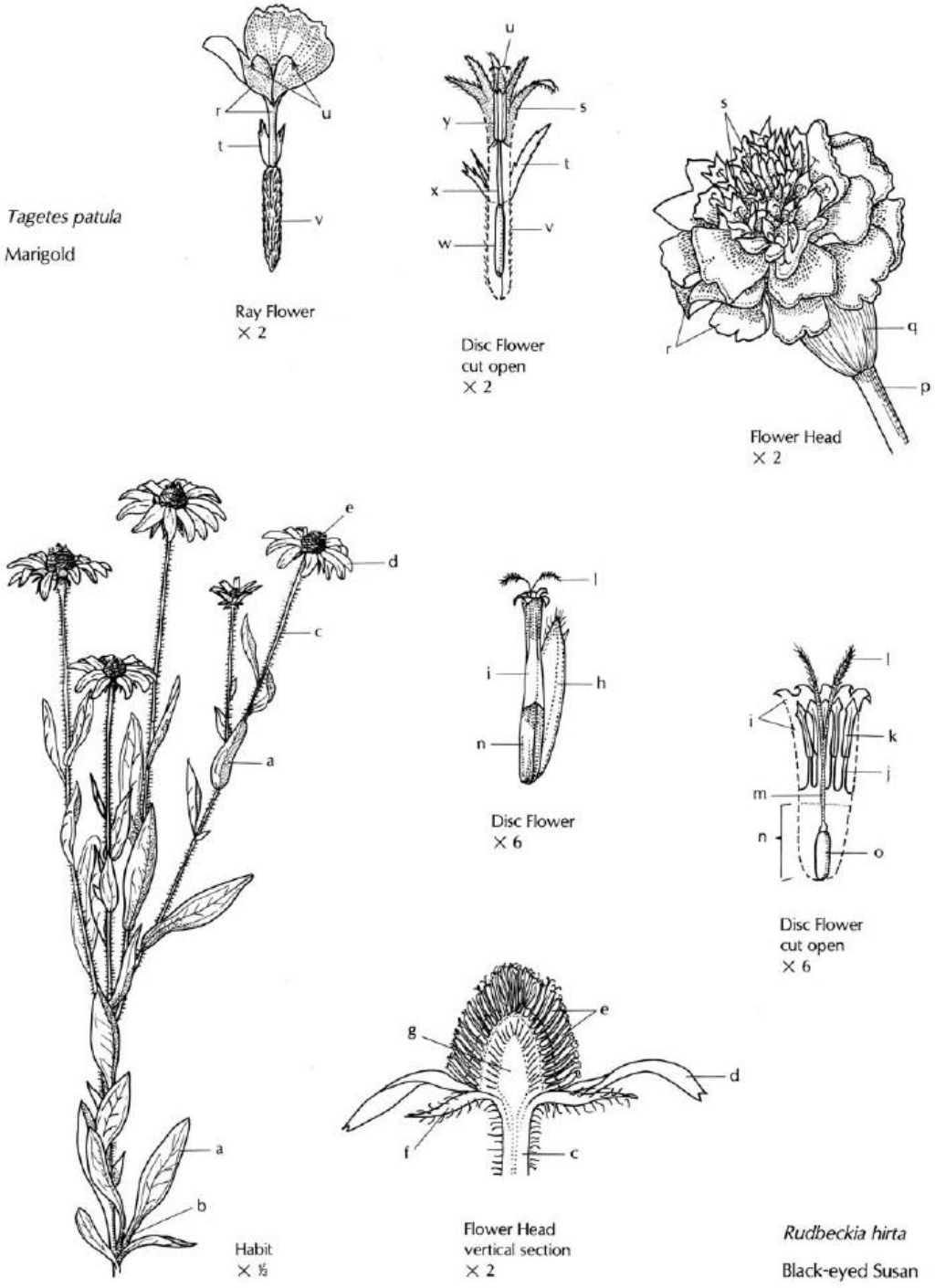
1. Food: *Carthamnus tinctorius* (safflower), *Cynara scolymus* (artichoke), *Helianthus tuberosus* (Jerusalem artichoke), *H. annuus* (sunflower seeds, oil), *Lactuca sativa* (lettuce);

2. Medicine: *Achillea santolina* (سةربةدؤ constituents cyanogentic glucoside, explusion of gases - carminative); *Anthemis nobilis* (بابونج constituents anthemol, anthemic acid, an indigestion): *Artemisia annua* (sweet wormwood, source of artemisinin, an anti-malaria drug), *Calendula officinalis* (used in the treatment of sprains and bruises); *Matricaria chamomilla* (بةيبون possesses antiphlogistic and antiseptic properties).

3. Ornamentals: *Ageratum, Aster, Calendula, Dahlia*, *Helianthus* (sunflower), *Helichrysum* (strawflower), *Leucanthemum* (daisy), *Solidago* (goldenrod, an attractive fall-flowering addition to the garden, height varies with the cultivar and flowers attract many beneficial insects, commonly assumed that this insect-pollinated plant is the culprit that causes hay fever when the blame goes to wind-pollinated.

4. Weeds: *Echinops* (globe thistle), *Ambrosia* (ragweed), *Cirsium* (thistle), *Sonchus* (sow-thistle), *Taraxacum* (dandelion), *Xanthium spinosum* (cocklebur), a seed-head with tiny hook-like spines on the surface clings to animal fur to facilitate seed dispersal.

5. Poisonous pasture plants: *Crepis foetida*, *Arctium lappa* (أرقيطون), *Helenium* (sneezeweed), *Senecio vernalis* (ورد حوذان), *Xanthium strumarium* (لزيج), .


Tagetes patula
Marigold
r
u
t
v
Ray Flower
× 2
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s
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Disc Flower
cut open
× 2
s
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Flower Head
× 2
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× ½
l
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n
Disc Flower
× 6
l
i
k
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m
n
o
Disc Flower
cut open
× 6
e
g
d
f
c
Flower Head
vertical section
× 2
Rudbeckia hirta
Black-eyed Susan

APIALES

The Apiales contain 8 - 10 families includes; **Apiaceae,** Araliaceae, Aralidiaceae (incl. Torricelliaceae), Melanophyllaceae, Myodocarpaceae, Pennantiaceae, Griseliniaceae, and Pittosporaceae, of which the most common family is described here.

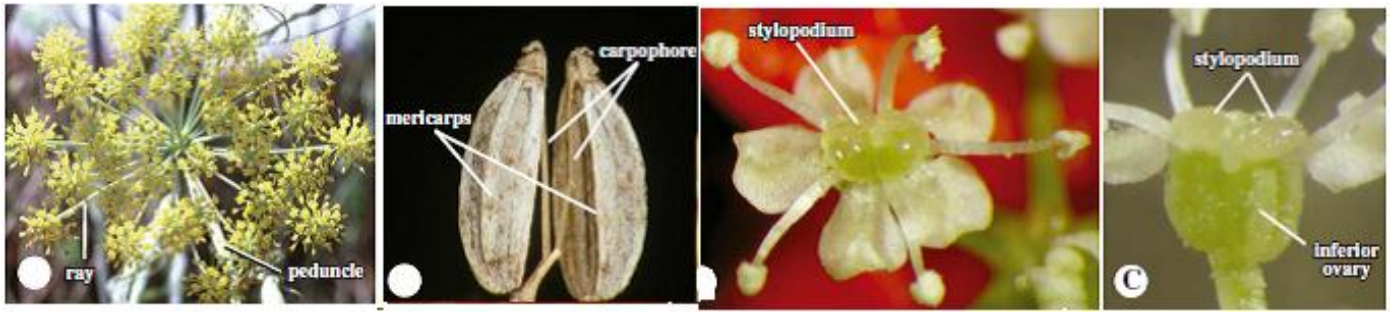
Carrot f amily (Umbelliferae --- Apiaceae)

A*pium*, used by Pliny for a celerylike plant, comprises 3540 species within 446 genera. The Apiaceae consist of herbs, less often shrubs or trees. The **leaves** are usually pinnate, ternate, or decompound [rarely simple or palmate], spiral, with a broad sheathing base. The **inflorescence** is usually a compound umbel often with subtending involucral bracts, sometimes a head or simple umbel or reduced to a single flower or dichasium. The **flowers** are small, bisexual [marginal flowers sometimes sterile], actinomorphic, epigynous. The **perianth** is biseriate and dichlamydeous or uniseriate by loss of the calyx. The **calyx** is aposepalous with 5 lobes, which may be reduced or absent. The **corolla** is apopetalous and with 5 [rarely 0], valvate petals. The **stamens** are 5, whorled, alternipetalous, and apostemonous. The **gynoecium** is syncarpous, with an inferior ovary, 2 carpels, and 2 locules, often with a stylopodium at apex of ovary. **Placentation** is apical; **ovules** 1 per carpel. The **fruit** is a schizocarp of mericarps, supported by carpophores upon splitting. The **seeds** are endospermous, endosperm oily.

The Apiaceae have a worldwide distribution. Economically important members include a number of food, herb, and spice plants, such as *Apium*, celery; *Carum*, caraway; *Cuminum*, cumin; *Daucus*, carrot; and *Petroselinum*, parsely; some species are poisonous, such as *Conium maculatum*, poison hemlock (an extract of which Socrates drank in execution); others are used as ornamental cultivars.

The Apiaceae are distinctive in being **herbs**, with **sheathing leaves** (compound or simple, often decompound), the inflorescence usually an **involucrate compound umbel** [rarely a head, simple umbel, or reduced] with actinomorphic flowers having a 2-carpellate and 2-loculate, **inferior ovary**, each carpel with **one, apical, pendulous ovule**, the fruit a **schizocarp of mericarps**.

K 5 or 0 **C** 5 [0] **A** 5 $\bar{\mathbf{G}}$ (2), inferior.



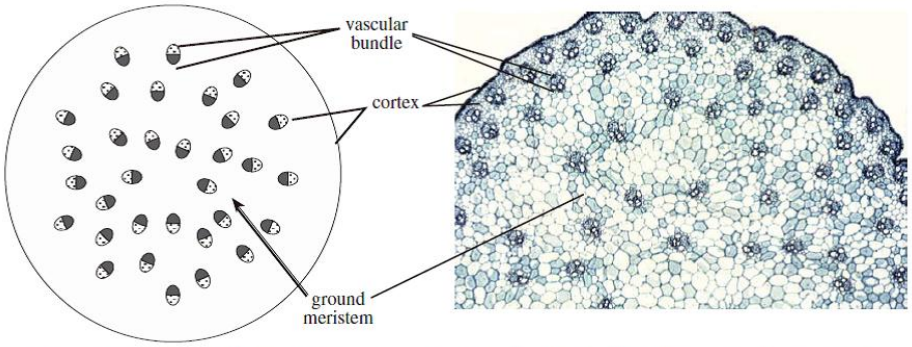
(2) MONOCOTYLEDONS

The monocotyledons, or monocots (also known as the Monocotyledonae or Liliidae), have long been recognized as a major and distinct group, comprising roughly 56,000 species, 22% of all angiosperms. Monocots include the well-known aroids, arrow leaf, lilies, gingers, orchids, irises, palms, and grasses. Grasses are perhaps the most economically important of all plants, as they include grain crops such as rice, wheat, corn, barley, and rye.

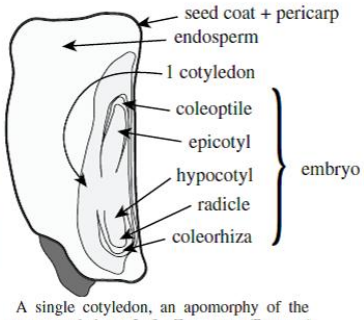
Traditionally, monocots have been defined in part by the occurrence of floral parts in multiples of three. The phylogenetic relationships of the major groups of monocots, as summarized from recent studies supported by several major morphological, anatomical, and ultrastructural apomorphies.

All monocots have a **single cotyledon**, the feature responsible for the name ***monocot***. Most monocots have **parallel leaf venation**. In leaves with parallel venation, the veins are either strictly parallel (as in most grasses), curved and approximately parallel, or penni-parallel (= pinnate-parallel). A penni-parallel leaf has a central midrib with secondary veins that are essentially parallel to one another. Parallel leaf venation is not a characteristic of all monocots. Numerous monocot taxa, for example some Araceae, the Dioscoreaceae (yam family), Smilacaceae (green briar family), and many others, have a reticulate leaf venation similar to that found in nonmonocots.

Another apomorphy for the group, no monocot has single continuous cylinder stem vascular that deposit rings of secondary tissue, as in plants that produce true wood. In addition, no monocot has a true vascular cambium that produces true wood.



The atactostele, an apomorphy of the monocotyledons. Note numerous vascular bundles; at left: xylem = dark; phloem = stippled.



A single cotyledon, an apomorphy of the monocotyledons. Left, *Zea mays* (Poaceae).

POALES

The Poales, as circumscribed by APG II (2003), is a large group of 18 families, of which Poaceae described here, the Poales is characterized by monoulcerate pollen grains; these have small, reduced, typically windpollinated flowers.

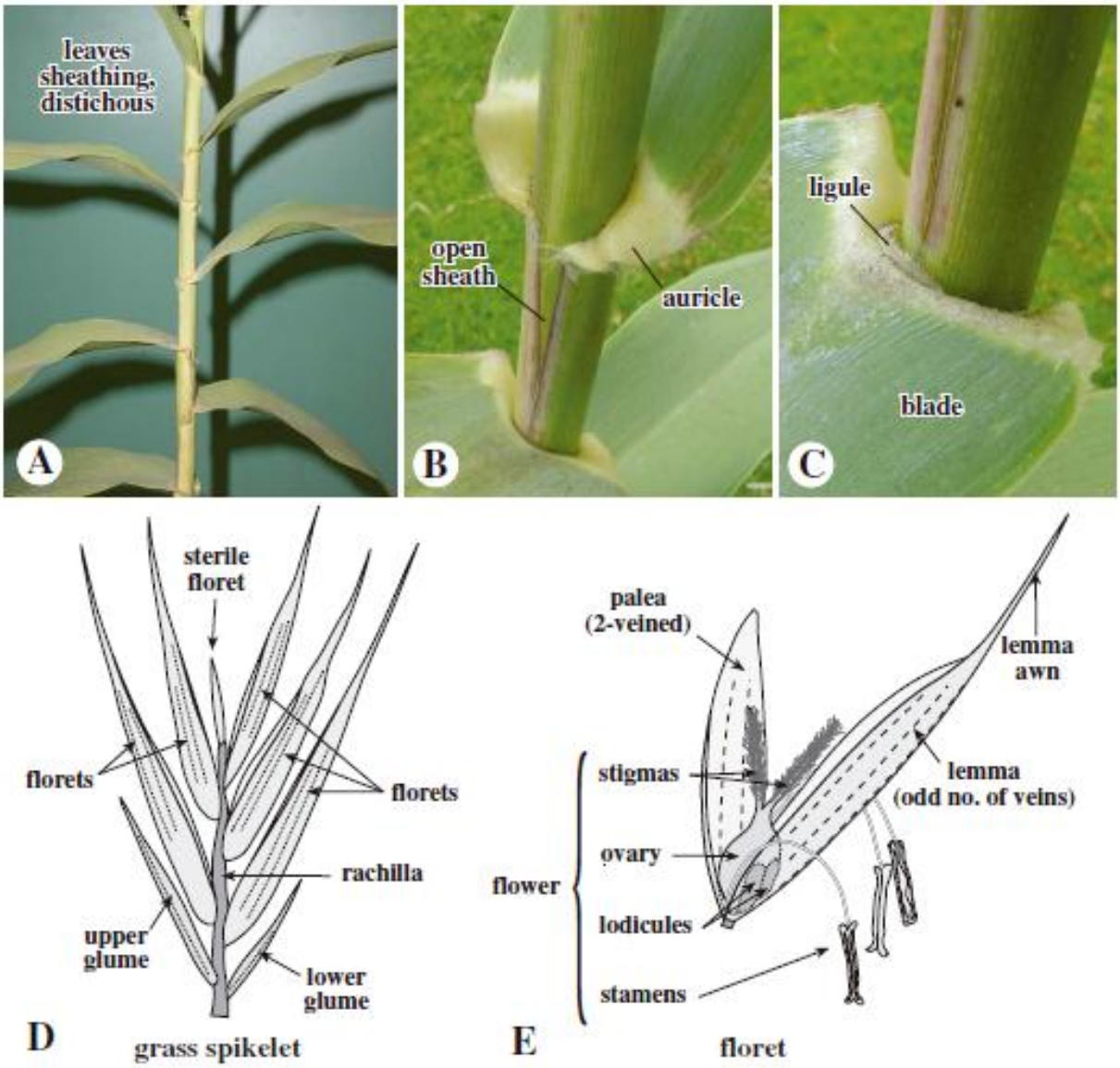
Grass family (Poaceae - - - - Gramineae)

Poaceae; from *poa*, Greek name for a grass, 668 genera / 9500 species. The Poaceae consist of perennial or annual, hermaphroditic, monoecious, or dioecious herbs or (in the bamboos) trees. The **roots** are adventitious. The underground **stems** of perennials are rhizomes or stolons, the erect stems (termed culms) are hollow (solid at the nodes). The **leaves** are simple, basal or cauline, distichous, rarely spiral, with a usually open, basal sheath; the leaf blade is parallel-veined, often auriculate at base, and typically ligulate, with a ligule at junction of sheath and blade (resembling a sheathlike structure or tuft of trichomes). The **inflorescence** consists of terminal or axillary spikelets (more properly termed grass spikelets), these aggregated in secondary inflorescences of spikes, racemes, panicles, or glomerules; the spikelets are sessile or stalked (the spikelet stalk termed a pedicel); the grass spikelet itself consists of an axis (termed the rachilla) bearing distichous parts: two basal bracts (termed glumes, the lower one called the first glume, the upper the second glume, sometimes modified or absent) and one or more florets ; each floret consists of a minute lateral axis with two additional bracts (termed the lemma and palea) and a flower; the lemma is the lower and larger bract; the palea is the upper, smaller bract, is partially enveloped or enclosed by the lemma. A bristle-like **awn** may be present at the apex of glumes or lemmas. The **flowers** are bisexual or unisexual, sessile, and hypogynous. The **perianth** is absent or modified into 2 or 3 **lodicules** (located on the lower side, toward the lemma), which upon swelling function to open the floret by separating the lemma from palea. The **stamens** are 2 or 3. **Anthers** are basifixed-versatile, usually sagittate at the base, generally pendulous on elongate filaments, dithecal, and longitudinal in dehiscence. The **pollen** is monoporate. The **gynoecium** is syncarpous, with a superior ovary, 2-3 carpels, and 1 locule. The **stigmas** are 2 or 3, usually plumose. **Placentation** is basal; **ovules** are usually bitegmic, 1 per ovary. **Nectaries** are absent. The **fruit** is a caryopsis (grain). The **seeds** are endospermous.

Plants are wind pollinated. The Poaceae are worldwide in distribution. The grasses are perhaps the most economically important group of plants, containing the agricultural grains, including barley (*Hordeum*), corn (*Zea*), oats (*Avena*), rice (*Oryza*), rye (*Secale*), wheat (*Triticum*), and others, as well as important forage and grazing plants. Members of the family are also important components of many ecosystems, such as grasslands and savannahs.

The Poaceae are distinctive in being herbs (trees in the bamboos) with **hollow-pithed stems** and **open-sheathed**, **distichous leaves** with a **ligule** at inner junction with blade; the inflorescence is a **grass spikelet**, typically with 2 basal bracts (**glumes**) on a central axis and 1-∞ **florets**, each consisting of a short lateral axis with 2 bracts (a lower, odd veined **lemma** and an upper, 2-veined **palea**) and a flower, the flower with perianth reduced to usually 2-3 **lodicules**, usually 2 3 pendulous stamens, and a single 2 3-carpellate, 1-ovuled ovary with 2 3 **plumose stigmas**, the fruitt a **caryopsis** (**grain**).

P 2-3 [-6+] lodicules **A** 2-3 [1] **G** (2-3), superior.



ASPARAGALES

The Asparagales, sensu APG II (2003), contain approximately 24 families of monocotyledons, including a large and diverse number of taxa, although note that many families could alternatively be united. Notable among the others are the **Agavaceae** Agave family (Asparagaceae , Agapanthaceae , **Agavaceae** , **Alliaceae**, **Amaryllidaceae**, **Asphodelaceae**, **Acoraceae** , **Iridaceae** and **Orchidaceae.** Three families are described here.

Onion family (Alliaceae)

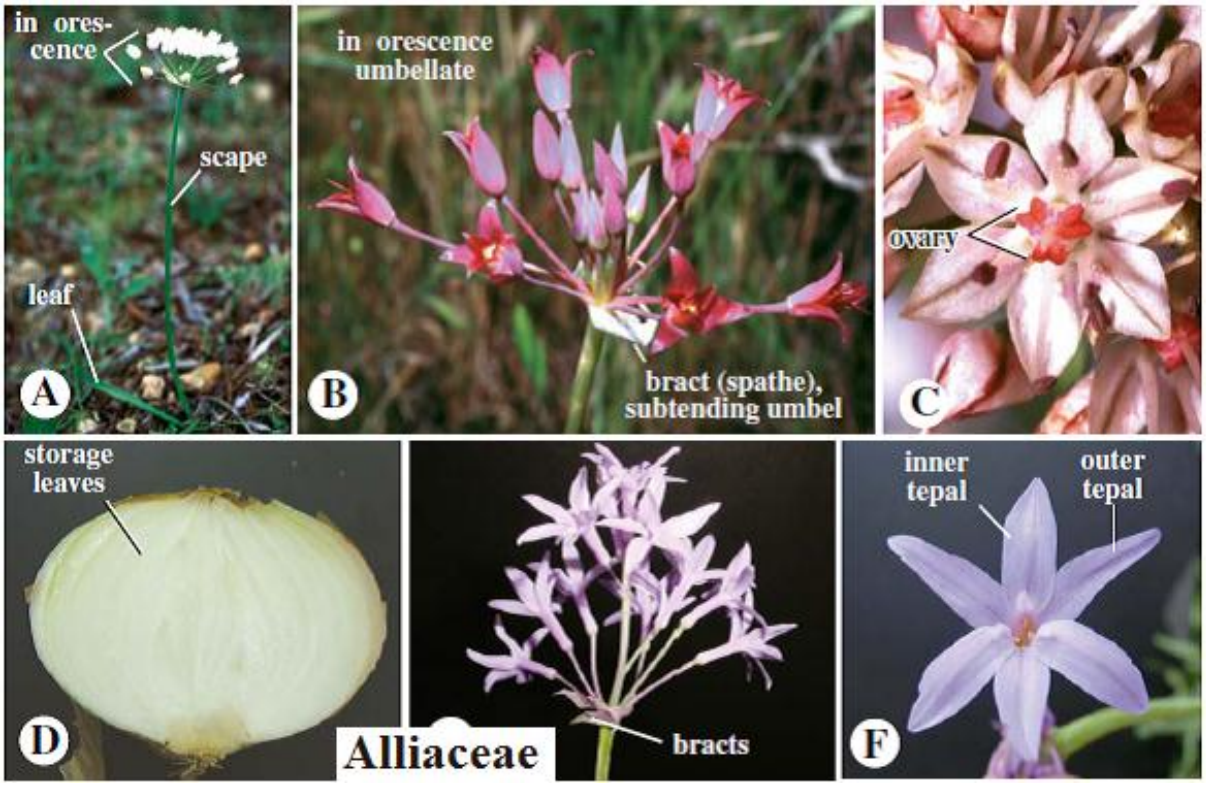
Latin name for garlic, ca.600 species within 13 genera. The Alliaceae consist of biennial or perennial herbs, usually with a distinctive onion-like (alliaceous) odor. The **stems** are acaulescent and usually a bulb, rarely a short rhizome or corm, typically enveloped by membranous scale leaves or leaf bases. The **leaves** are simple, basal, spiral, closed sheathing, acicular, linear, or lanceolate [rarely ovate], parallel veined. The **inflorescence** is a terminal, scapose umbel (sometimes termed a pseudo-umbel), rarely a spike or of solitary flowers, with membranous and spathy bracts. The **flowers** are bisexual, actinomorphic, pedicellate, membranous-bracteate, and hypogynous. The **perianth** is biseriate, homochlamydeous, campanulate to tubular, with 3 outer and 3 inner, distinct to connate tepals, a corona sometimes present. The **stamens** are 3+3 [rarely 3 or 2 with staminodes], whorled, diplostemonous, biseriate, unfused or epitepalous; the filaments are generally flat. **Anthers** are versatile, longitudinal and introrse in dehiscence. The **gynoecium** is syncarpous, with a superior [rarely half-inferior] ovary, 3 carpels, and 3 locules. The **style** is solitary, terminal or gynobasic; the **stigma** is solitary, trilobed to capitate, dry to wet. **Placentation** is axile; **ovules** are 2-∞ per carpel. Septal **nectaries** are present. The **fruit** is a loculicidal capsule. The **seeds** are black, ovoid, ellipsoid or subglobose, endospermous, the endosperm rich in oils and aleurone. Family members contain alliin, which is enzymatically converted by wounding to allyl sulfide compounds, the latter imparting the distinctive onion-like odor and taste.

The Alliaceae have a mostly worldwide distribution, mainly northern hemisphere, S. American, and S. African.

Economic importance includes important food and flavoring plants, including onion (*Allium cepa*), garlic (*A. sativum*), leek (*A. ampeloprasum*), and other *Allium* species. Garlic also has documented medicinal properties. Several taxa are used as ornamental cultivars, e.g., *Ipheion, Leucocoryne,* and *Tulbaghia* spp.

The Alliaceae are distinctive in being generally **bulbous herbs**, with **basal**, usually **narrow** leaves, an **umbellate** inflorescence,
and a usually **superior ovary**.

P 3+3 **A** 3+3 [3,2] **G** (3), superior [rarely half-inferior].



Amaryllis family (Amaryllidaceae)

Latin name for a country girl, 850 species within 59 genera. The Amaryllidaceae consist of terrestrial, rarely aquatic or epiphytic, perennial herbs. The **stems** are bulbs, covered by membranous leaf bases, the tunica. The **leaves** are simple, undivided, spiral or distichous, sheathing or not, sessile or petiolate, and parallel veined. The **inflorescence** is a terminal, scapose umbel (sometimes termed a pseudo-umbel), rarely of solitary flowers, with bracts present, enclosing the flower buds. The **flowers** are bisexual, actinomorphic or zygomorphic, pedicellate or sessile, bracteate, epigynous to epiperigynous. The **perianth** is biseriate, homochlamydeous, trimerous, apotepalous or syntepalous, and forming a short to long hypanthial tube, sometimes with a perianth corona (e.g., *Narcissus*). The **stamens** are generally biseriate, 3+3 [3-18], distinct or connate, forming a staminal corona in some (e.g., *Hymenocallis*). **Anthers** are usually dorsifixed, longitudinal, and introrse in dehiscence. The **gynoecium** is syncarpous, with an inferior ovary, 3 carpels, and 3 [1] locules. **Placentation** is axile or basal; ovules are unitegmic, or ategmic. The **fruit** is a loculicidal capsule or rarely a berry. The **seeds** are phytomelaniferous.

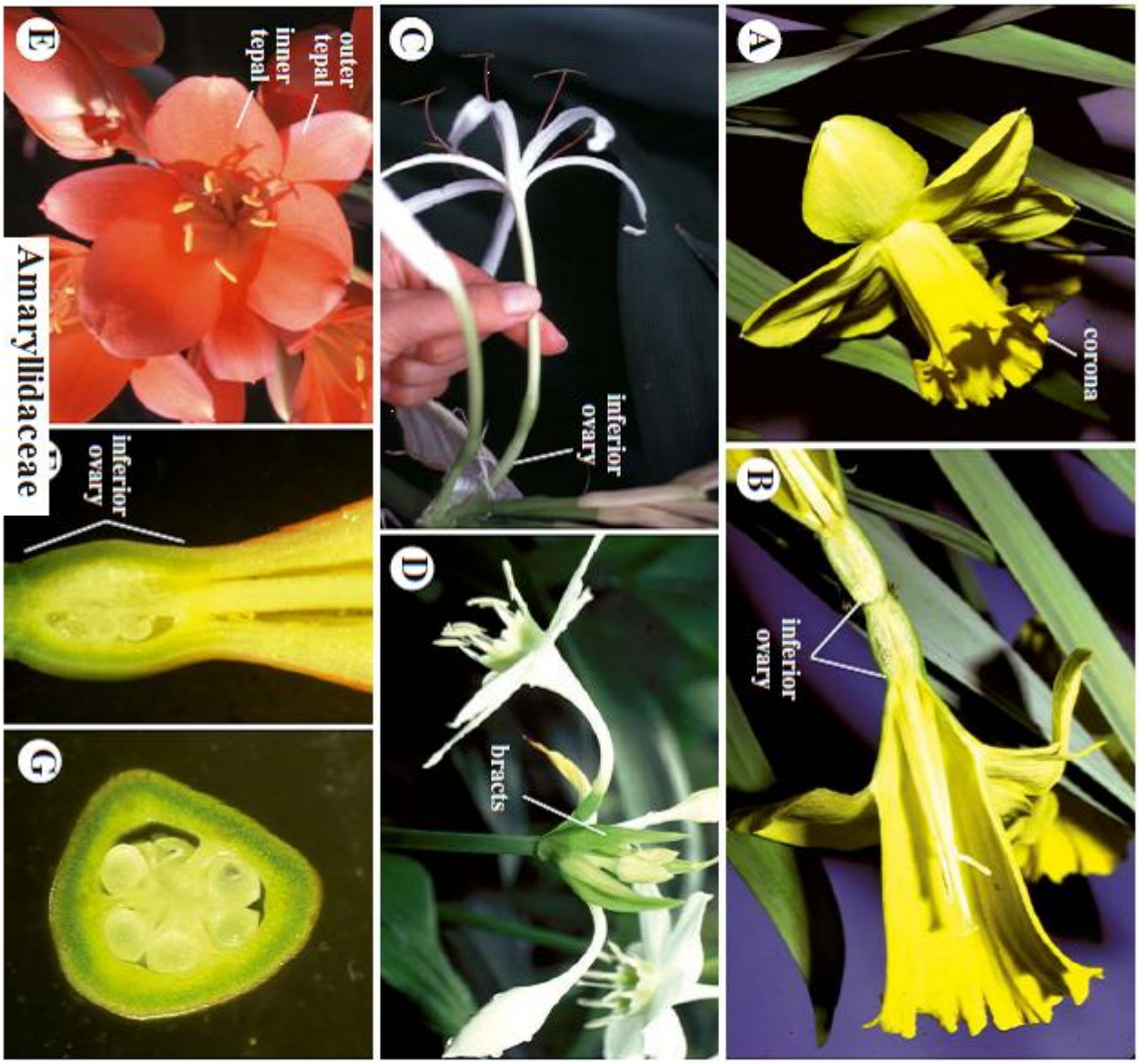
The Amaryllidaceae have a worldwide distribution, being especially concentrated in South America and South Africa.

Economic importance is primarily as innumerable cultivated ornamentals, such as *Amaryllis* (belladonna-lily), *Crinum*, *Galanthus* (snowdrop), *Hippeastrum* (amaryllis), *Leucojum* (snowflake), *Lycoris* (spider-lily), and *Narcissus* (daffodil);

several taxa are used by indigenous peoples for medicinal, flavoring, psychotropic, or other purposes.

The Amaryllidaceae are distinctive in being perrenial, **bulbous herbs** with an **umbellate** inflorescence and an **inferior ovary**.

P 3+3 or (3+3) **A** 3+3 or (3+3) [3-18] **G** (3), inferior, hypanthium present.



Iris family (Iridaceae)

After Iris, mythical goddess of the rainbow. 1750 species within 70 genera. The Iridaceae consist of perennial [rarely annual] herbs or shrubs with anomalous secondary growth. The **stems** are rhizomatous, cormose, bulbous, or a woody caudex. The **leaves** are unifacial (with leaf plane parallel to stem) or terete, simple, narrow and generally ensiform, sheathing, often equitant, distichous, and parallel-veined. The **inflorescence** is a terminal spike, solitary flower, or a spike or panicle of clusters of 1to many monochasial cymes, typically subtended by two spathelike bracts. **Flowers**

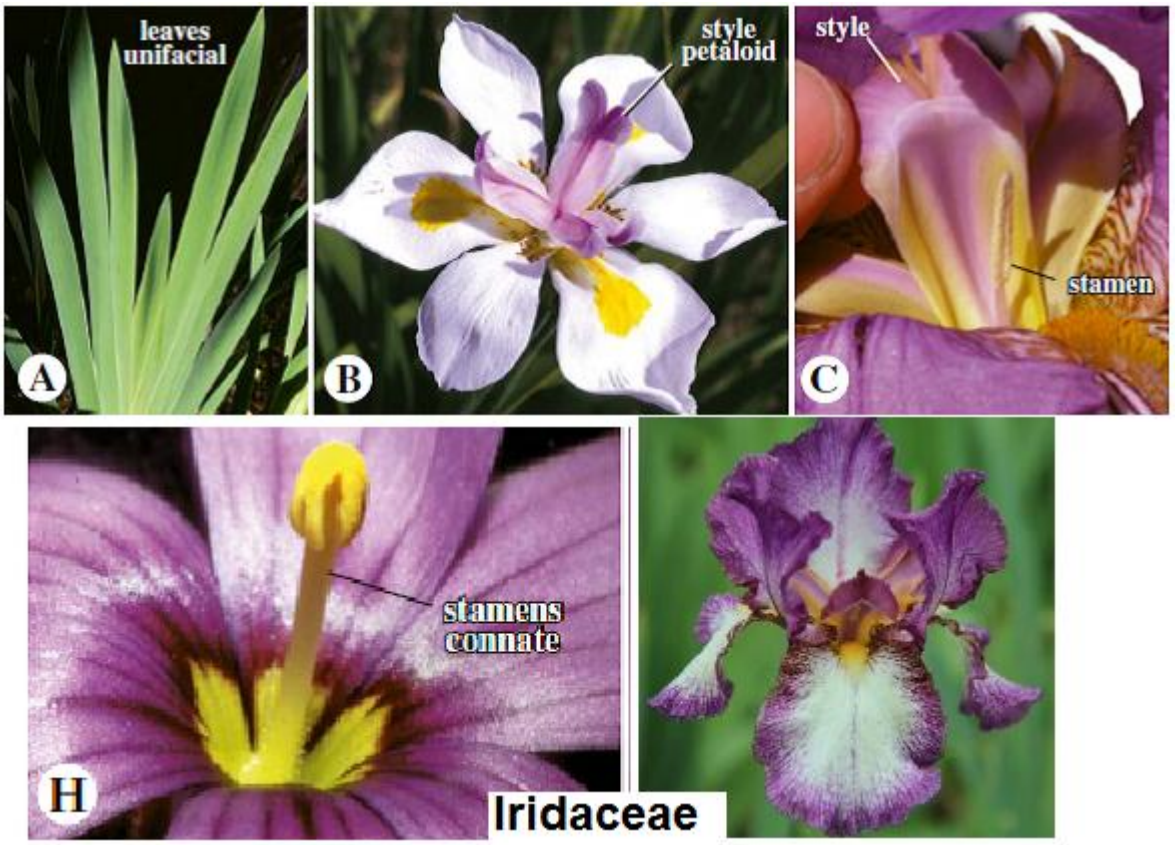
are bisexual, actinomorphic or zygomorphic, pedicellate or sessile, bracteate, epigynous. The **perianth** is biseriate, homochlamydeous, 3+3, apotepalous or syntepalous. **Stamens** are 3, opposite the outer tepals, distinct or monadelphous; anthers are longitudinally extrorse or poricidal in dehiscence. The **gynoecium** is syncarpous, with an inferior ovary, 3 carpels and locules, style(s) terminal, petaloid in many Iridoideae. **Placentation** is axile (rarely parietal); ovules are bitegmic, 1-∞ per carpel. The **fruit** is a loculicidal capsule; seeds are endospermous with a dry or fleshy seed coat.

Members of the family have a worldwide distribution, being especially diverse in southern Africa.

Economic importance includes extensive use as ornamental cultivars, e.g., as cut flowers, especially species of *Iris*, *Gladiolus*, *Freesia*, and *Crocus*; the styles and stigmas of *Crocus sativus* are the source of the spice saffron; corms of some species are eaten by indigenous people.

The Iridaceae are distinguished from related families in being usually **perennial herbs** with generally **ensiform, unifacial** leaves, a bracteate **spike or panicle** of **solitary flowers** or **monochasial cyme (rhipidia) clusters**, and flowers with **three stamens opposite outer tepals**.

P 3+3 or (3+3) **A** 3 or (3) **G** (3), inferior



APPENDAGES

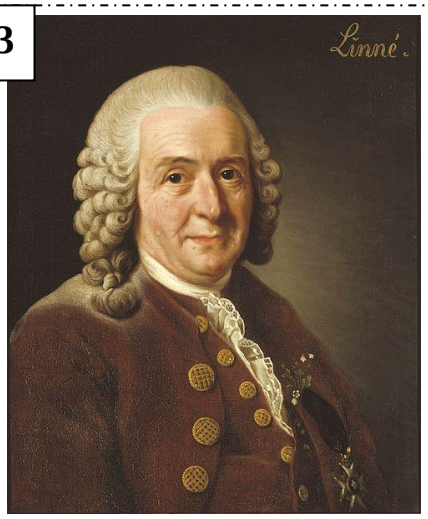
1

Theophrastus: Father of Botany
(370 – 287 B.C.)

2

JON RAY
(1628 – 1705 A.D.)

3



CARL VON LINNAEUS
(1707-1778)

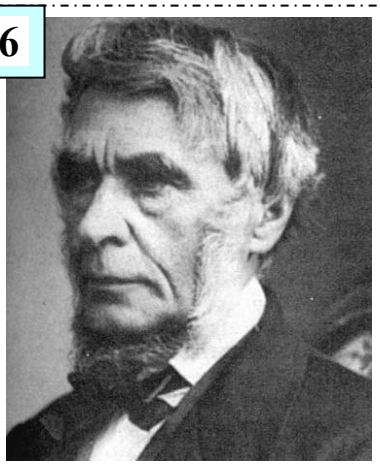
4

ANTOINE LAURENT DE JUSSIEU
(1686 – 1758)

5

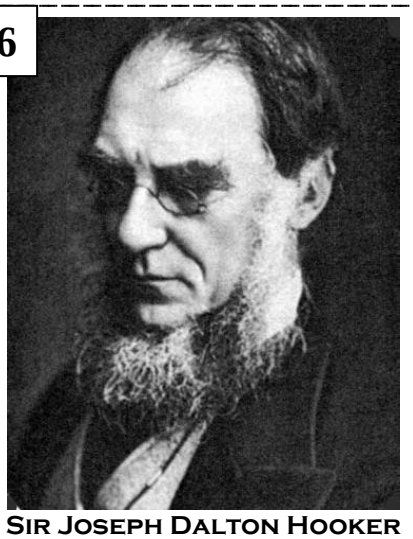
AUGUSTIN PYRAME LAURENT DE CANDOLLE (1778-1841)

6



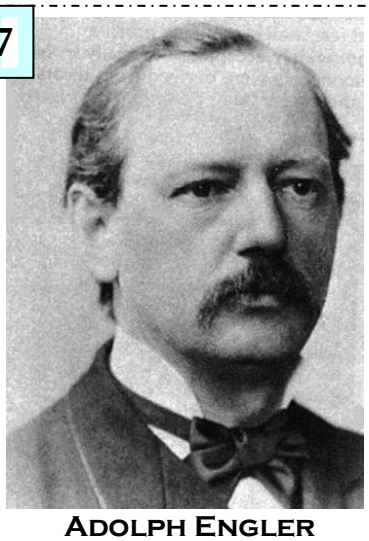
GEORGE BENTHAM
(1800 – 1884)

6



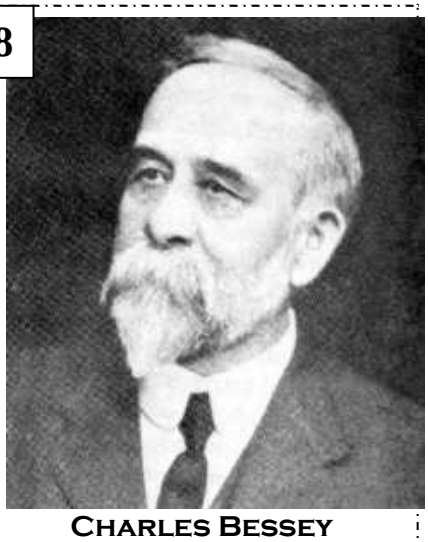
SIR JOSEPH DALTON HOOKER
(1817 – 1911)

7

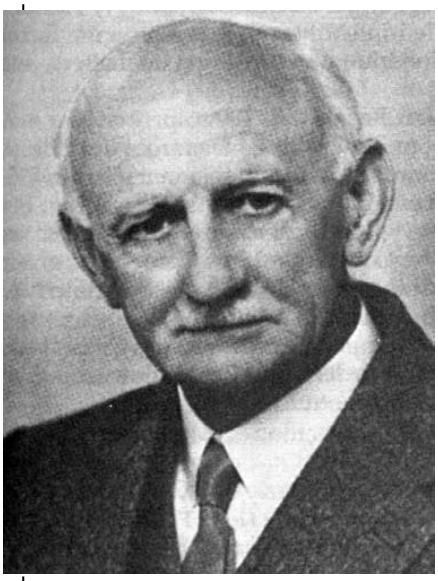


ADOLPH ENGLER
1844 – 1930)

8

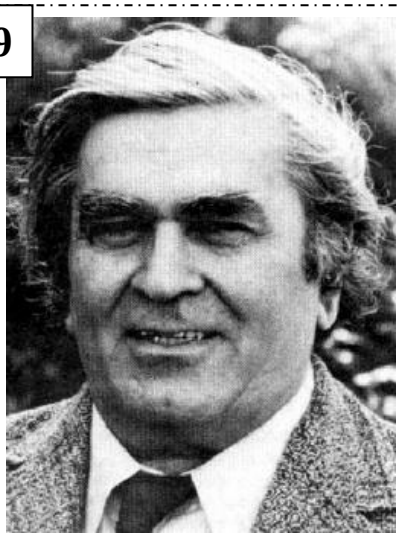


CHARLES BESSEY
(1845-1915)



JOHN HUTCHINSON
(1884-1972)

9



ARMEN TAKHTAJAN
(1910-2009)

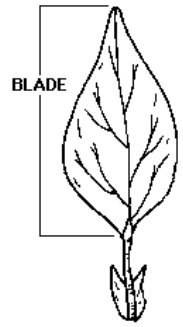
9

ARTHUR CRONQUIST (1919-1992)

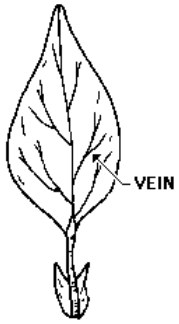
ANDREA CESALPINO (1519-1603 A.D.)

Leaf Structure

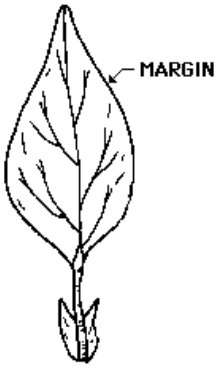
Knowing the features of a leaf will help you learn to identify plants.



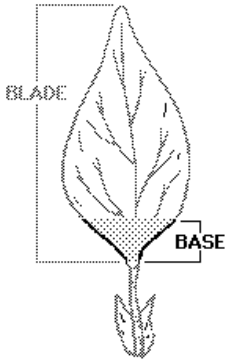
The Leaf Blade



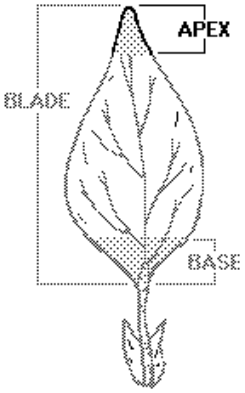
The Leaf Veins



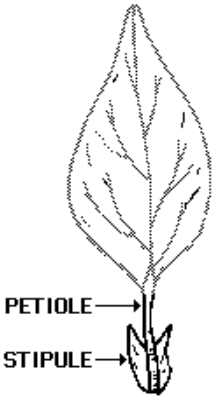
The Leaf Margin



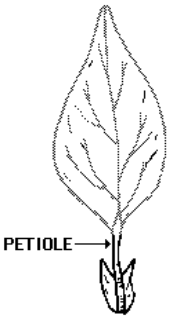
The Leaf Base



The Leaf Apex

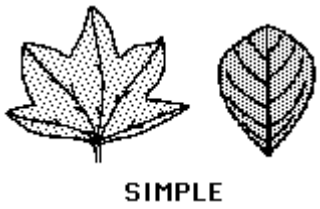


The Stipule



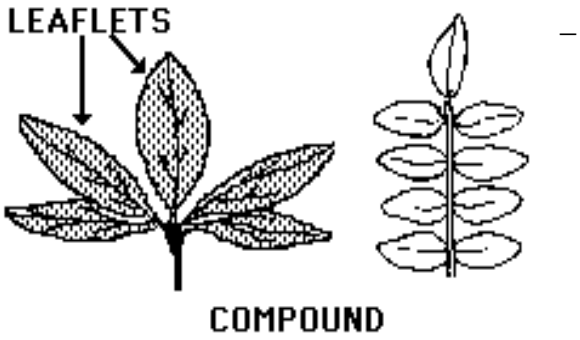
The Petiole

Simple



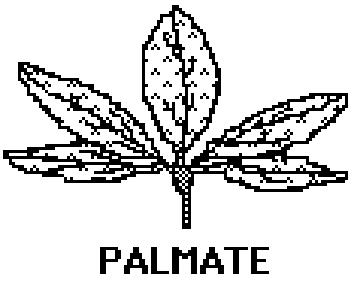
and

Compound

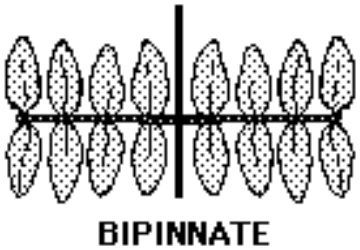


–

Palmate



Bipinnate



Leaf Arrangement :

Opposite…

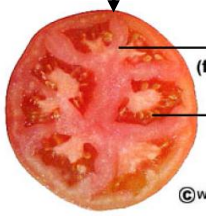
Alternate …

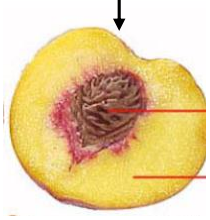
Whorled

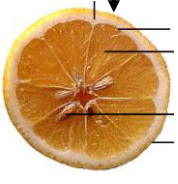
Simple fruits

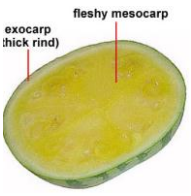
1. Fleshy Succulent fruits

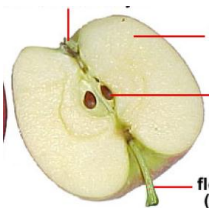
(A) Berry	(B) Drupe	(C) Hesper-idium	(D) Pepo	(E) Pome
Vitis vinifera Lycopersicum sp.	Prunus amygdalus P. Armenica	Citrus sp.	Cucurbita sp.	Malus sp. Pyrus sp.









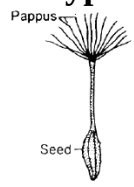


2. Dry simple fruits

a- Indehiscent

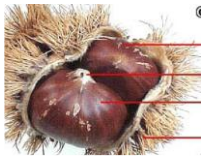
1. Achene

2. Cypesla

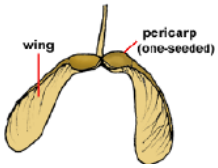


Cypsela of sunflower

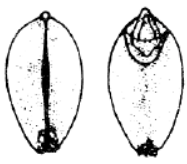
3. Nut



4. Samara



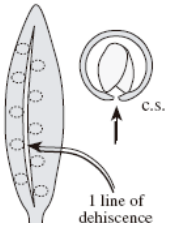
5. Caryopsis



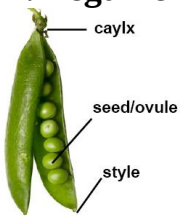
Caryopsis of wheat

b- Dehiscent

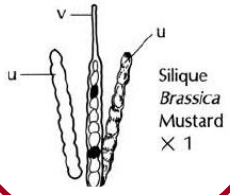
1. Follicle



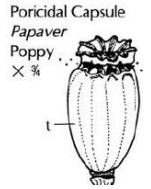
2. Legume



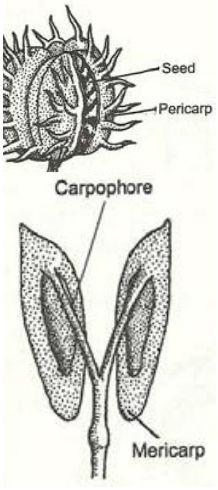
3. Silique



4. Capsule



C- Schizocarp



Multiple Fruit Types

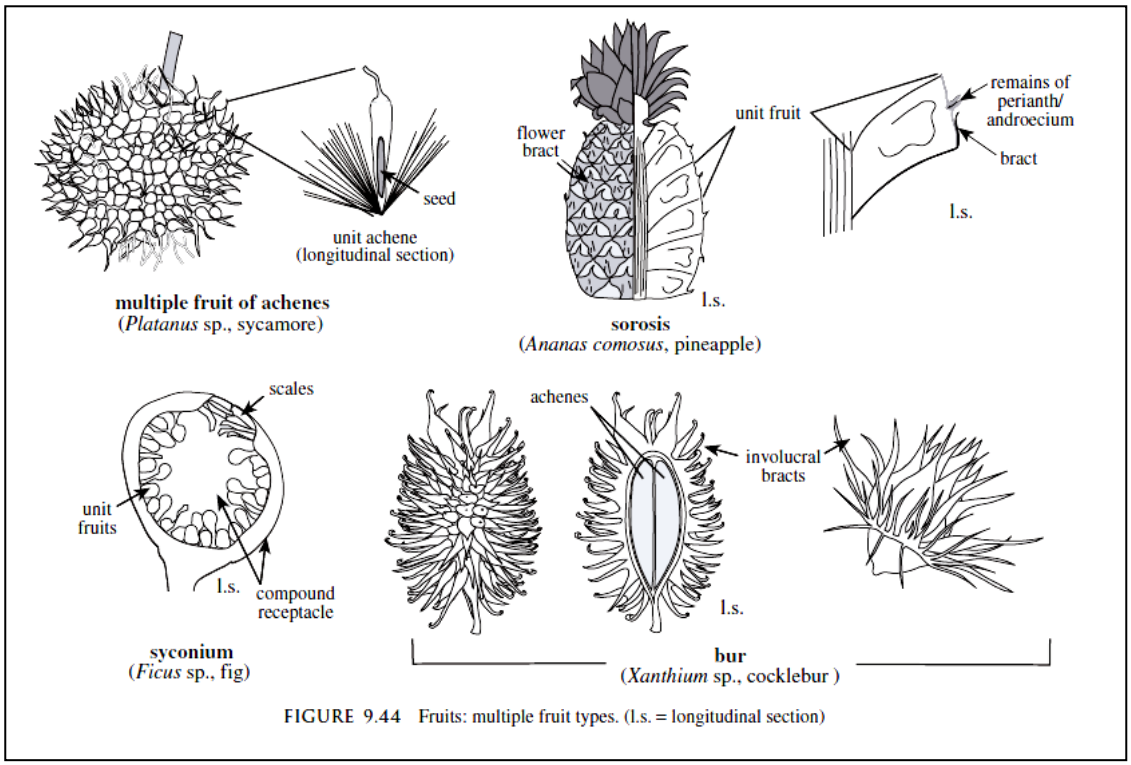


FIGURE 9.44 Fruits: multiple fruit types. (l.s. = longitudinal section)

Departments: Plant protection, Field crops, Forest and Horticulture
College of Agricultural Engineering Sciences
Salahaddin University- Erbil
Subject: Theoretical Part of Plant Taxonomy
Course Book – Year 2
Lecturer's name: Serwan Taha Saleh Al-dabbagh
Academic Year: 2023/2024

Course Book

1. Course name	Theoretical Plant Taxonomy
2. Lecturer in charge	Serwan Taha Al-dabbagh
3. Department/ College	Field Crops / Agricultural Engineering Sciences
4. Contact	e-mail: serwan.saleh@su.edu.krd
5. Time (in hours) per week	Theoretical: (2) + Practical: (3) hours
6. Office hours	(8 hrs.)
7. Course code	
8. Teacher's academic profile	There is no doubt that the teacher as a main factor of the teaching process, has a very good and important role in performance the teaching program and preparing the students, he is the follower of the results of teaching process and try to progress this process. The teacher is an affected factor among the teaching factors, and has effect on the student's characters and their future, therefor; the teacher must beware in his treatment with the students and the teaching staff. For all the progress that take place in the world, in all the fields, such as cultural, social, scientific, technology, etc. … , the teacher must suit himself with all these changes and benefit from them in order he can finally to reach these benefits to all peoples that he treat with them.
9. Keywords	Flora, Plant, Reproductive organs, Taxonomy, Vegetative

10. Course overview:

Plant Systematics is an introduction to the morphology, evolution, and classification of land plants. The objective is to present a foundation of the approach, methods, research goals, evidence, and terminology of plant systematics and to summarize information on the most recent knowledge of evolutionary relationships of plants as well as practical information vital to the field. Systematics, gives a general overview of the concepts and methods of the field of systematics. An introduction to the definition, relationships, classification, and importance of plants and summarizes the basic concepts and principles of systematics, taxonomy, evolution, and phylogeny must be involved. Evolution and Diversity of Plants, describes the characteristics and classification of plants. The beginning student may be given a basic understanding of the evolution of Green and Land Plants, Vascular Plants, Woody and Seed Plants, and Flowering Plants evolutionary approach to plant systematics makes learning the major plant groups and their features conceptually. The student may learn to recognize and know the basic features of the major lineages of plants, diagnostic features that a student might use to recognize a plant family, and some economically important uses of family members. Plant collecting and documentation emphasizes both correct techniques for collecting plants and thorough data acquisition, the latter of which has become increasingly important today in biodiversity studies and conservation biology. Information on herbaria and data information systems reviews the basics of herbarium management, emphasizing the role of computerized database systems in plant collections for analyzing and synthesizing morphological, ecological, and biogeographic data. A list of characters used for detailed plant descriptions may give, this list is useful in training students to write descriptions suitable for publication. Students need to learn to draw, in order to develop their observational skills. Finally, I would like to propose that each of us, instructors and students, pause occasionally to evaluate why it is that we do what we do, this offer these suggestions as possible goals: 1- to realize and explore the beauty, grandeur, and intricacy of nature; 2- to engage in the excitement of scientific discovery; 3- to experience and share the joy of learning.

11. Course objective:

After completing the course, students should be able to:

1. State, define, and give examples of the components of taxonomy: description, identification, nomenclature, and classification.
2. Describe a plant, using the descriptive terminology of plant morphology, anatomy, embryology, palynology, and reproductive biology.
3. Name, classify, and diagnose several of the major families of flowering plants.
4. Collect (including properly recording field data), identify, and process a plant for a herbarium specimen.
5. State the principles and rules of plant nomenclature, including how to apply botanical names.

Students will be assessed for the above skills with quizzes, exercises, lecture exams, lab practical's.

12. Student's obligation

The role of students and their obligations throughout the academic year involve theirattendance in the lectures, drawing all the plates and plant specimens concerning to the lecture, and completion of all daily (quizzes) and monthly tests, exams, and preparing some herbarial plant specimens.

Laboratory Notebook

Students will need to keep a laboratory notebook for the duration of the course. This notebook should contain illustrations that you make during lab, primarily those that are listed for you to draw in the laboratory exercises. The notebook may be of two possible formats: a bound lab notebook, available at the bookstore, or 3-hole punched white paper, placed in a separate 3-ring notebook. I will evaluate your drawings early in the semester (after the first week or two) to give you suggestions. The laboratory notebook is due (counts as a quiz) during the semester.

13. Forms of teaching

Different forms of teaching will be used to reach the objectives of the course: definitions, discussions and conclusions, plates and shapes by using Data-show (in power point) as well as using the white board to illustrate the lecture or sides of the lecture for the students.

14. Assessment scheme

Every the daily (quizzes) tests given 10 marks and finally calculated as a monthly test (100 marks) in addition to the monthly tests (1-2 tests), all these marks calculated as the course attempt mark, as well as additional marks will be given to the students whom bringing fresh plant specimens.

15. Student learning outcome:

The objective of the course is to present a foundation of the approach, methods, research goals, evidence, and terminology of plant systematics and to summarize information on the most recent knowledge of evolutionary relationships of plants as well as practical information vital to the field.The student may learn to recognize and know the basic features of the major lineages of plants, diagnostic features that a student might use to recognize a plant family, and some economically important uses of family members. When the student be able to recognize and identify the plant specimens he will be able to work in the herbaria, preparing the Floras, national parks, botanical gardens, as well as preparing the scientific researches. The student will learn from Plant Taxonomy and all its subjects that: to realize and explore the beauty, grandeur, and intricacy of nature; to engage in the excitement of scientific discovery; and to experience and share the joy of learning.

16. Course Reading List and References:

1. Al-Rawi, A. (1964). Wild plants of Iraq with their distribution. Ministry of Agriculture & Irrigation, state board for agricultural & water resources research, National Herbarium of Iraq, Baghdad.

2. Al-Rawi, A. and H. L. Chakravarty (1988). Medicinal plants of Iraq. Second edition. Ministry of Agriculture & Irrigation, state board for agricultural & water resources research, National Herbarium of Iraq, Baghdad.
3. Al-Rawi, A. (1988). Poisonous plants of Iraq with. Third edition. Ministry of Agriculture & Irrigation, state board for agricultural & water resources research, National Herbarium of Iraq, Baghdad.
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11. - تصنيف النباتات البذرية: يوسف منصور الكاتب.

17. Theoretical Topics (If there is any)	Lecturer's name
Week l: Fundamental Components of Taxonomy, International Code of Botanical Nomenclature. (I.C.B.N.): Week 2: Historical Retrospect 1. Early History of Plant Taxonomy 2. Later Progress in Plant Taxonomy 3. Recent Systems of Classification Week 3: Modern Trends or Scope of Plant Taxonomy 1. Anatomy 2. Palynology 3. Embryology 4. Cytology 5. Chemotaxonomy 6. Numerical TaxonomyWeek4: Plant Morphology Week 4: Root: Origin of roots. Root system. Modified Roots STEM: Origin of stem. Parts of the stem. 1. Monopodial and Sympodial system of branching. 2. Stem habit types . 3. Modified stems 4. Leaf: Origin of leaf 5. Phyllotaxy. 6. Leaf incision (simple & compound leaves). Week 5: Bract and Bracteols: 1. Types of bracts 2. Specialized bracts 3. Flower: Flower parts, Type of perianth cycles, Week 6: Flower symmetry, Appendages and Androecium 1. Stamen Arrangement, Cycly, and Position. Stamen Attachment. 2. Nectaries, Stamen fusion, Anthers parts, Type, and Attachment. 3. Anthers dehiscence. Pollen grain, Pollen unite, Pollen polarity. Week 7: Gynoecium, (Carpels, and Pistil): 1. Carpel number, Ovary position.	Dr. Serwan Taha Saleh Al-dabbagh The theoretical lecture takes 2 hrs. And Every practical lecture takes 3 hrs.

2. Placentation. 3. Inflorescence; 1. Inflorescence parts, 2. Inflorescence type, Inflorescence development, 3. Specialized inflorescences. Week8: Fruits; Fruit types, 1. Simple fruit types, Fleshy (succulent) Fruits, 2. Simple dry at maturity, Aggregate fruit types, Multiple fruit types. 3. Seeds; Seed endosperm type, Seed germination type, General Terminology, Color, Size, Shape,. Week9: Environment and Geographical Distribution 1. Floras 2. Flora of Iraq 3. Iraq Topography 4. Soils of Iraq Week9:Vegetation Structure in Iraq 1. Population 2. Frequency and Density 3. Vegetation types in Iraq 4. Vegetation Zones in Iraq Week10: Plant Identification: Construction and Use of Keys, Types of keys: 3) Indented or Yoked keys; 4) Bracketed or Parallel keys:. Week11: Some an important (Angiosperms) families; Aster Family (Asteraceae) - Mustard Family (Brassicaceae) Week 12: Nightshade Family (Solanaceae) - Carrot Family (Apiaceae): Week 13: Grass Family (Poaceae): Lily Family (Liliaceae): Week 14:Beech Family (Fagaceae): Iris Family (Iridaceae):	

Possible questions

Q1/ Fill the blanks with missing words; (choose 10 phrases from the box and write the appropriate one in the blank): (20 Marks)

Genera Plantarum, Poaceae, opsida, Equatorial view, Fabaceae, ales, law or rule, Polar view, Apiaceae, De Plantis, Historia Plantarum. arrangement, phyta, Arecaceae.

1. The literal meaning of taxonomy in Greek, taxus means- - - - - - - - - - - - , and nomos means - - - - - - - - - - - - - - -.
2. The published works of Caesalpino was - - - - - - - - - - - - - - - , and of De Jussieu was - - - - - - - - - - - - - - - .
3. The ending of the name indicates its rank, as Subdivision ends with (phytina); The Class ends with - - - - - - -; and Order ends with - - - - - - -.
4. The families' alternative new names are also permitted ending in-aceae as: Umblliferae to - - - - - - - -, Gramineae to - - - - - - - - , Palmae to - - - - - - - -.
5. Observing a pollen grain from the direction of either pole is known - - - - - - - - - , and observing from the equatorial direction is known - - - - - - - - - - - - - - .

Q2/ Define only four of the following: (20 Marks)

1. Taxonomy 2. Plant habitat 3. Chemotaxonomy 4. Roots 5. Buds

Q3/ Enumerate and mention only three below: (30 Marks)

1) **Aestivation** arrangement of petals in the flower buds with figures help.
2) Five types of **Palmate compound** leaves with scientific names examples.
3) List the **Fleshy (succulent) fruits** and mention the scientific names for each.
4) types of capsule fruits based on the type or location of dehiscence with scientific names examples.

Q4/ Draw a Diagram of the following, with pointing their parts: (30 Marks)

1. Impari- pinnate Compound Leaf
2. Typical Flower parts (Four flower cycles).
3. Typical Root and Shoot system.

Dr. Serwan T. Al-dabbagh
Theoretical lecturer

Answer Keys:

Q1/ / Fill the blanks with missing words; (20 Marks)

1. Arrangement, law or rule
2. De Plantis, Genera Plantarum
3. opsida, ales
4. Apiaceae, Poaceae, Arecaceae
5. Polar view, Equatorial view

Q2/ Define only four of the following: (20 Marks)

1. **Taxonomy** is a major part of systematics that includes four components: **D**escription, **I**dentification, **N**omenclature, and **C**lassification (**DINC**).
2. **Plant habit** refers to the general form of a plant, encompassing a variety of components such as stem duration and branching pattern, development, or texture.
3. **Chemotaxonomy** The application of chemistry to systematics is called chemotaxonomy or chemical taxonomy**.** Chemical characters of plants have long been of practical value. Distribution of secondary compounds of low molecular weight such as, **Non-protein amino acids, Phenolic compounds, Flavinoids, Alkaloids, Terpenoids** and **Steroids** provide valuable clues to the systematist.
4. **Roots** are present in almost all vascular plants and typically function in absorption of water and minerals. The root is the underground organ of the plant. Its primary function includes uptake of water and minerals and anchorage of the above-ground (aerial) portions of the plant. Roots consist of an apical meristem that gives rise to a protective root cap, a central endodermis-bounded vascular system, absorptive epidermal root hairs, and endogenously developed lateral roots.
5. **Buds:** Buds are immature shoot systems, typically located in the axils of leaves. Buds may grow to form lateral vegetative branches or reproductive structures.

Q3/ Enumerate and mention only three below: (30 Marks)

1. **Aestivation** arrangement of petals in the flower buds with figures help.

Arrangement of sepals and petals in the bud which may be of following types:

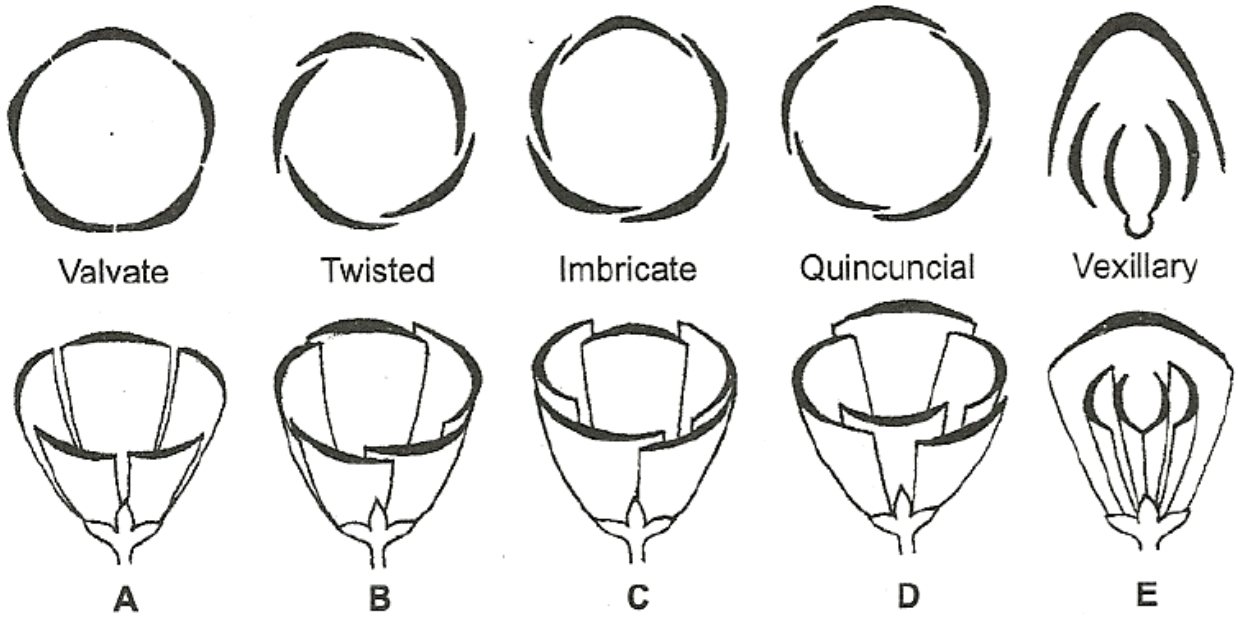
A. Valvate;

B. Twisted;

C. Imbricate;

D. Quincuncial;

E. Vexillary;



2. Five types of **Palmate compound** leaves with scientific names examples.
1. **Uni-foliate**, as in *Citrus*.
2. **Bi-foliate**, as in *Bignonia grandiflora*.
3. **Tri-foliate**, as in *Oxalis*.
4. **Quadri-foliate**, as in *Paris quadrifolia* and *Marsilea quadrifoliata*.
5. **Multi-foliate**, as in *Acanthopanax*.

3. List the **Fleshy (succulent) fruits** and mention the scientific names for each.
Fleshy (succulent) simple fruits:

F. **Berry;** as in *Vitis*, *Phoenix* and *Lycopersicon*.

G. **Drupe;** as in *Prunus amygdalus*, *P. percicu*, *P. armenica*, *Juglans* spp. *Olea europaeus*, etc.

H. **Hesperidium;** as in *Citrus* spp. (orange, lemon, grapefruit, etc.).

I. **Pepo;** as in Cucurbitaceae (*Benincasa hispida* and *Cucurbita maxima*).

J. **Pome;** as in *Malus* and *Pyrus*

4. types of capsule fruits based on the type or location of dehiscence with scientific names examples.
a. **Loculicidal capsules,** as in *Hibiscus esculentus*.
b. **Septicidal capsules**, as in *Linum*.
c. **Circumscissile capsules**, as in *Plantago* and *Hyoscyamus*.
d. **Poricidal capsules**, as in *Papaver*, (POPPOY-**E**).