

Plant Morphology

Michael G. Simpson

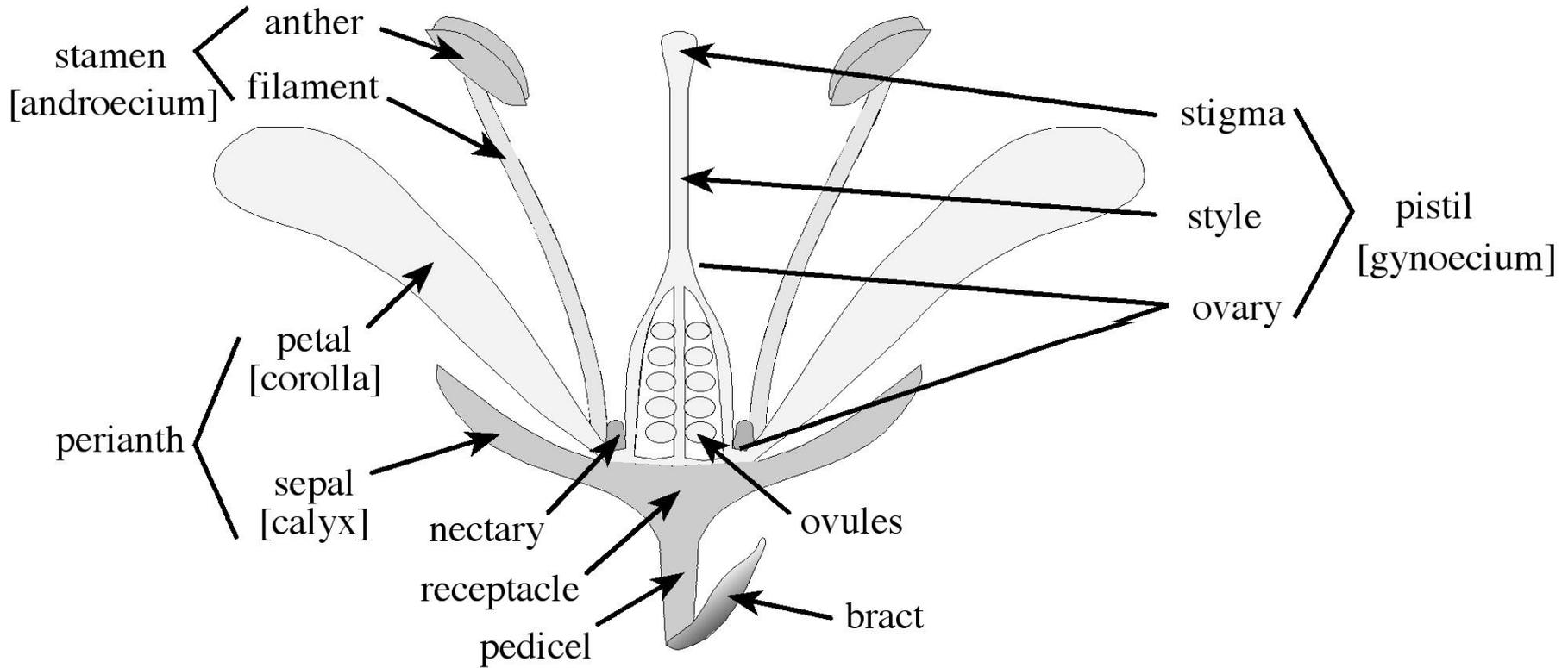
Reproductive Organs

Flower

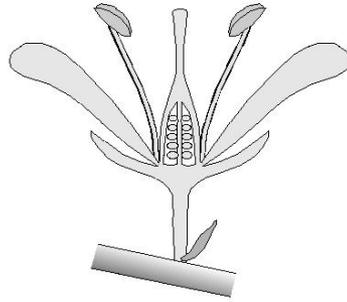
**reproductive organ of flowering plants
(angiosperms)**

**= a modified, determinate shoot bearing
sporophylls (stamens and/or carpels),
with or without outer modified leaves (the
perianth)**

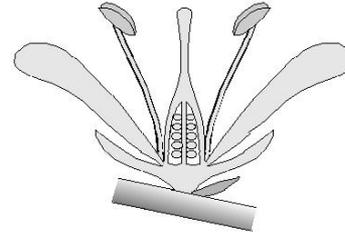
Flower Parts



Flower Attachment

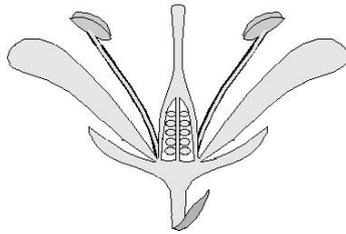


pedicellate

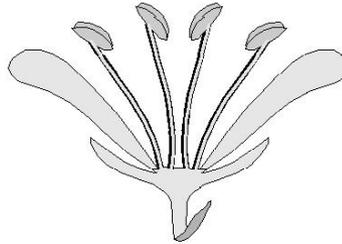


sessile

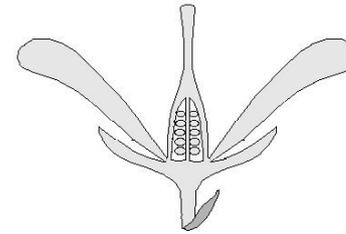
Flower Sex



perfect/bisexual



staminate



pistillate

└──────────┬──────────┘
unisexual

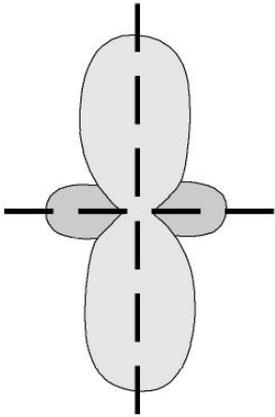
Plant sex:

if flowers bisexual: **hermaphroditic**

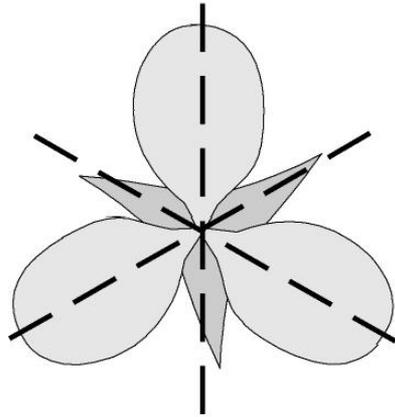
if flowers unisexual: **monoecious** - on same plant

dioecious - on different plants

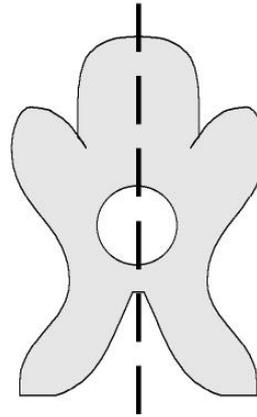
Symmetry



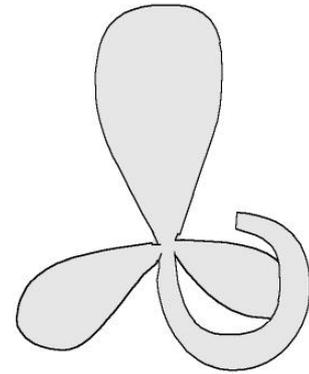
biradial



**radial /
actinomorphic**



**bilateral /
zygomorphic**



asymmetric



**radial /
actinomorpic**



**bilateral
/zygomorphic**

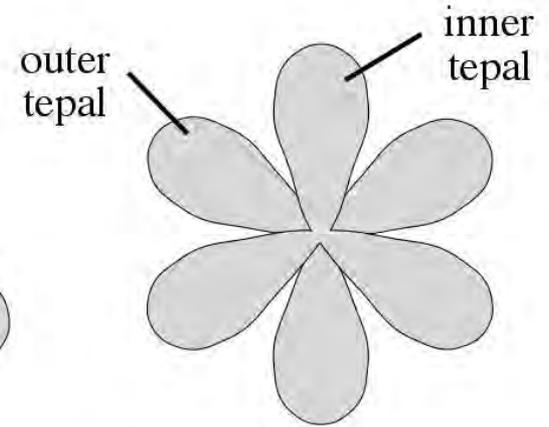
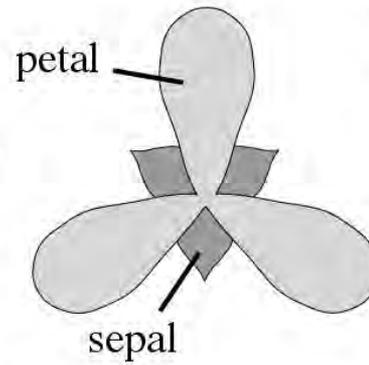
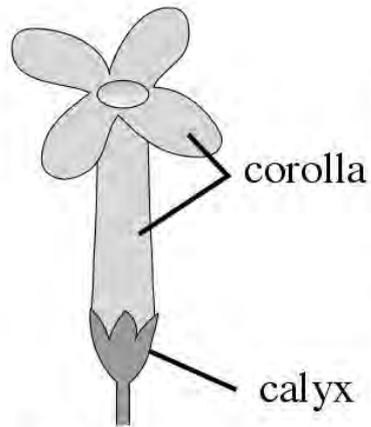
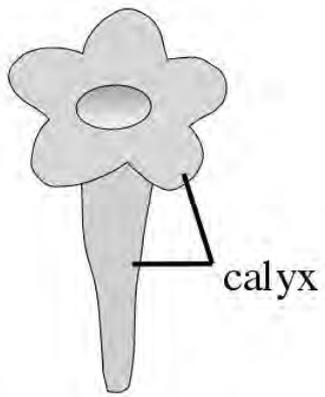


**bilateral
/zygomorphic**

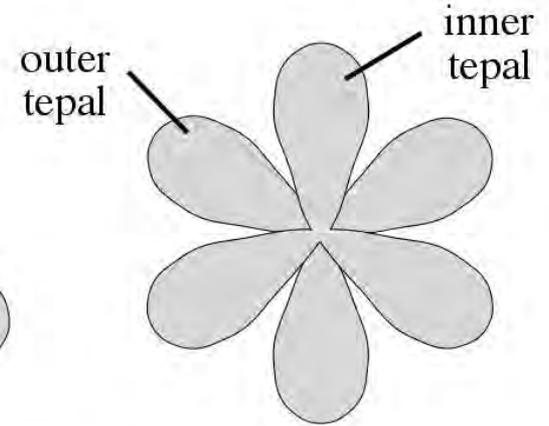
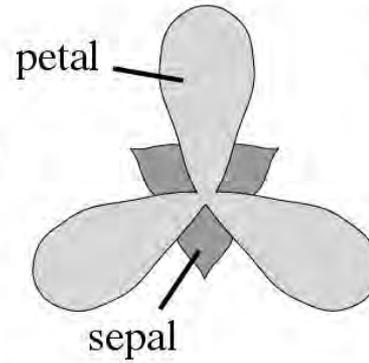
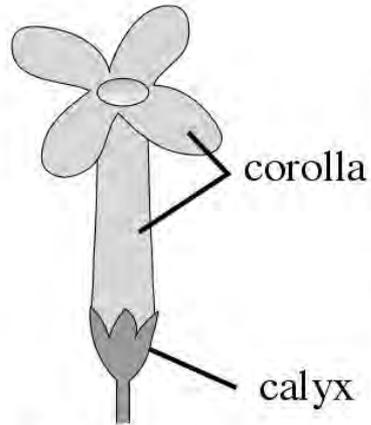
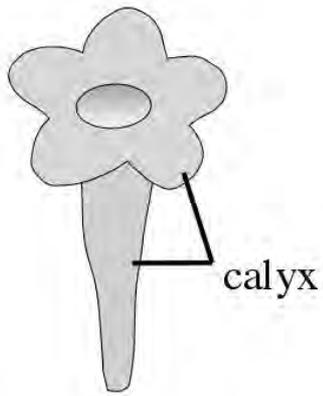


asymmetric

Perianth cyclcy = no. of whorls in perianth
Perianth merosity = no. of parts per whorl

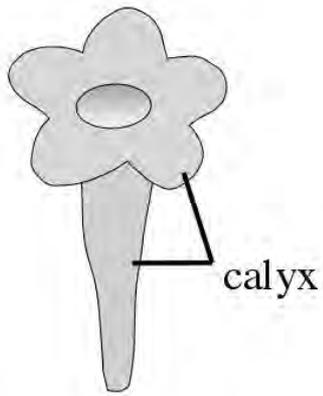


Perianth cyclcy = no. of whorls in perianth
Perianth merosity = no. of parts per whorl

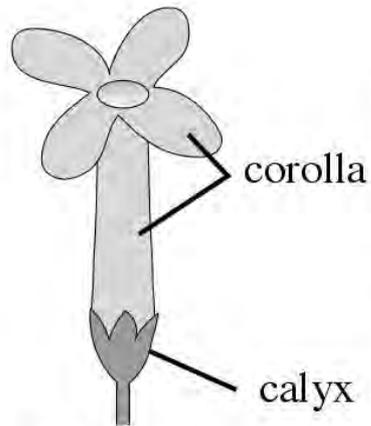


uniseriate
pentamerous

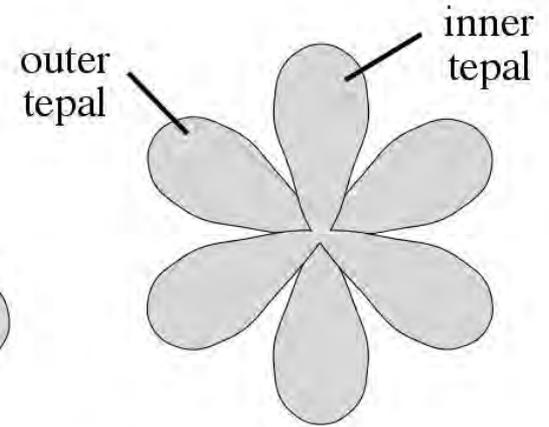
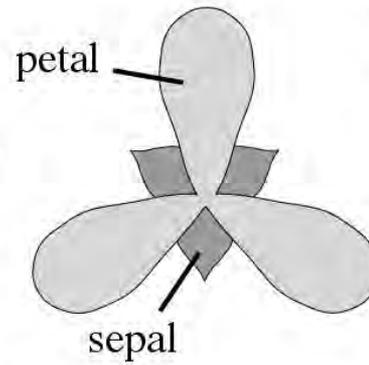
Perianth cyclcy = no. of whorls in perianth
Perianth merosity = no. of parts per whorl



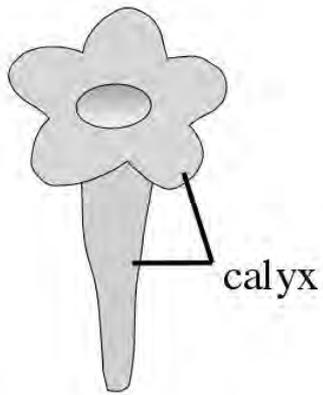
**uniseriate
pentamerous**



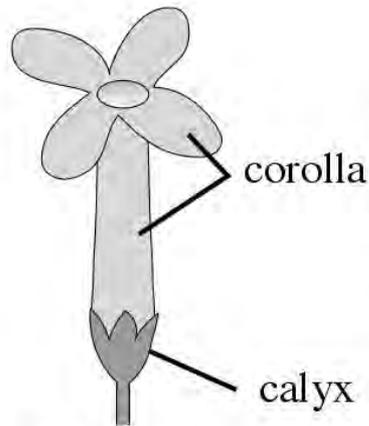
**biseriate
tetramerous**



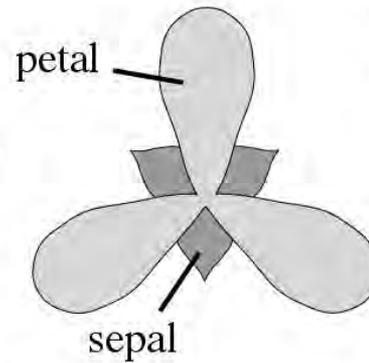
Perianth cyclcy = no. of whorls in perianth
Perianth merosity = no. of parts per whorl



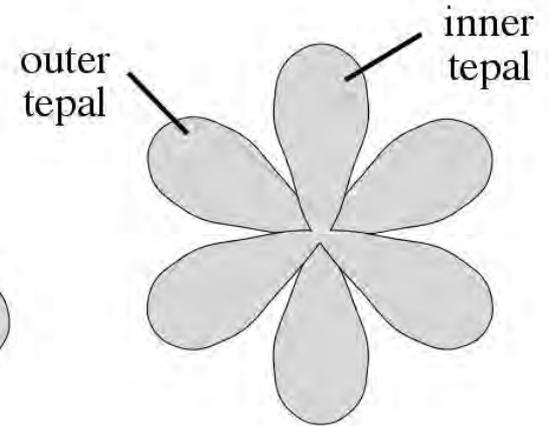
**uniseriate
pentamerous**



**biseriate
tetramerous**



dichlamydeous



homochlamydeous

biseriate / trimerous

Perianth cycl



**biseriate
dichlamydeous**

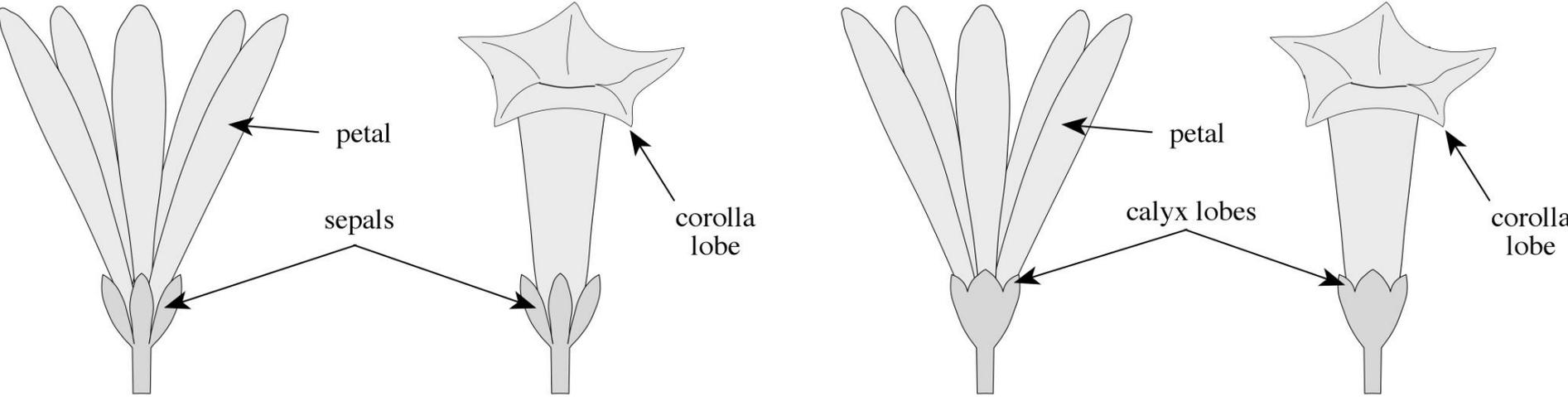


uniseriate



**biseriate
homochlamydeous**

Perianth Fusion:



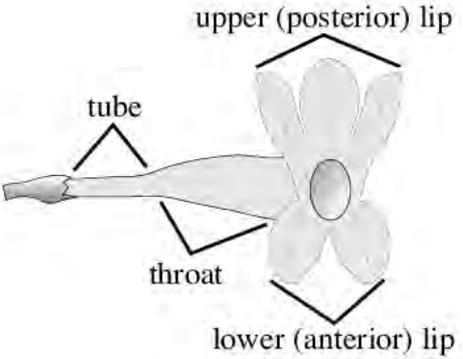
**aposepalous
apopetalous**

**aposepalous
sympetalous**

**synsepalous
apopetalous**

**synsepalous
sympetalous**

Perianth Types/Parts:



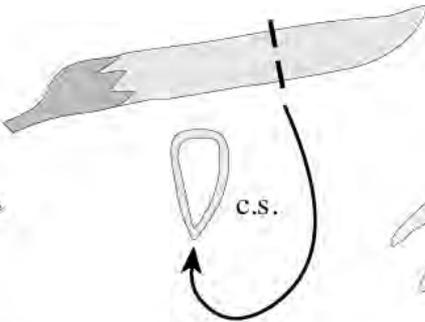
bilabiate



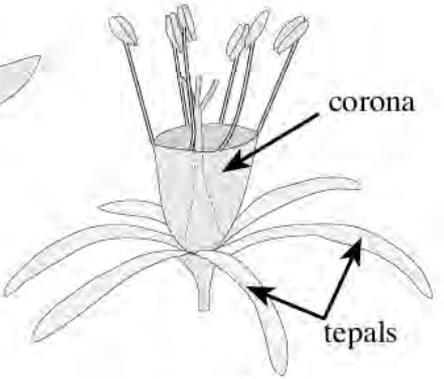
**calyptrate/
operculate**



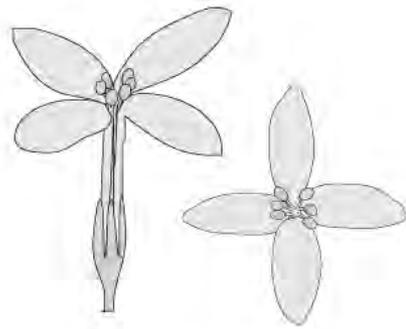
campanulate



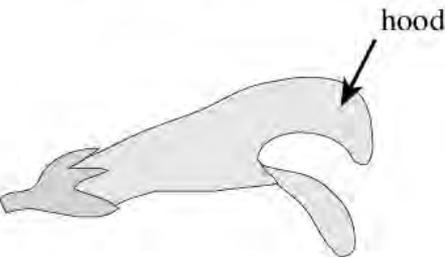
carinate



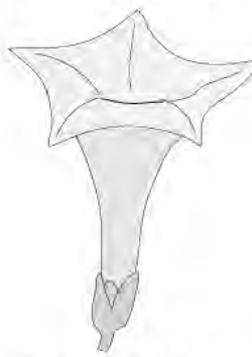
coronate



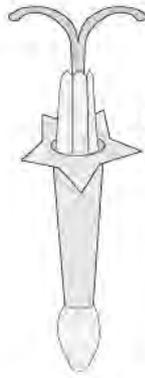
cruciate



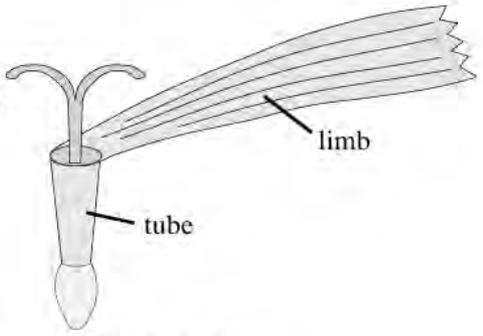
cucullate (hooded)



infundibular



disk



ligulate/ray

Perianth Types/Parts:



bilabiate



campanulate



calyptrate



carinate



coronate



cruciate



hooded



infundibular

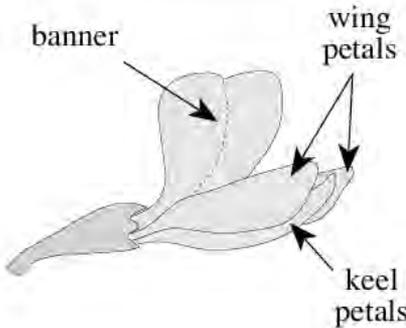


disk

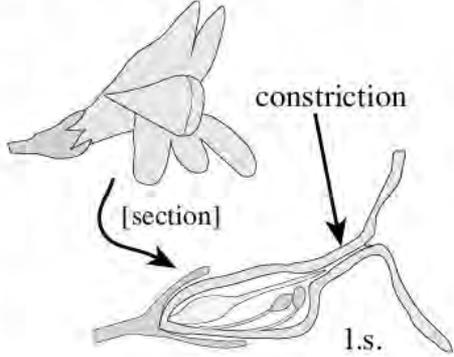


ray

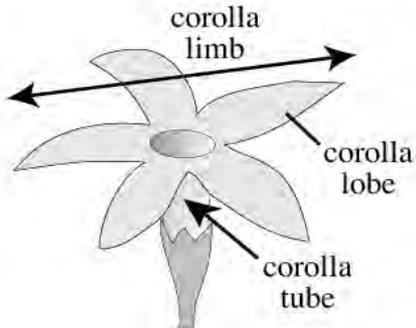
Perianth Types/Parts:



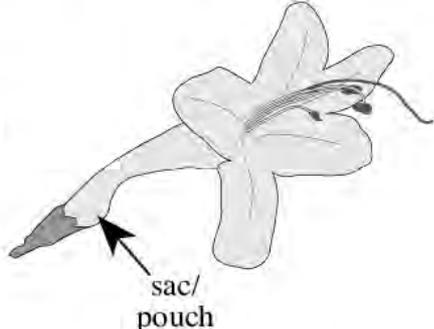
papilionaceous



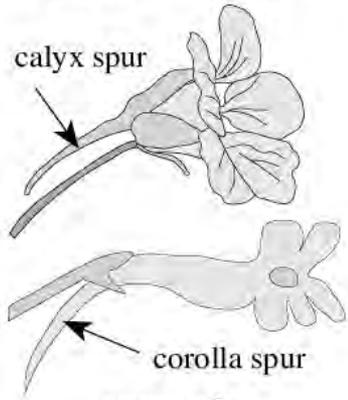
personate



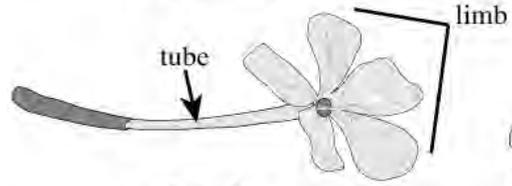
rotate



saccate



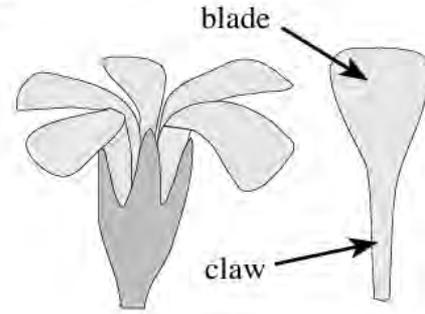
spurred



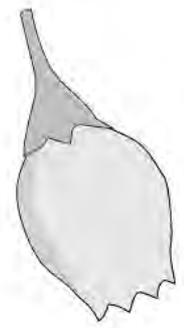
salverform



tubular



unguiculate



urceolate

Perianth Types/Parts:



papilionaceous



personate



rotate



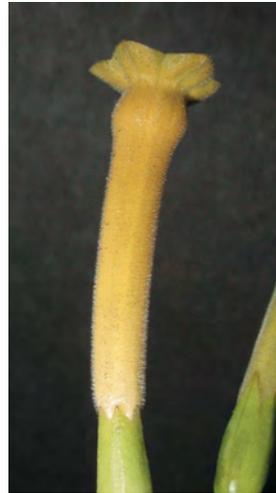
saccate



spurred



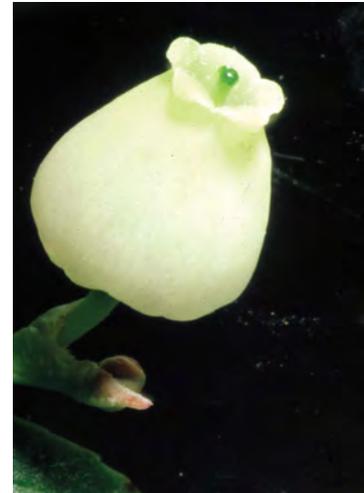
salverform



tubular

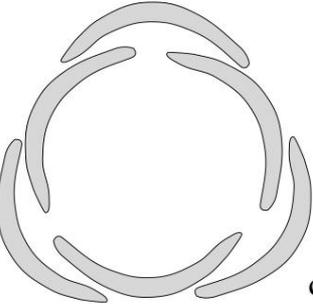


unguiculate

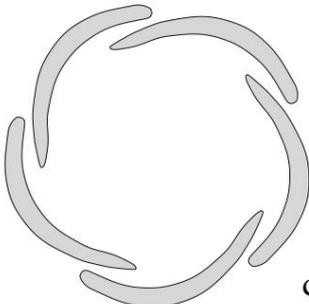


urceolate

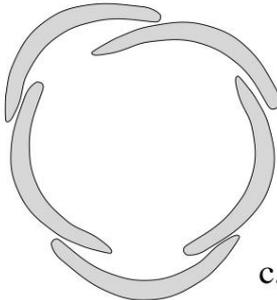
Aestivation:



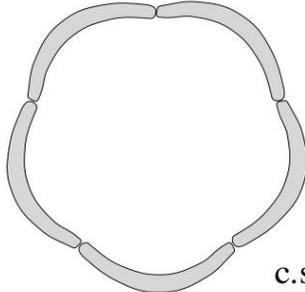
C.S.



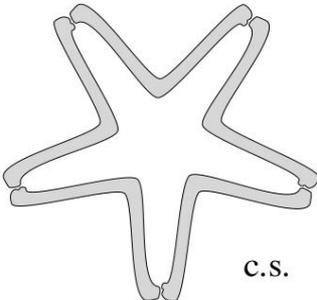
C.S.



C.S.



C.S.



C.S.

imbricate-alternate

convolute/contorted

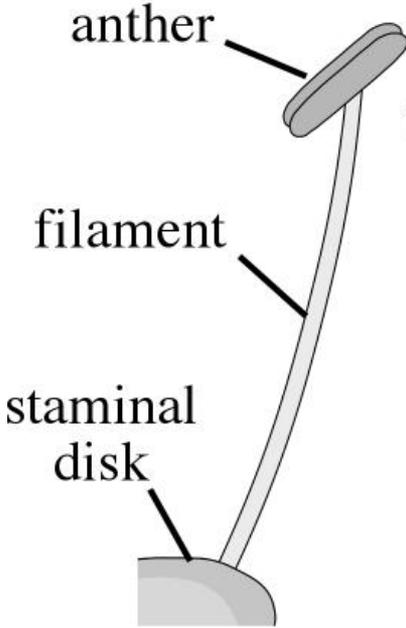
quincuncial

valvate

involute

Androecium:

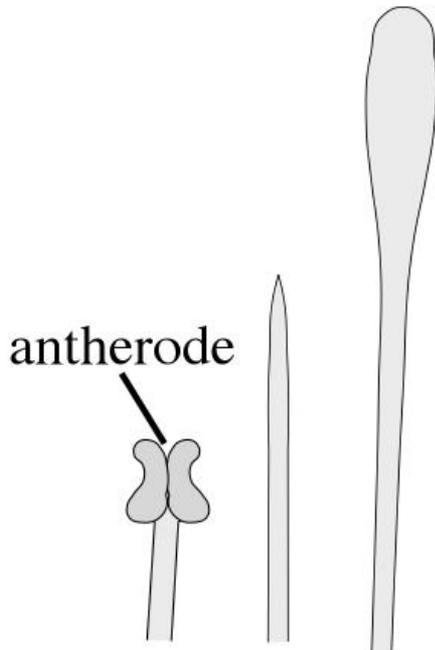
Stamen Types / Parts



filamentous

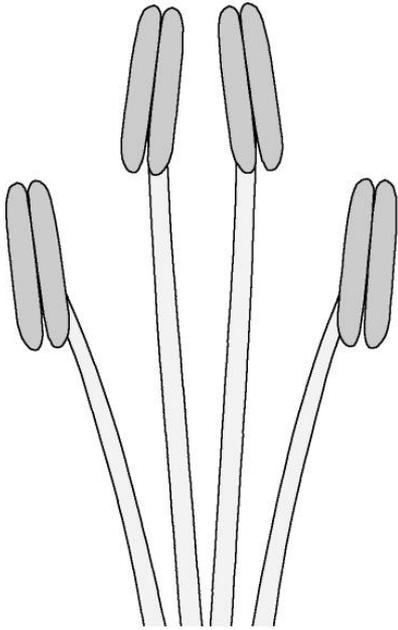


laminar

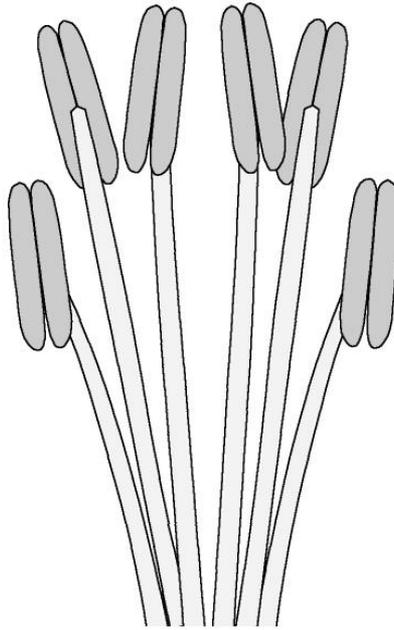


staminodia

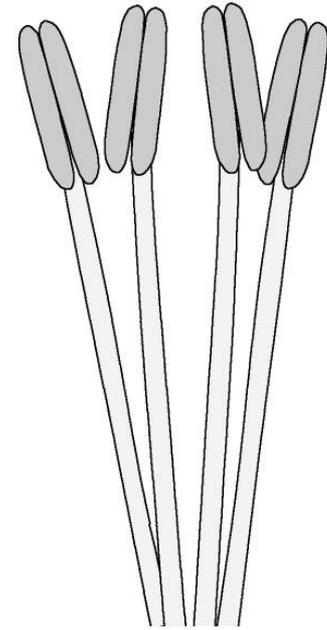
Stamen Arrangement



didynamous



tetradynamous



didymous

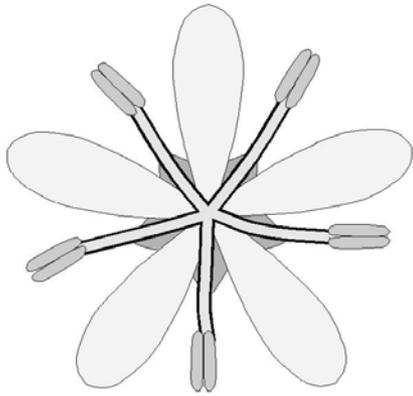


tetradynamous

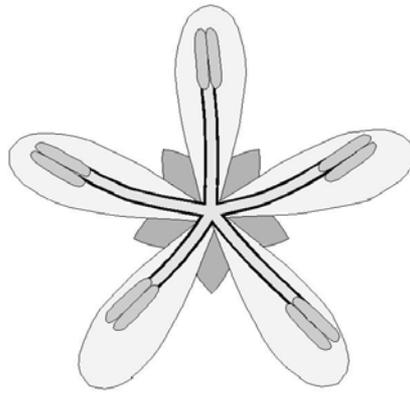


didynamous

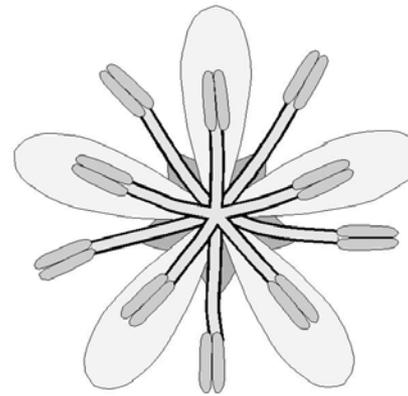
Stamen Cycle/Position



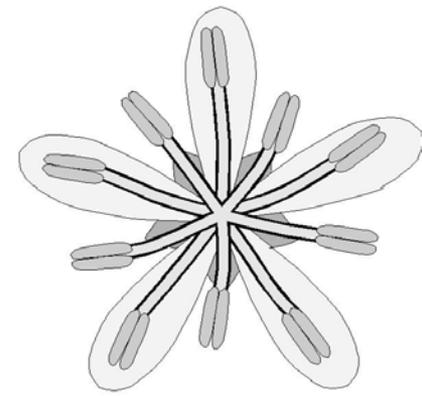
**antisepalous
(alternipetalous)**



**antipetalous
(alternisepalous)**



diplostemonous

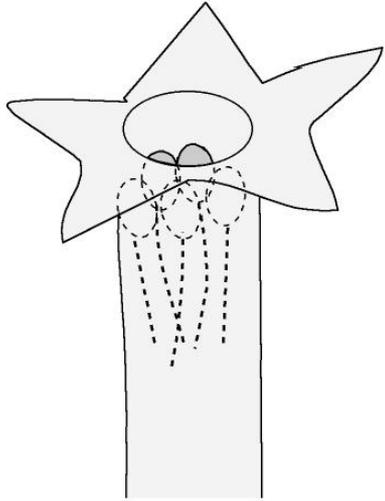


obdiplostemonous

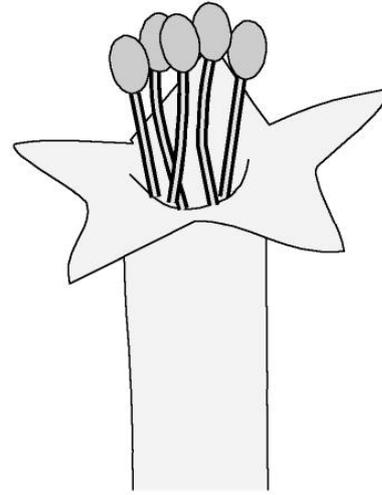
uniseriate

biseriate

Stamen Insertion

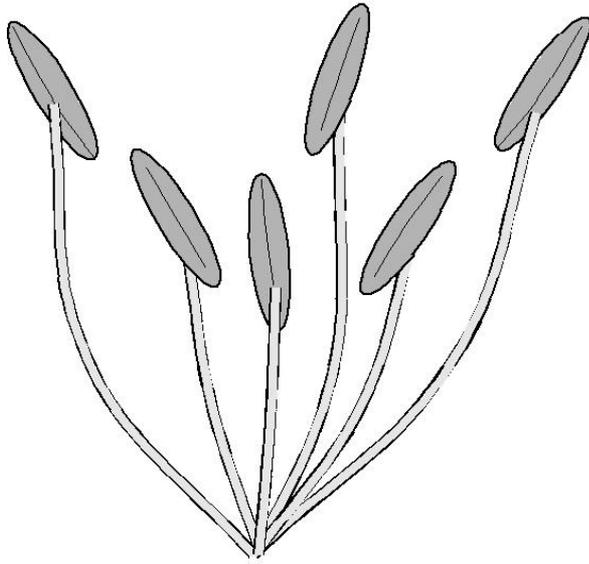


inserted

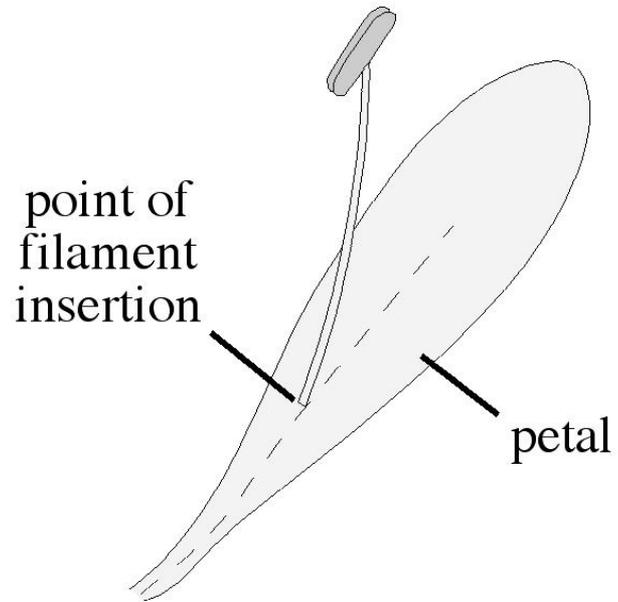


exserted

Androecial / Stamen Fusion

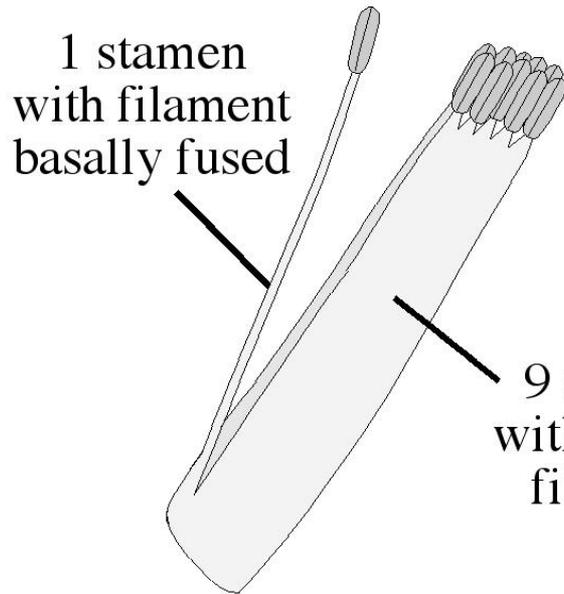


apostemonous

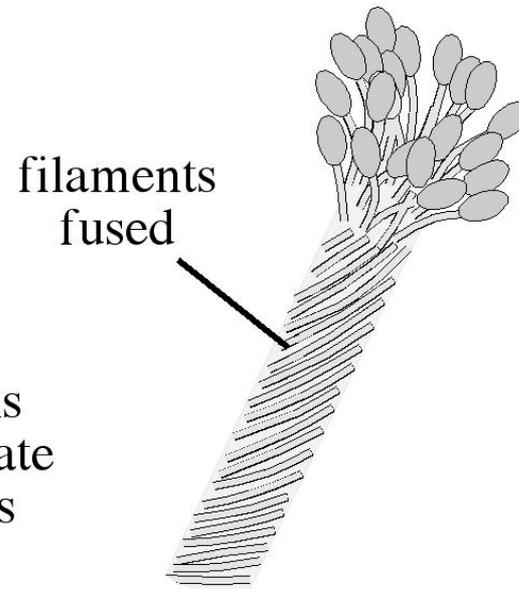


epipetalous

Androecial / Stamen Fusion

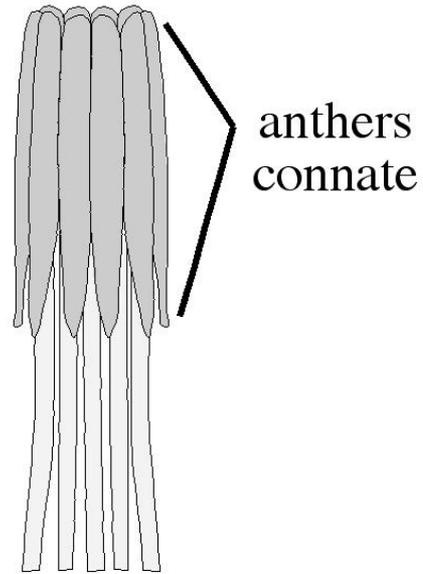


diadelphous



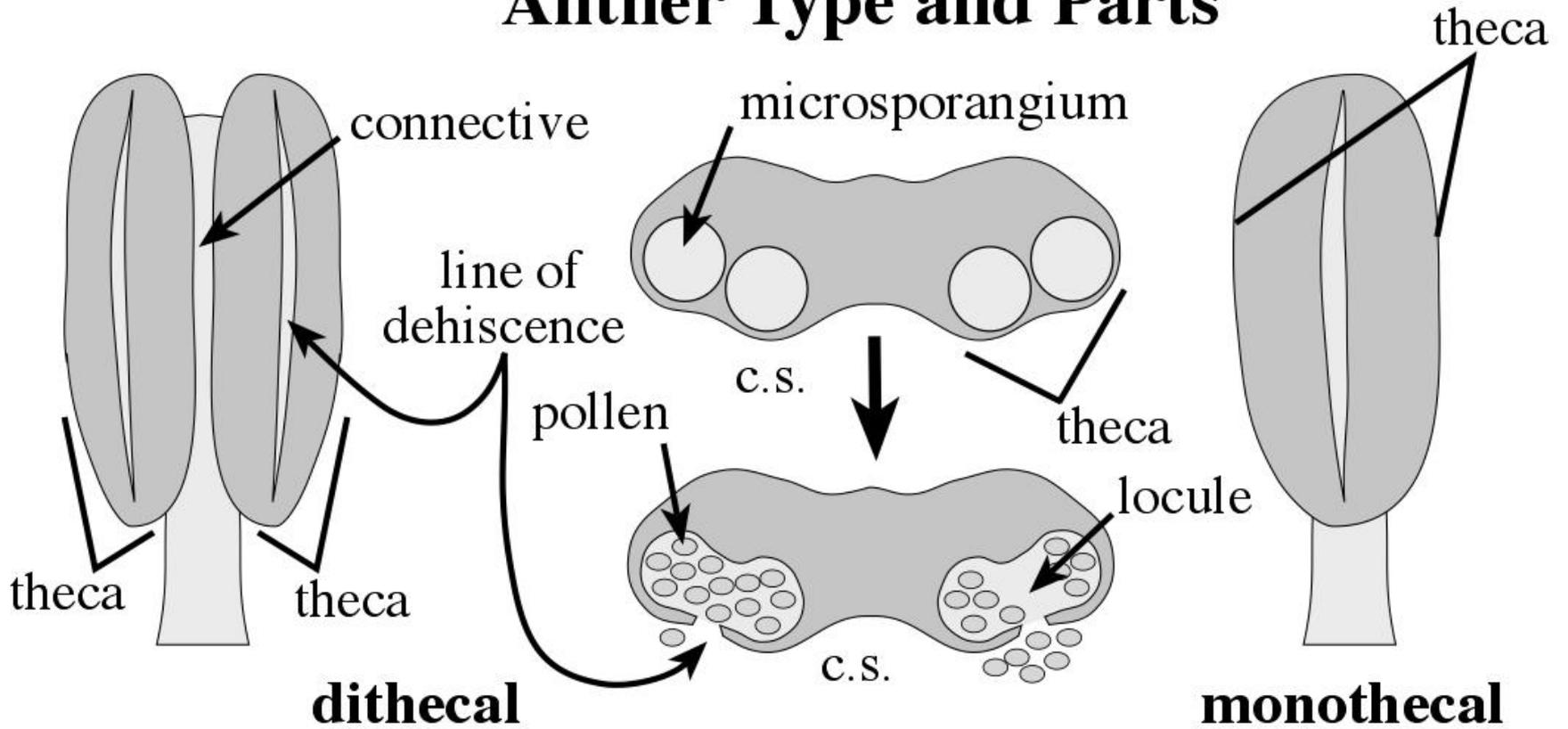
monadelphous

Androecial / Stamen Fusion

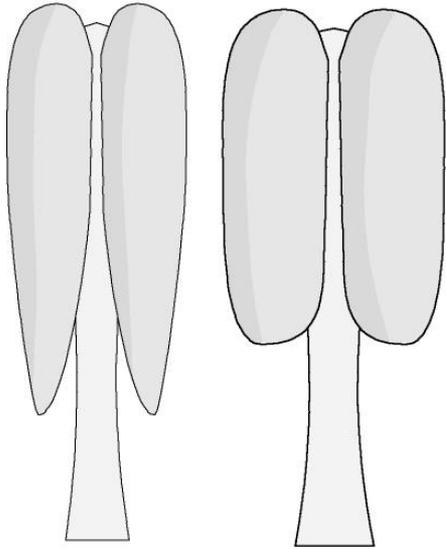


syngenesious

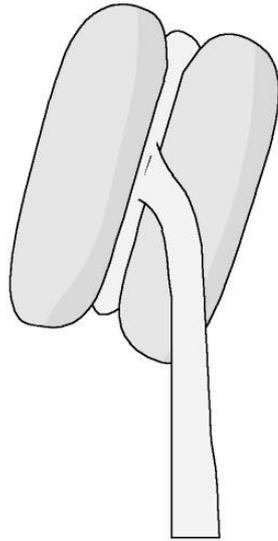
Anther Type and Parts



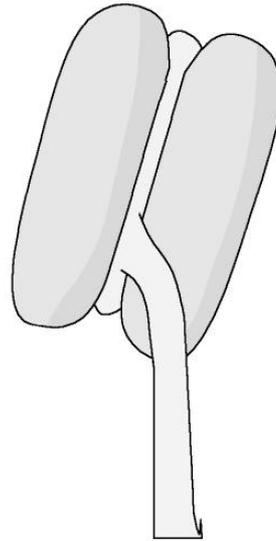
Anther Attachment



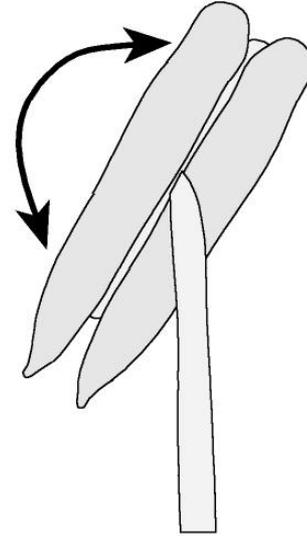
basifixed



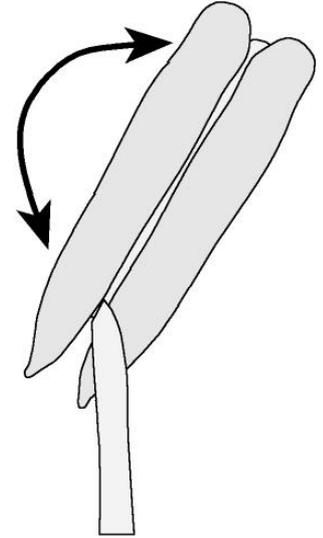
dorsifixed



subbasifixed



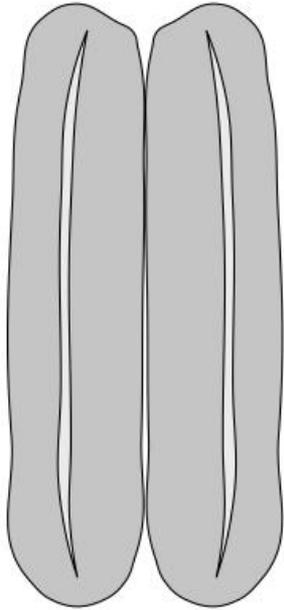
dorsifixed



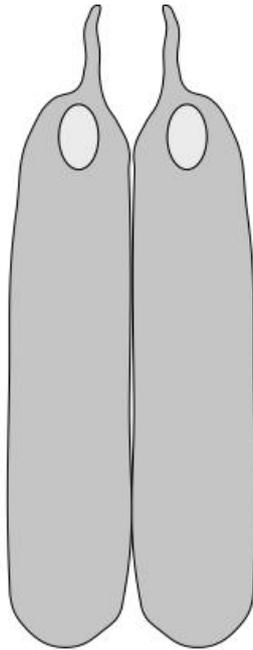
basifixed

versatile

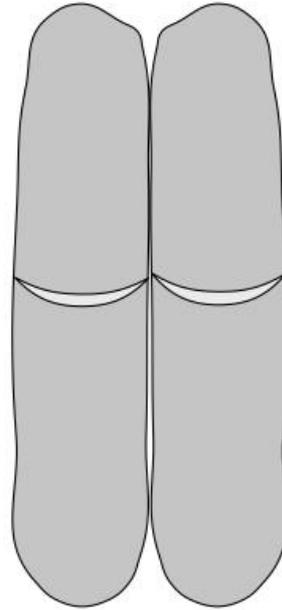
Anther Dehiscence Types



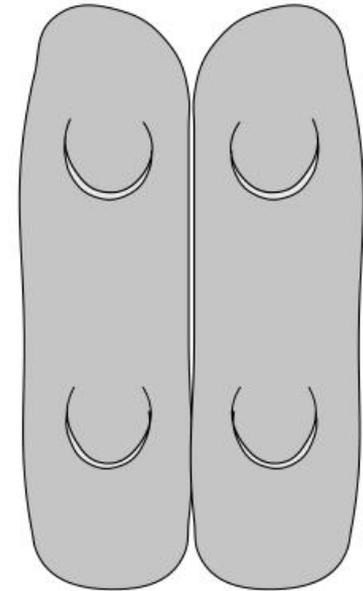
longitudinal



poricidal

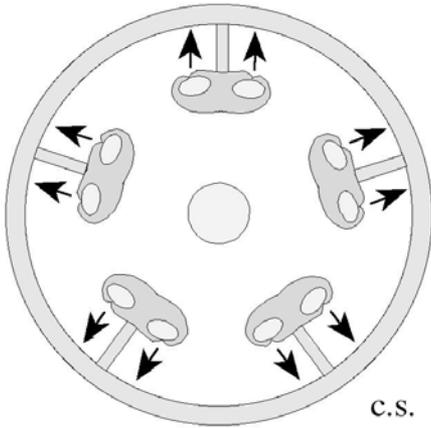


transverse

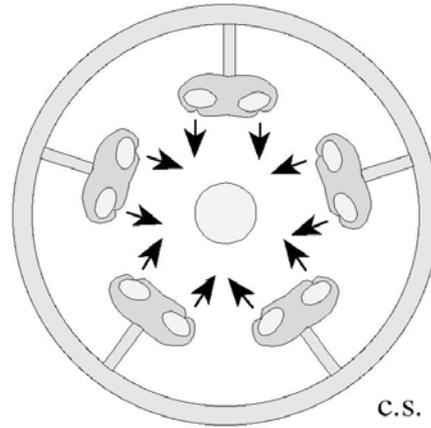


valvular

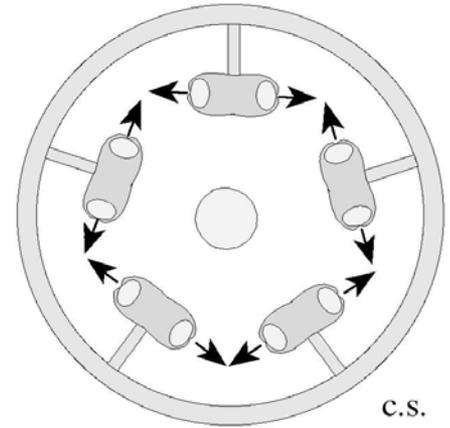
Anther Dehiscence Direction



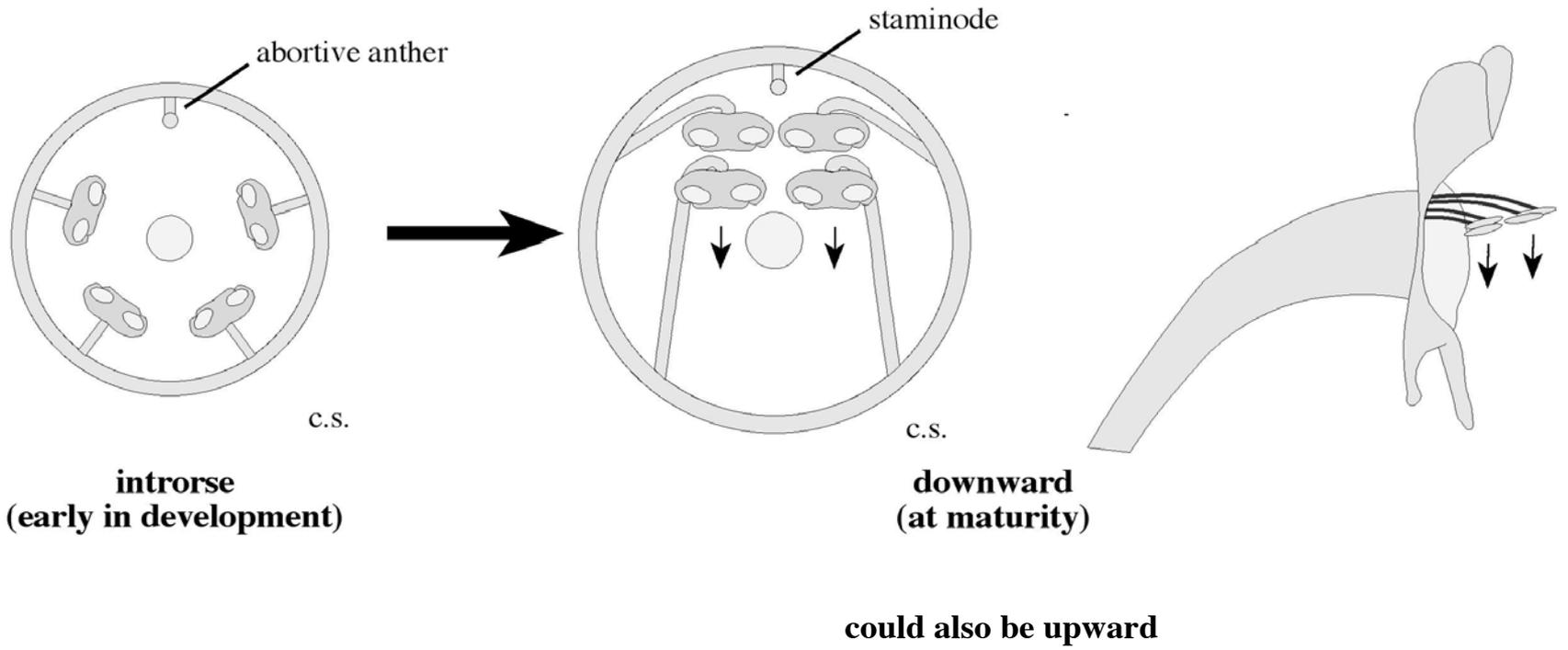
extrorse



introrse



latrorse



Gynoecium

= all female parts of a flower

Pistil

= structure consisting of ovary, style(s), and stigma(s)

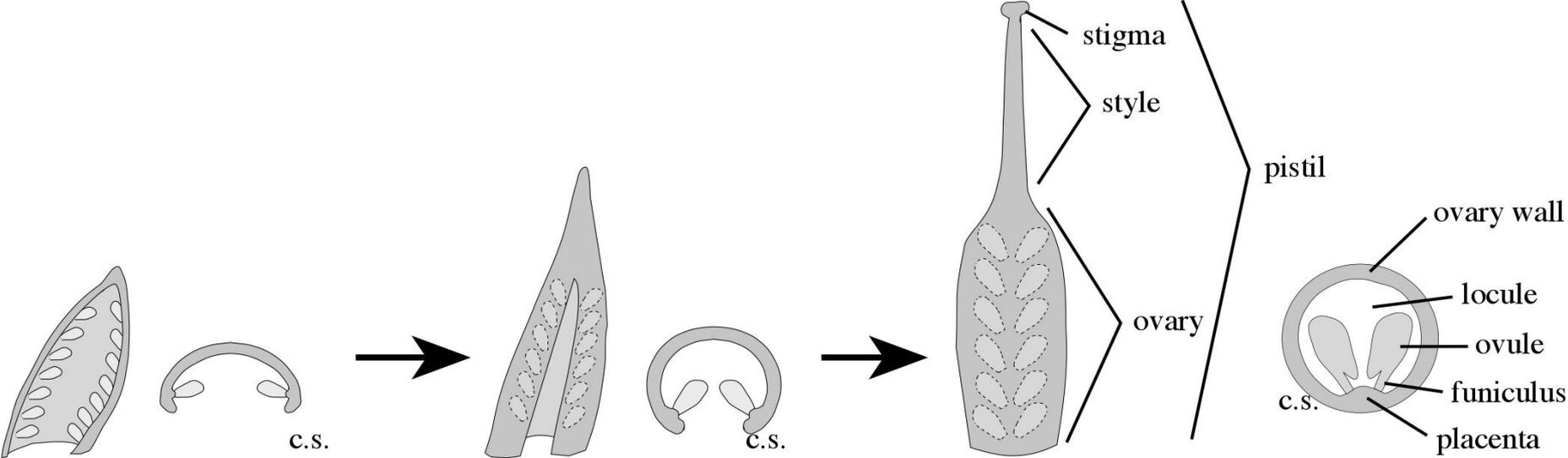
Carpel

= conduplicate megasporophyll

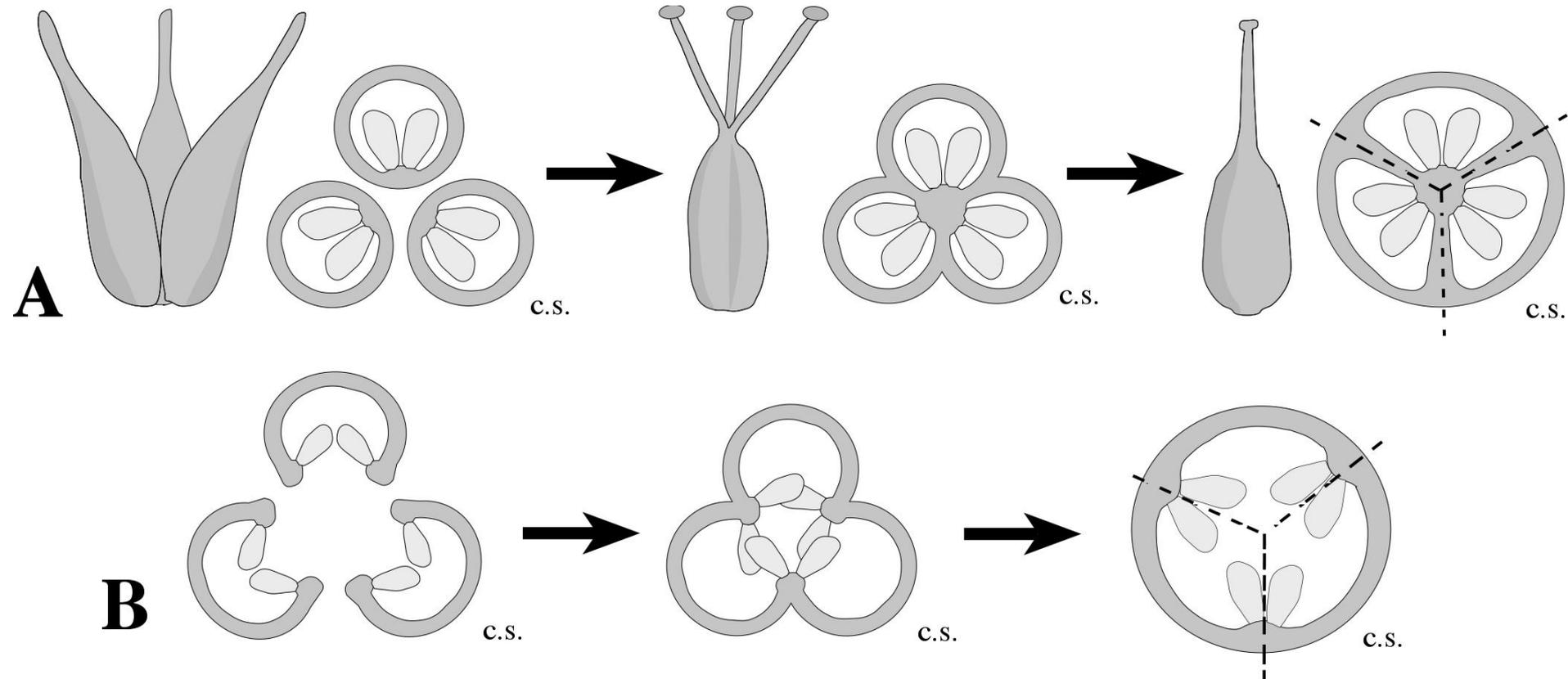
**Carpel can be unit of pistil, if pistil compound
(composed of >1 carpel)**

Gynoecium:

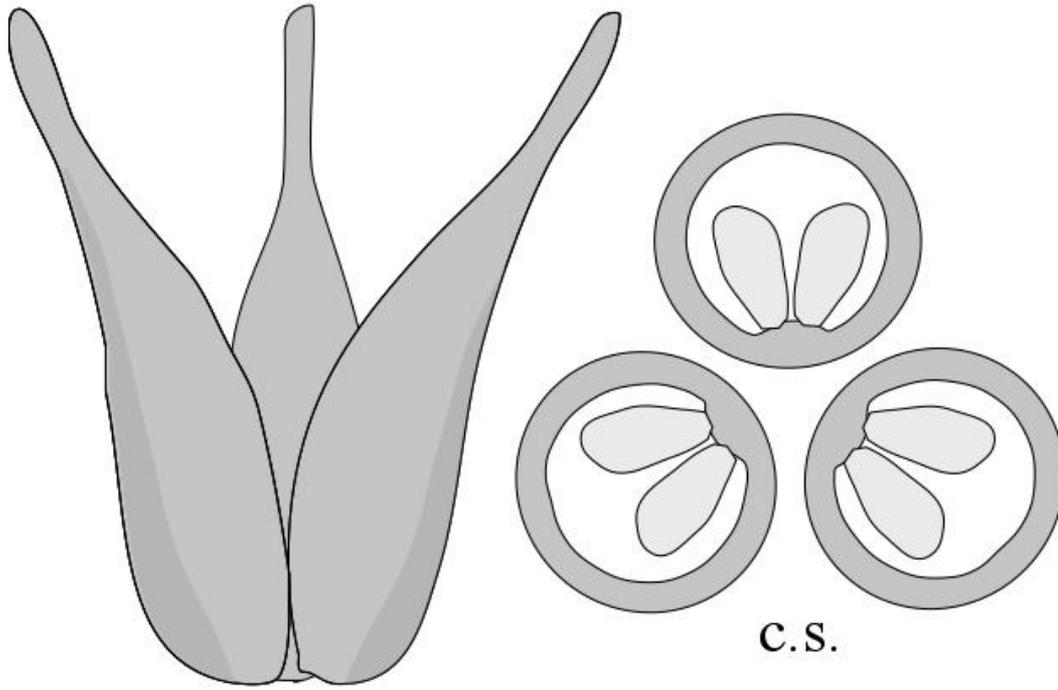
Carpel Development / Pistil Parts



Gynoecial Development/Fusion:



Gynoecial Fusion:



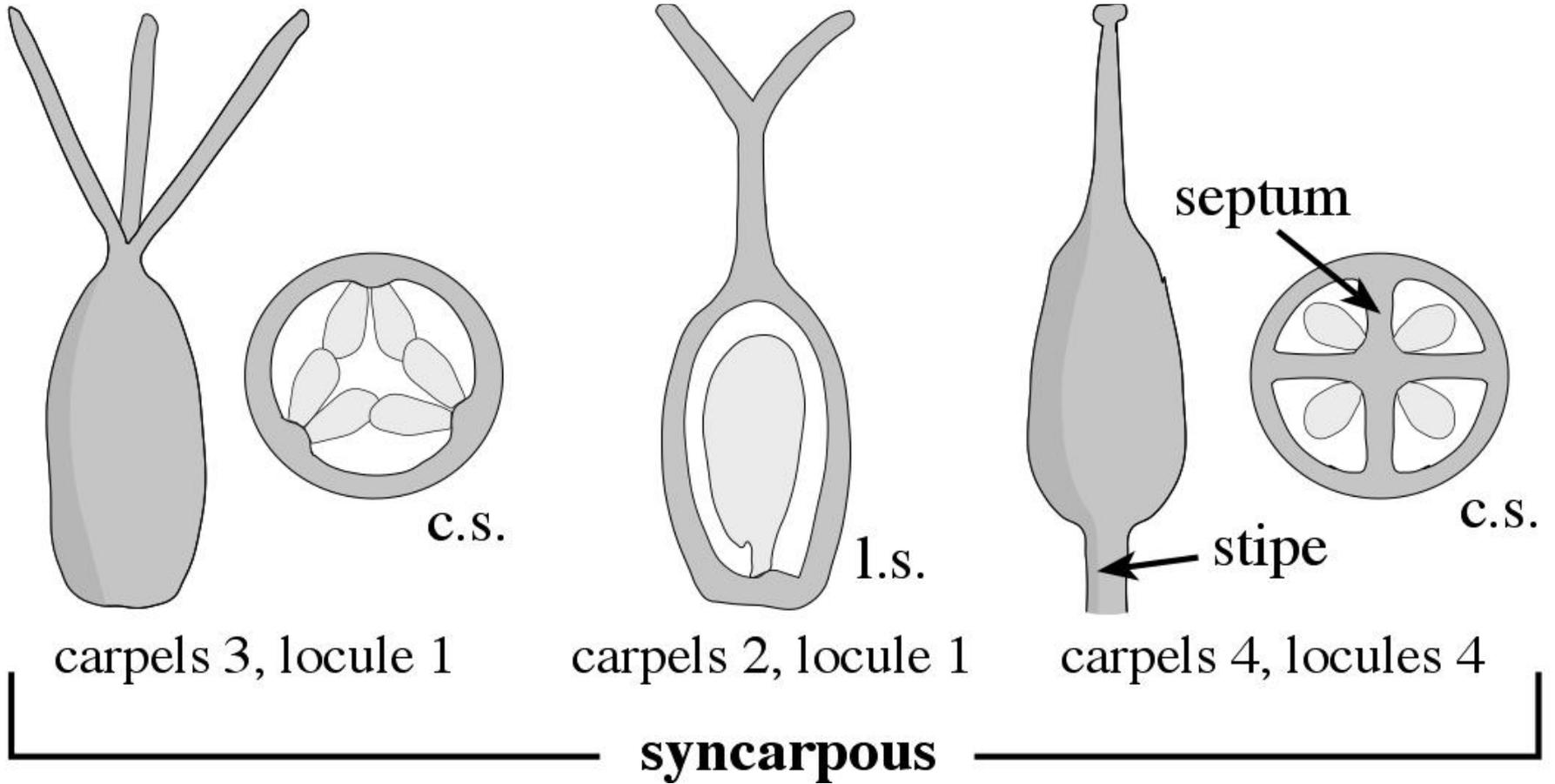
carpels 3, locule 1 per carpel

apocarpous



Crassula argentea Crassulaceae

Gynoecial Fusion:

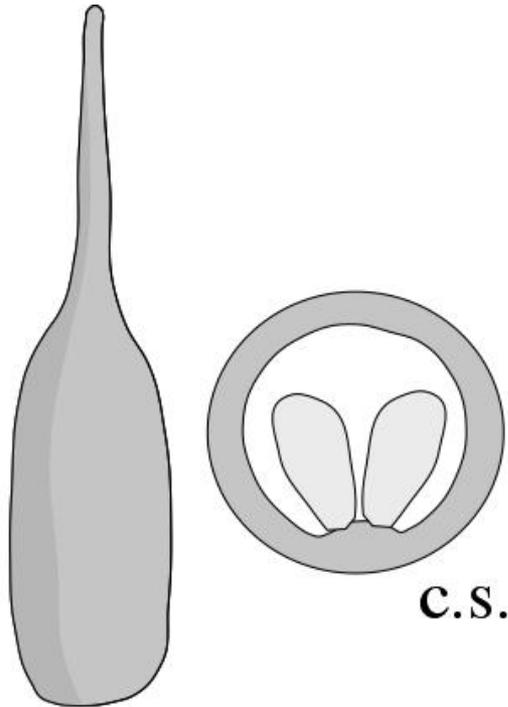


Gynoecial Fusion:



syncarpous

Gynoecial Fusion:



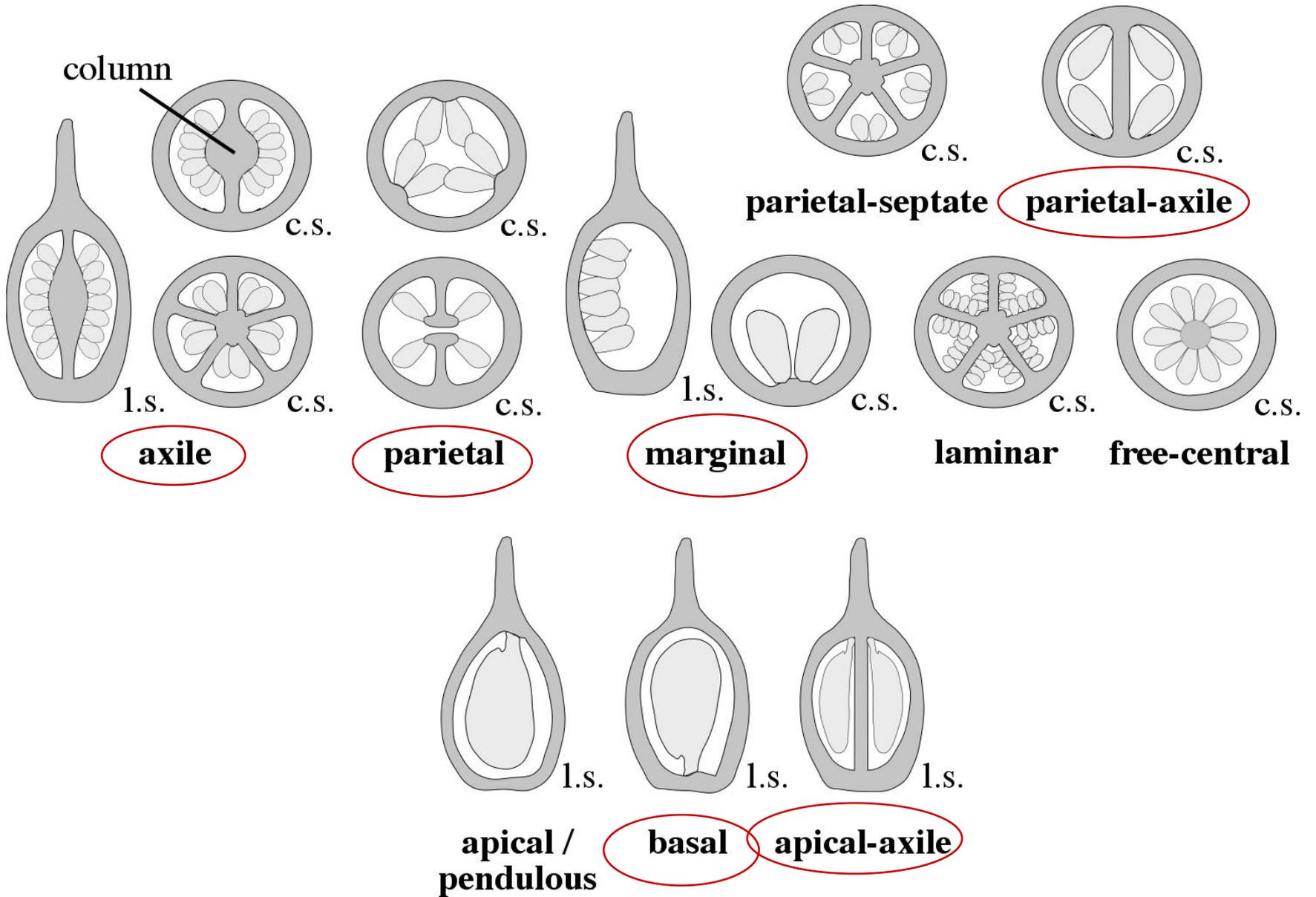
carpel 1, locule 1

unicarpellous

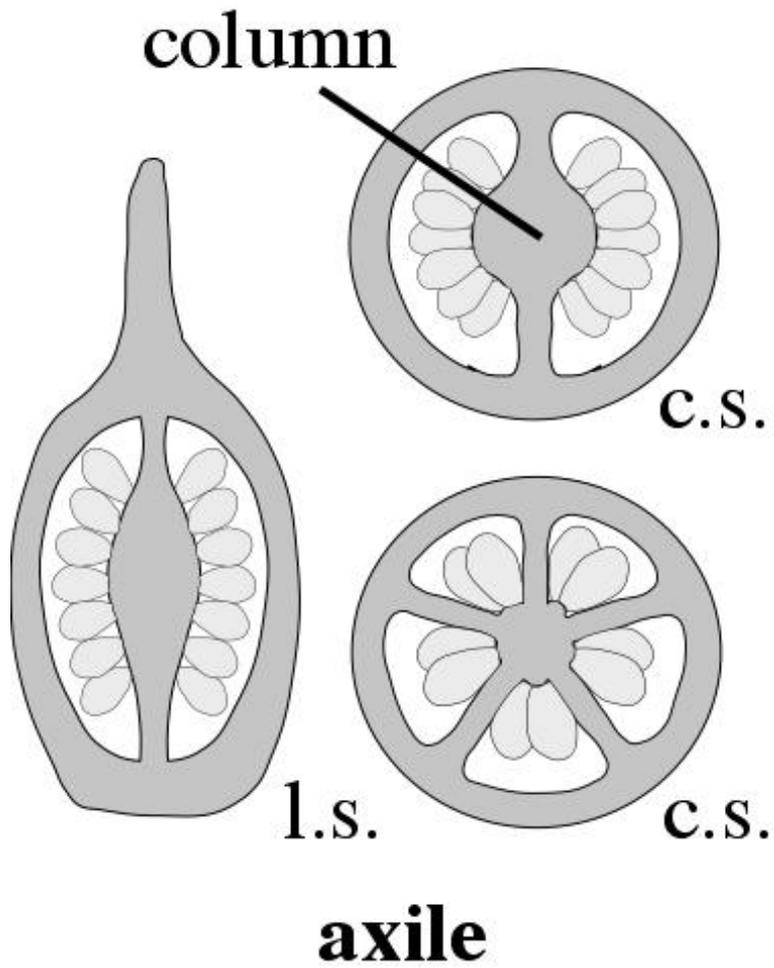


Erythrina caffra Fabaceae

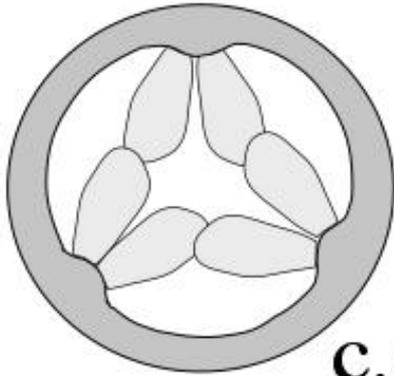
Placentation



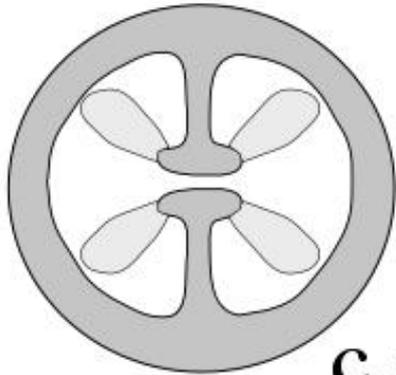
Placentation



Placentation



C.S.

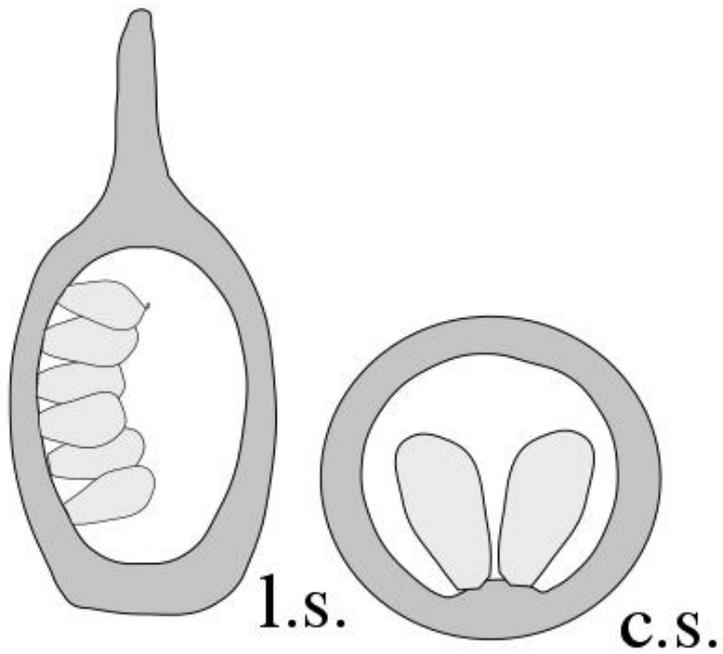


C.S.

parietal



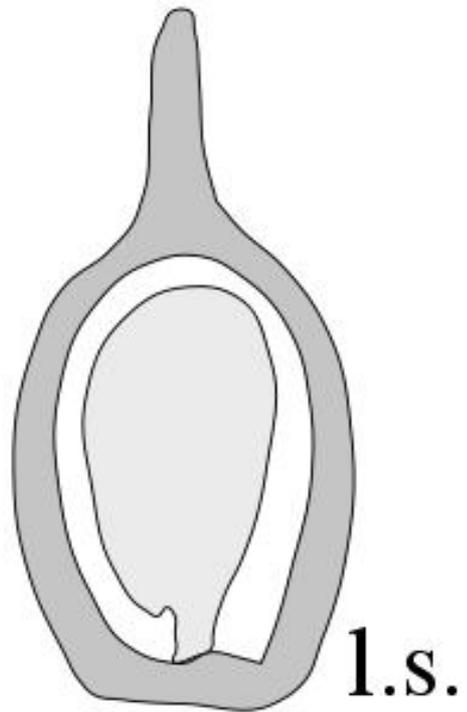
Placentation



marginal



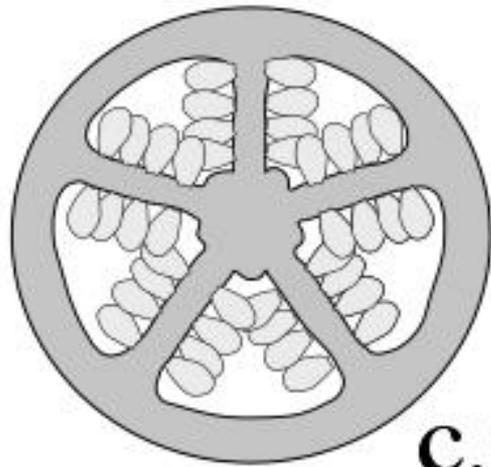
Placentation



basal



Placentation

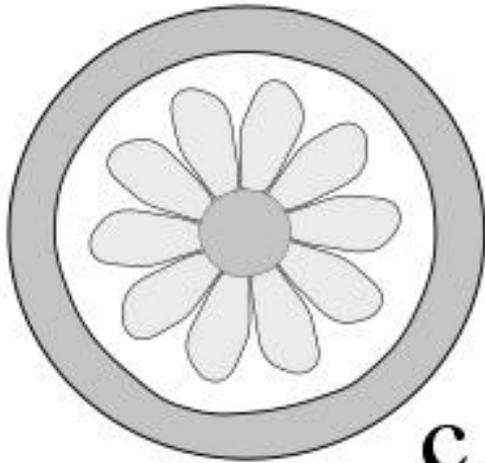


C.S.

laminar

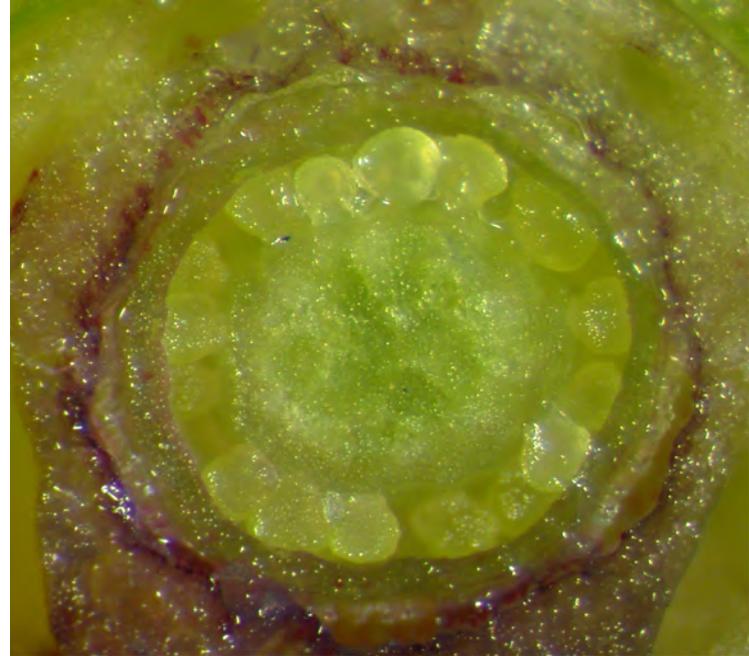
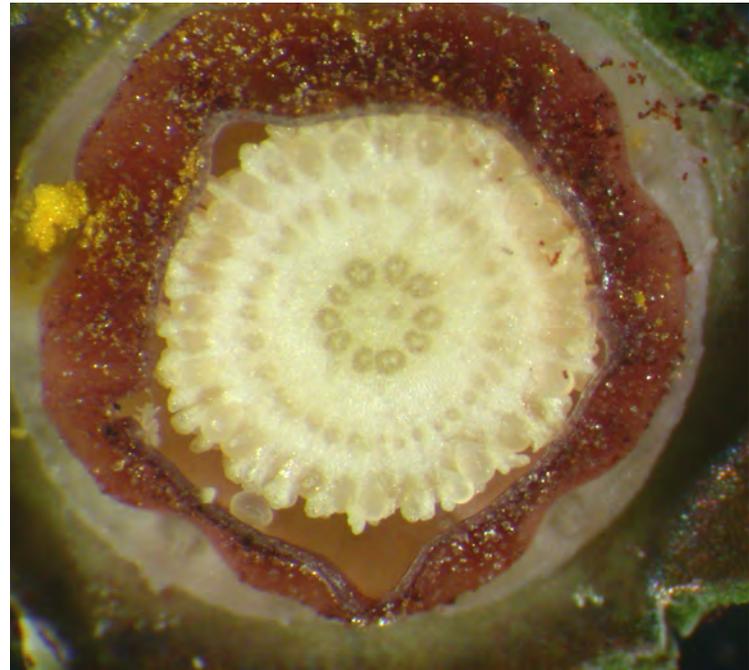


Placentation

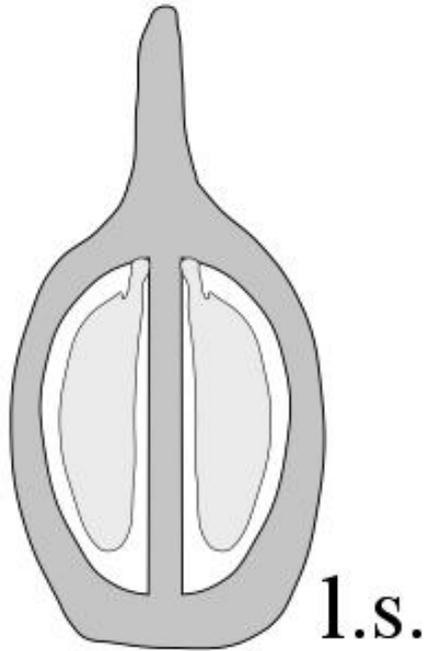


C.S.

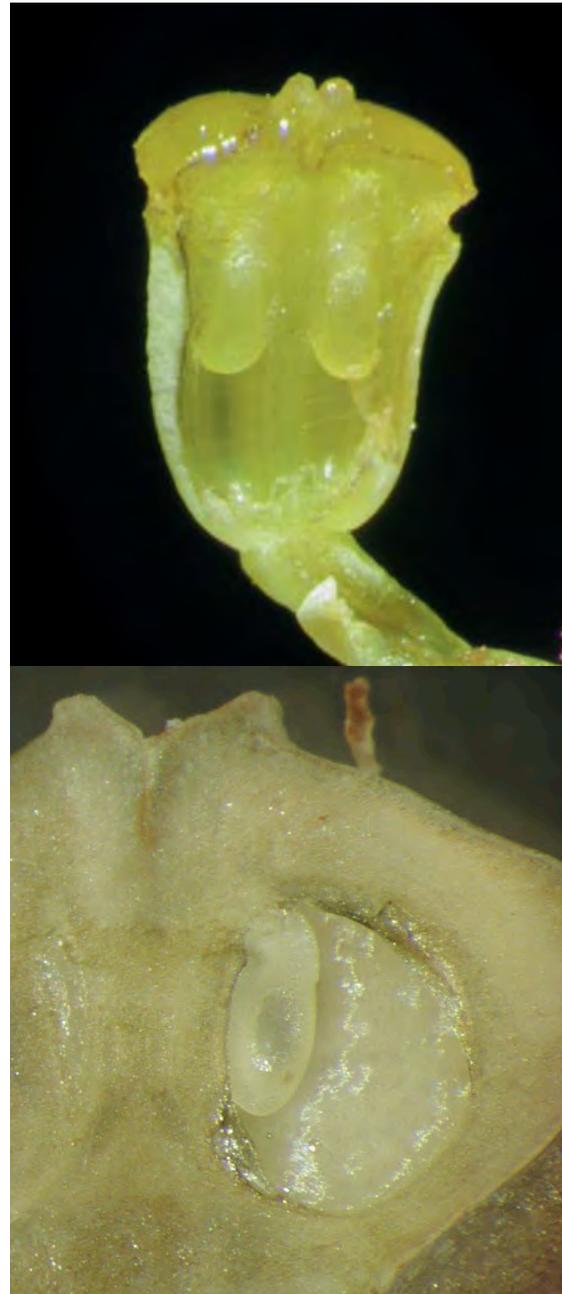
free-central



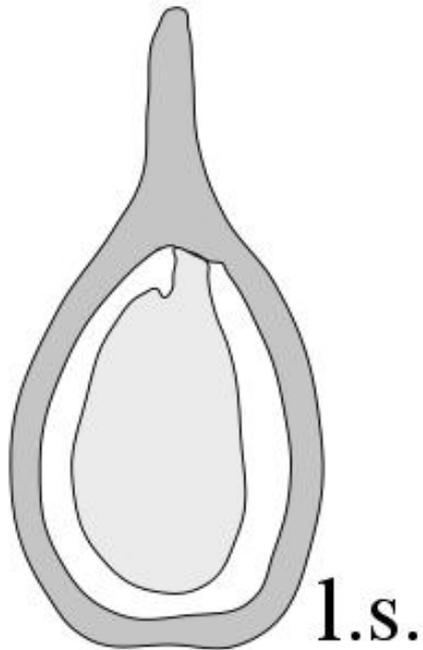
Placentation



apical-axile



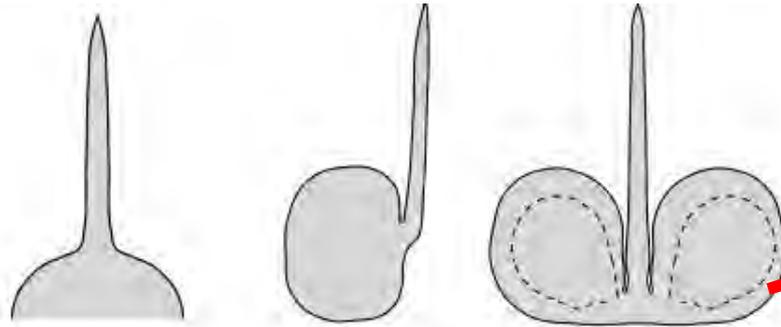
Placentation



**apical /
pendulous**



Style Position



terminal lateral gynobasic



Verbena rigida
Verbenaceae

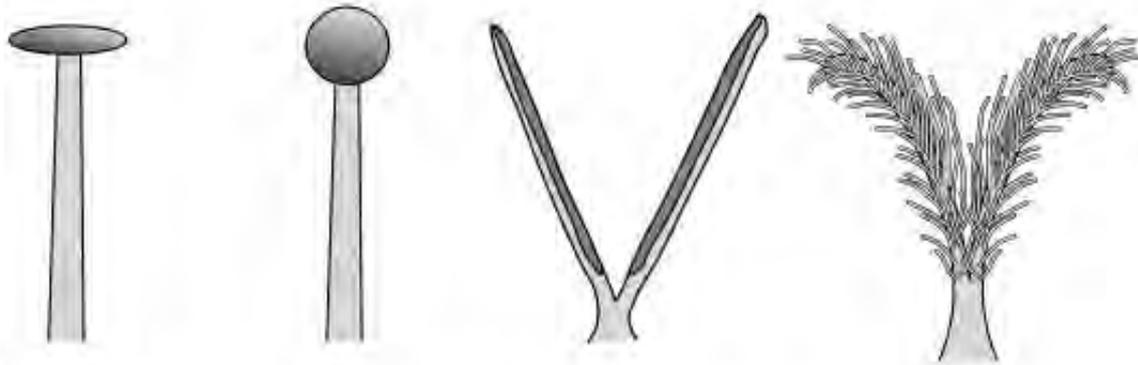


Borago officinalis
Boraginaceae



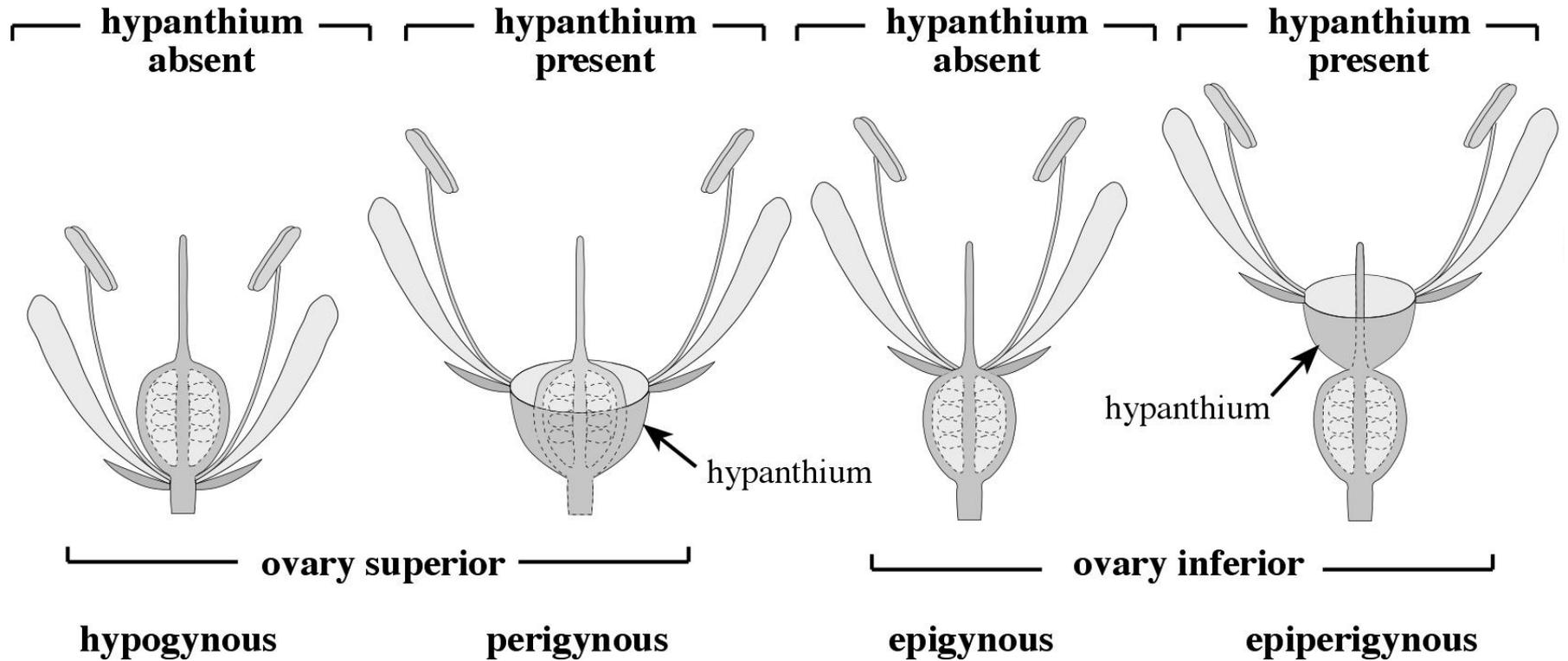
Fragaria sp.
Rosaceae

Stigma Types



discoid **globose** **linear** **plumose**

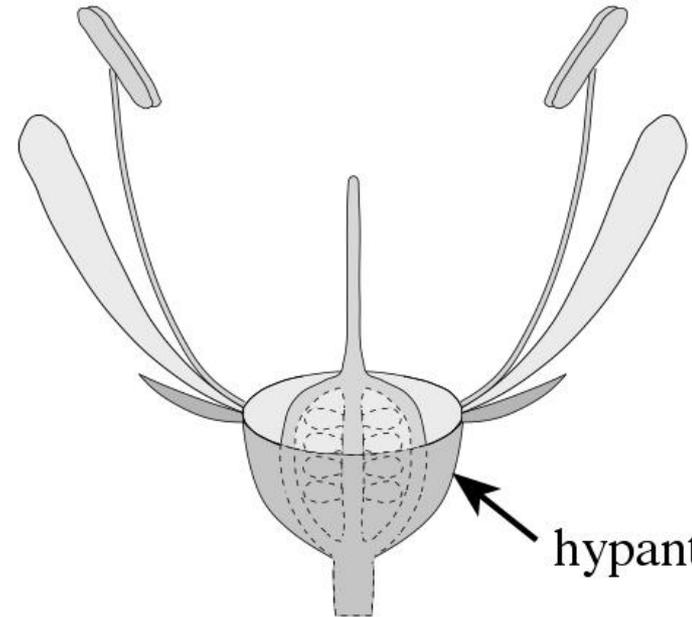
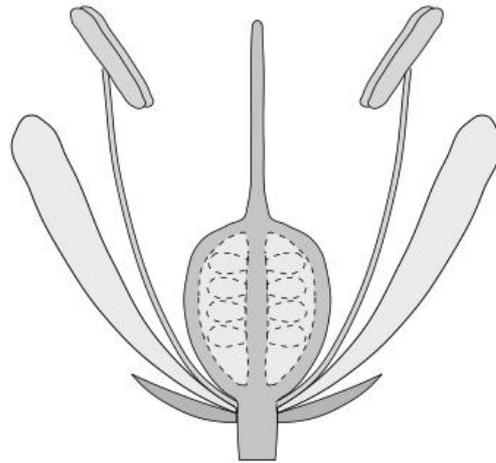
Hypanthium Presence / Ovary Position / Perianth-Androecial Position



Hypanthium Presence / Ovary Position / Perianth-Androecial Position

hypanthium
absent

hypanthium
present



ovary position

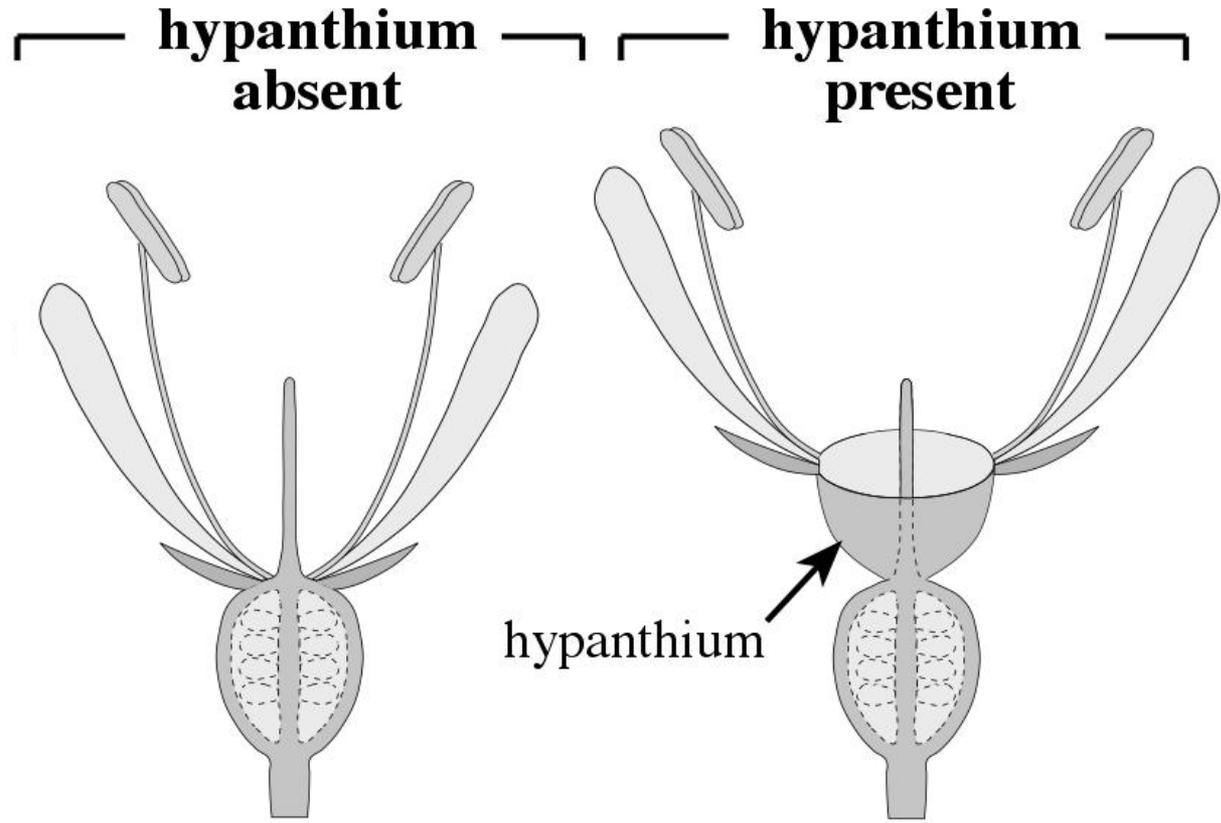
superior

perianth-androecial
position

hypogynous

perigynous

Hypanthium Presence / Ovary Position / Perianth-Androecial Position



ovary position

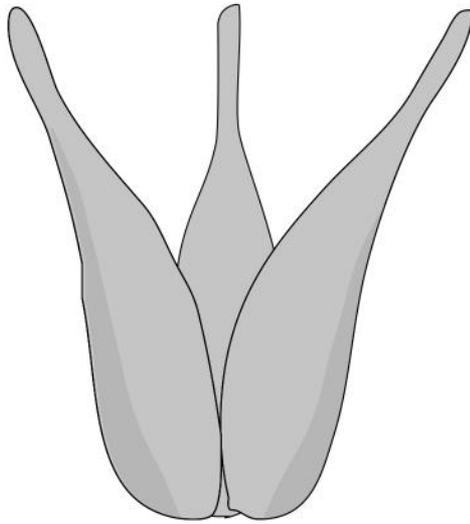
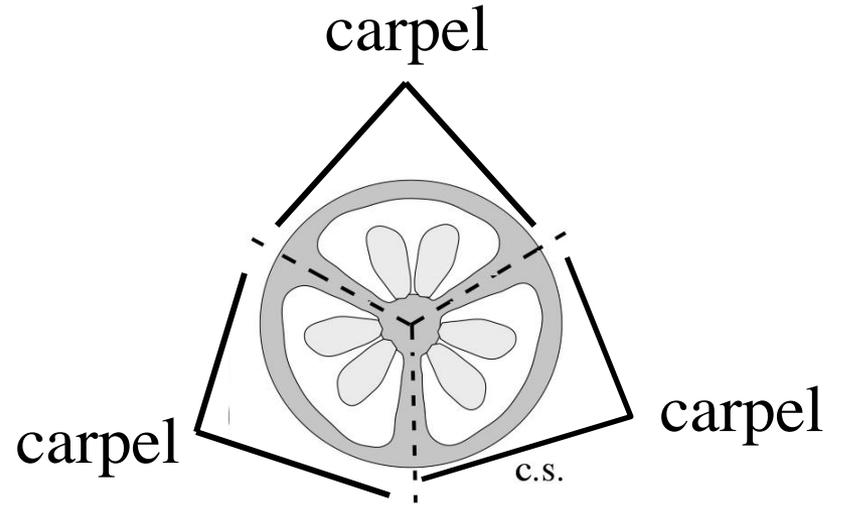
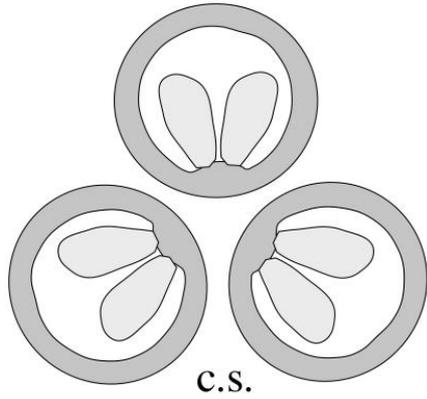
inferior

perianth-androecial position

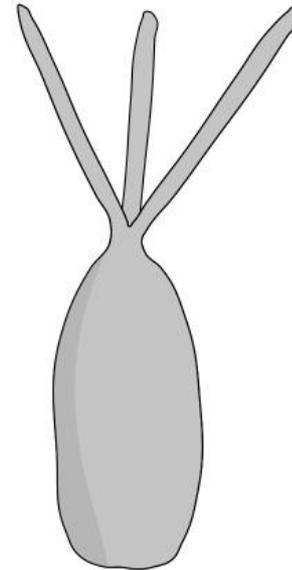
epigynous

epiperigynous

Carpel boundaries:

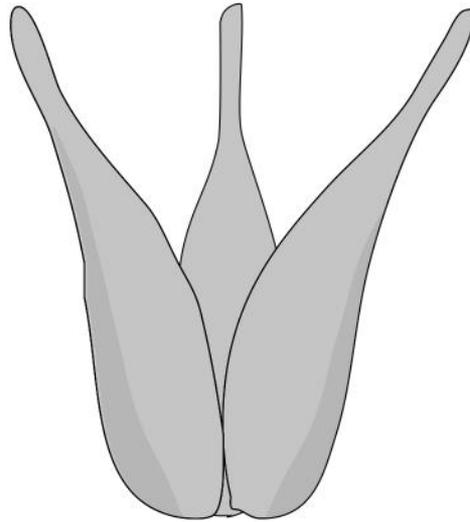


evolutionary
→
transition



Carpel number:

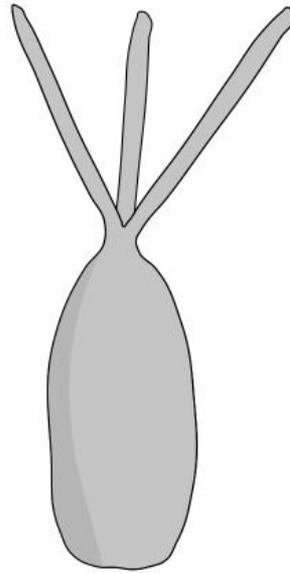
= number of pistils (if > 1 pistil)



**Carpels 3
(pistils 3)**

Carpel number:

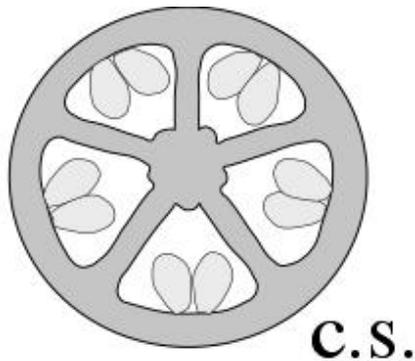
(if 1 pistil) = number of styles (if > 1 style)



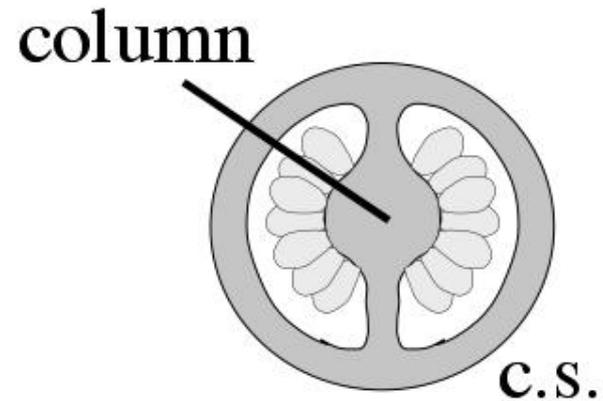
**Carpels 3
(styles 3)**

Carpel number:

(if 1 style) = number of locules (if > 1)



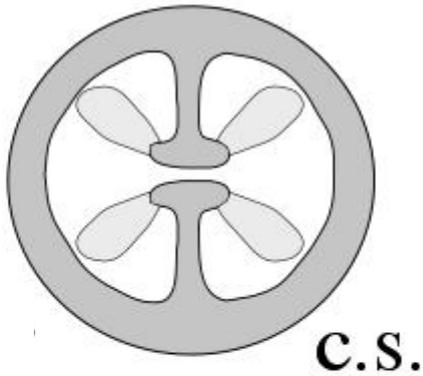
Carpels 5
(locules 5)



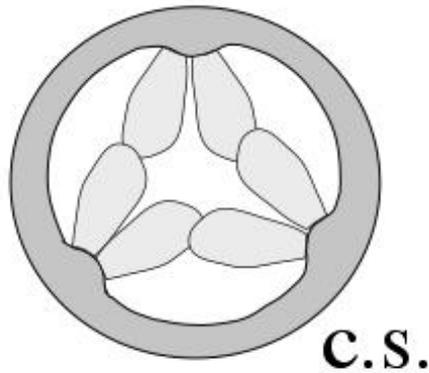
Carpels 2
(locules 2)

Carpel number:

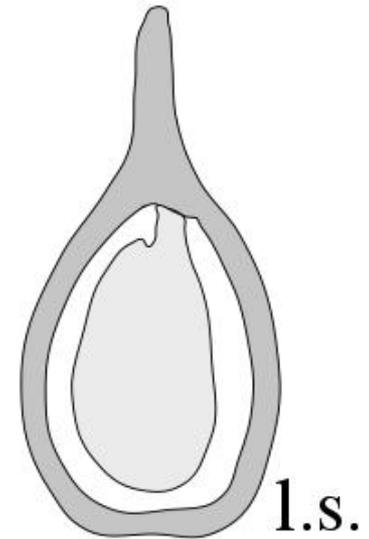
(if 1 locule) = number of placentae



**Carpels 2
(placentae 2)**

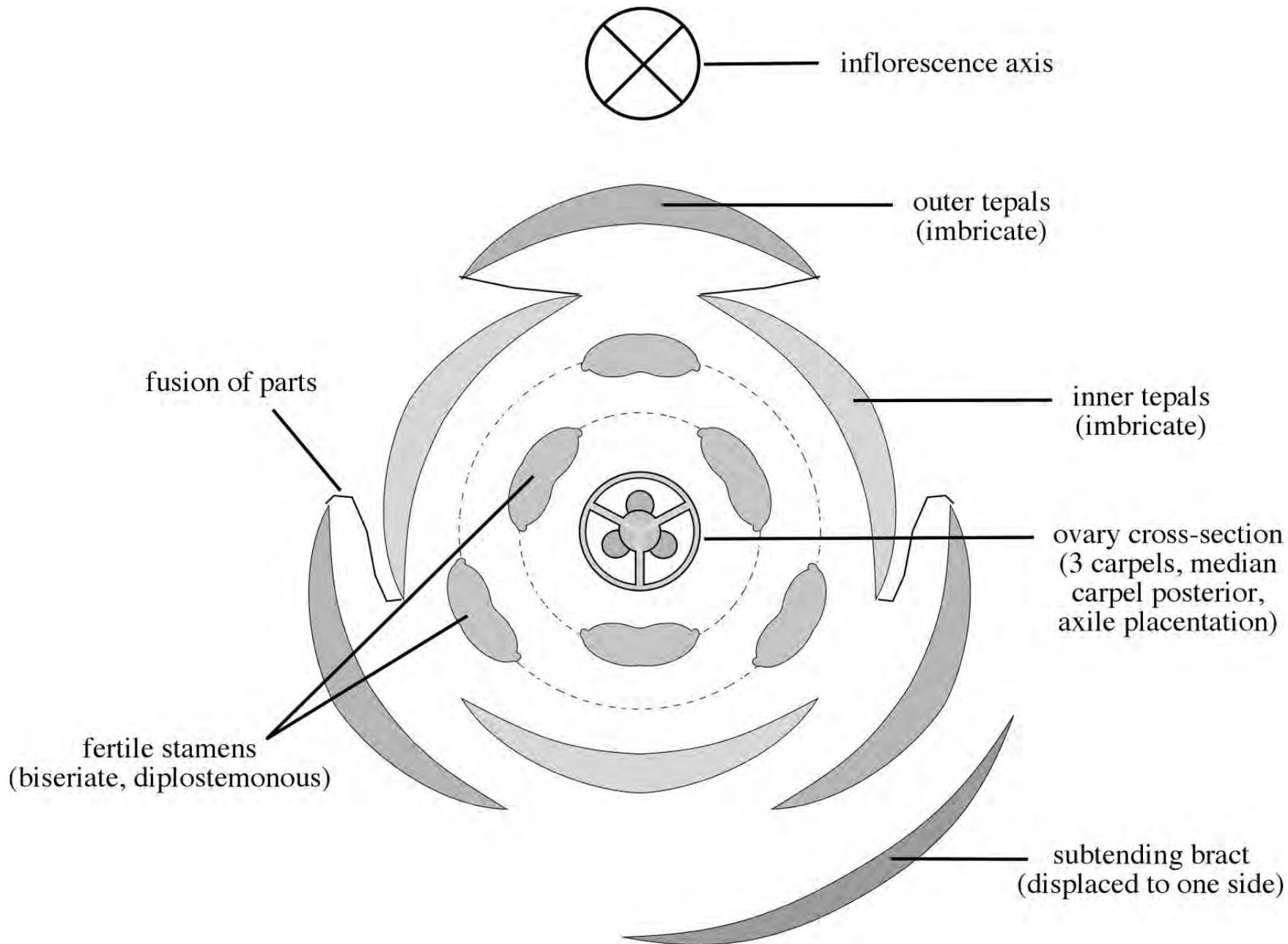


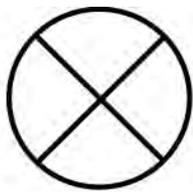
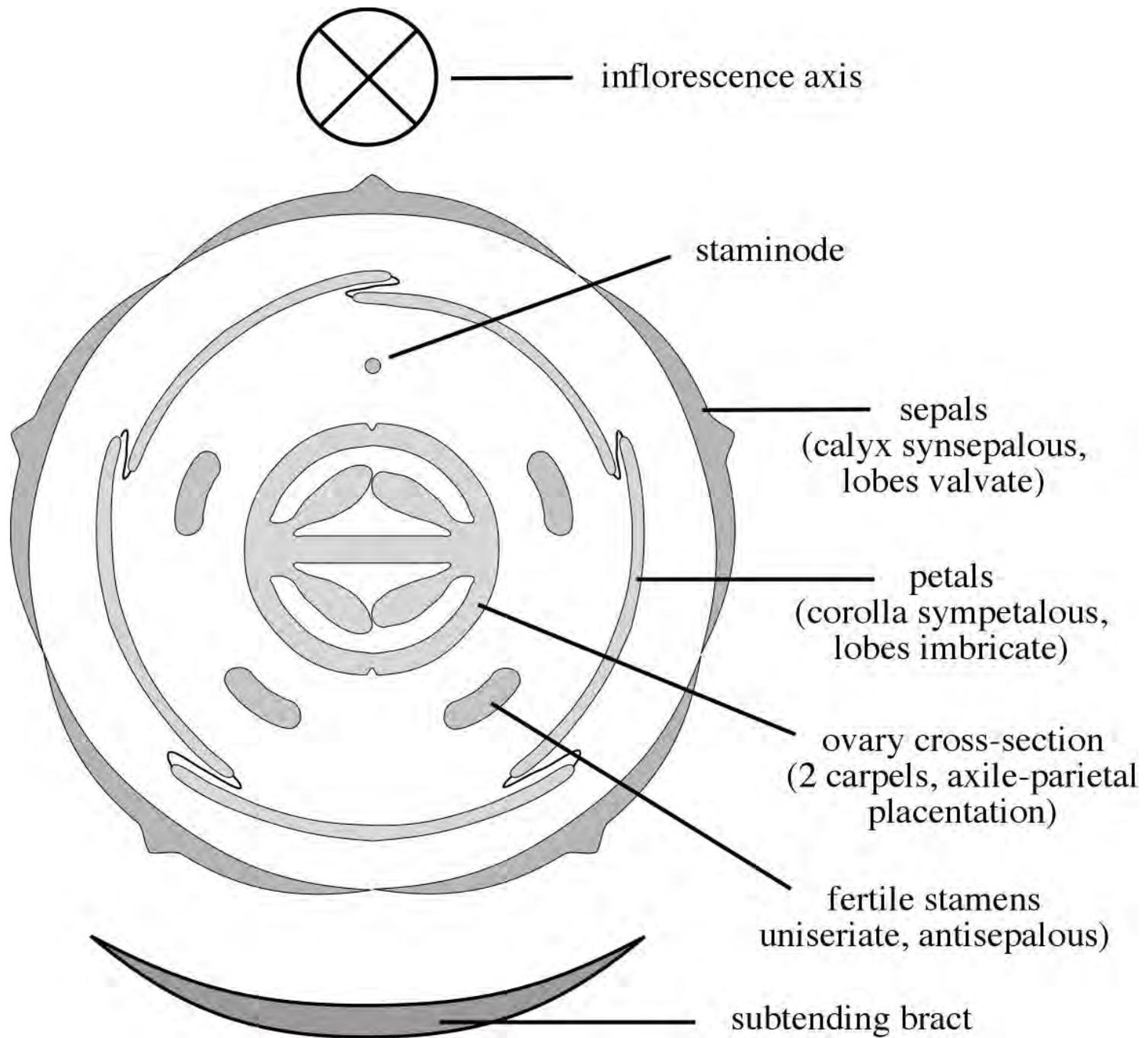
**Carpels 3
(placentae 3)**



**Carpel 1
(placenta 1)**

Floral Diagrams:





inflorescence axis

staminode

sepals
(calyx synsepalous,
lobes valvate)

petals
(corolla sympetalous,
lobes imbricate)

ovary cross-section
(2 carpels, axile-parietal
placentation)

fertile stamens
(uniseriate, antisepalous)

subtending bract

Inflorescence:

A collection or aggregation of flowers
Boundaries defined by vegetative leaves below
(not always clear what the boundaries are)

Inflorescence position:

Terminal - develops from apical meristem of primary shoot or of an extended lateral branch, with vegetative leaves.

Axillary - develops from axillary bud of a vegetative leaf, does not develop into an extended branch system.

Inflorescence parts:

Peduncle - stalk of inflorescence

Inflorescence axes - branches of inflorescence

Bract

Flower bract - subtends individual flower

Inflorescence bract - subtends entire inflorescence or an inflorescence axis.

Involucre - group of inflorescence bracts subtending entire inflorescence, e.g., in compound umbel of Apiaceae, head of Asteraceae

Spathe - specialized single inflorescence bract that subtends entire inflor., e.g., spadix of Araceae

Inflorescence development:

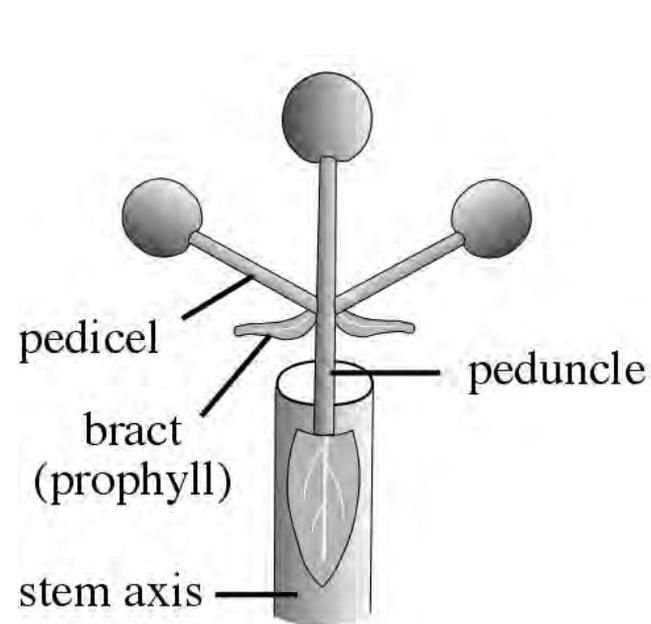
Determinate - apical meristem of the primary inflorescence axis terminates in a flower; typically, the terminal flower matures first, with subsequent maturation occurring from apex to base

Indeterminate - apical meristem of the primary inflorescence axis does not develop into a flower; typically, the basal flower matures first, with maturation occurring from base to apex

Cyme:

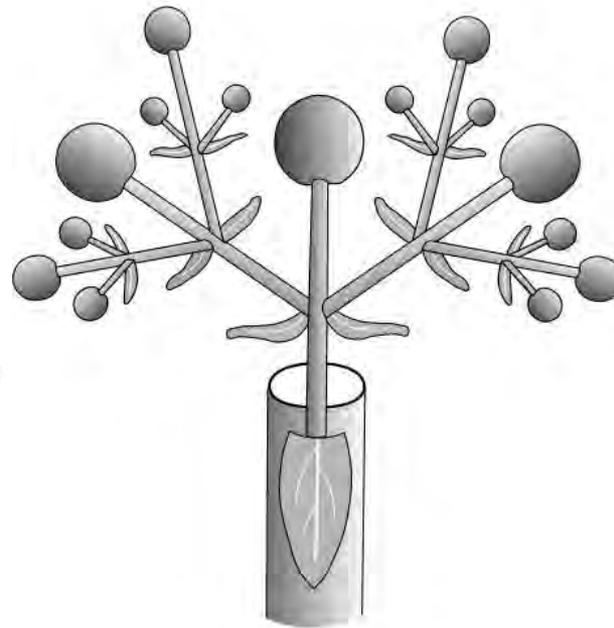
General term for a determinate inflorescence

Dichasium:



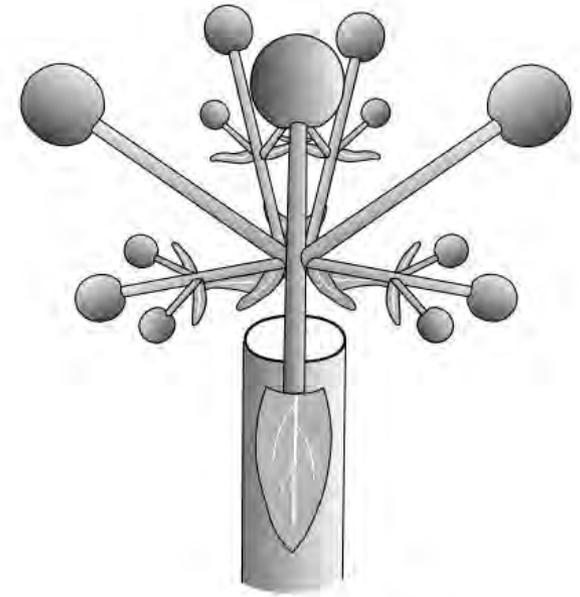
simple dichasium

-a 3-flowered cyme, with a single terminal flower and two, opposite lateral flowers, the pedicels of equal length; bracts typically subtend the two lateral flowers, although they may be absent



compound dichasium

-a many flowered cyme of repeatedly branching, simple dichasia units, the branches typically decussately arranged, thus in multiple planes

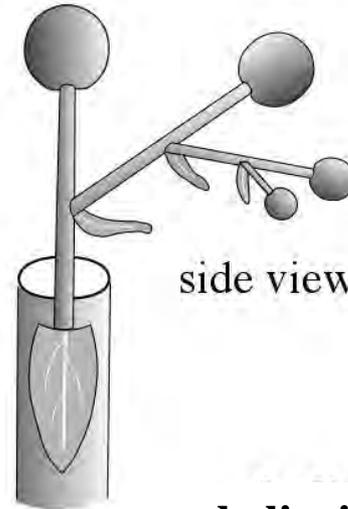
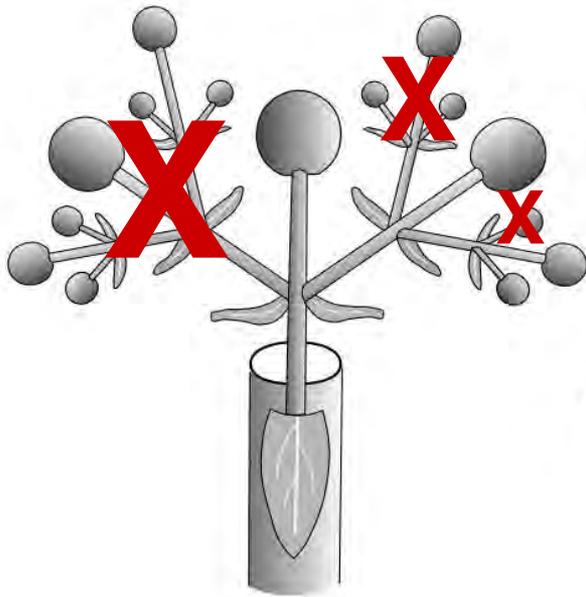


compound cyme

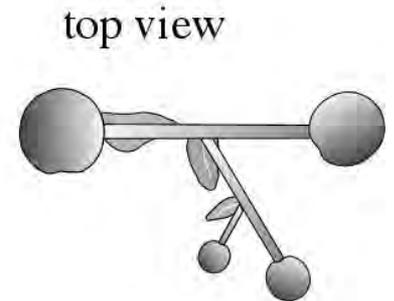
-a branched cyme, similar to a compound dichasium but lacking a consistent dichasial branching pattern. Some have the same branching pattern as a compound dichasium but with certain internodal axes reduced or missing, appearing more congested

Monochasium

- a cyme that develops along one axis only



side view



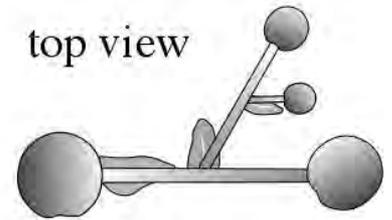
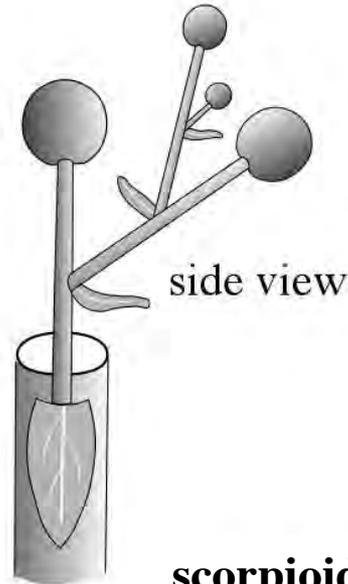
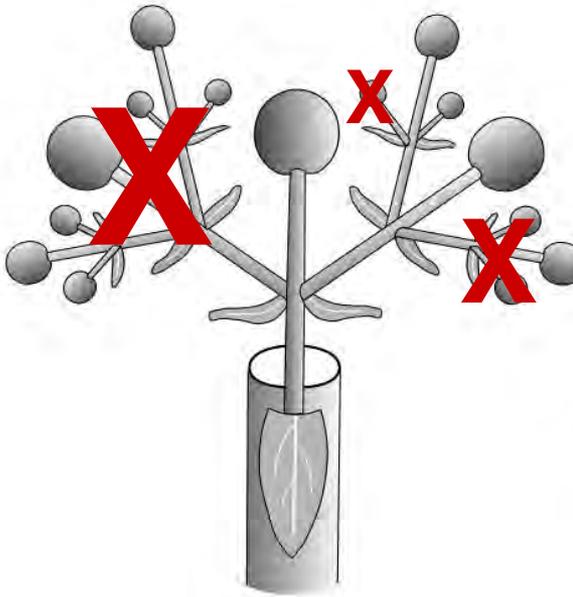
top view

helicoid cyme (bostryx)

-a monochasium in which the axes develop on only one side of each sequential axis, appearing coiled at least early in development

Monochasium

- a cyme that develops along one axis only

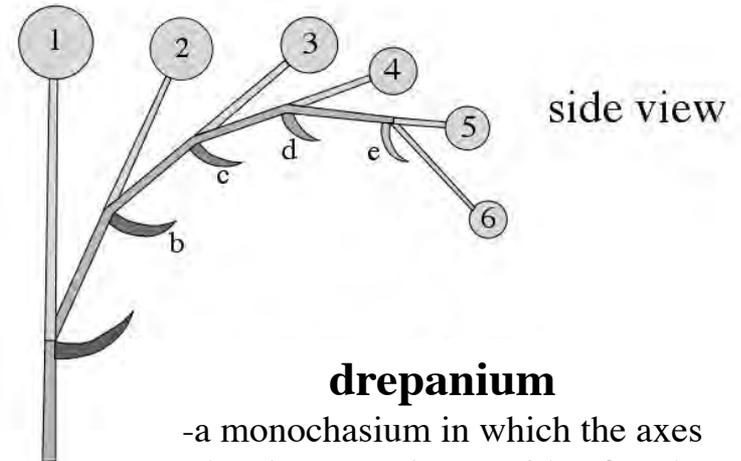
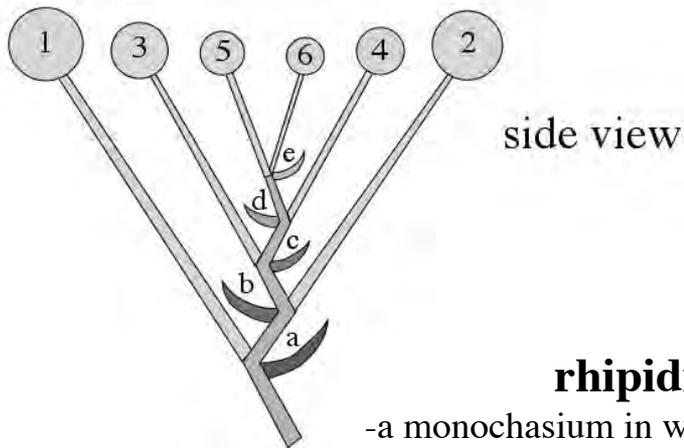
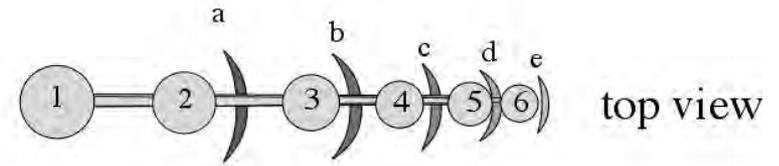
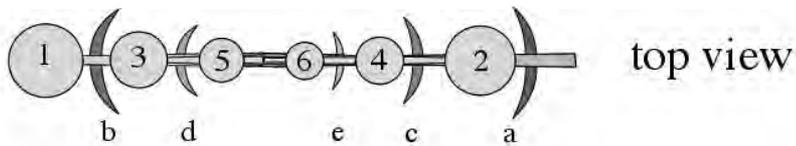


scorpioid cyme (cincinnus)

-a monochasium in which the branches develop on alternating sides of each sequential axis, typically resulting in a geniculate (zig-zag) structure, which can also be coiled (circinate)

Monochasium

- a cyme that develops along one axis only



rhipidium

-a monochasium in which the branches develop on alternating sides of each sequential axis; like scorpioid cymes, rhipidia typically have a geniculate (zig-zag) appearance.

(Rhipidia are treated as scorpioid cymes in some terminology.)

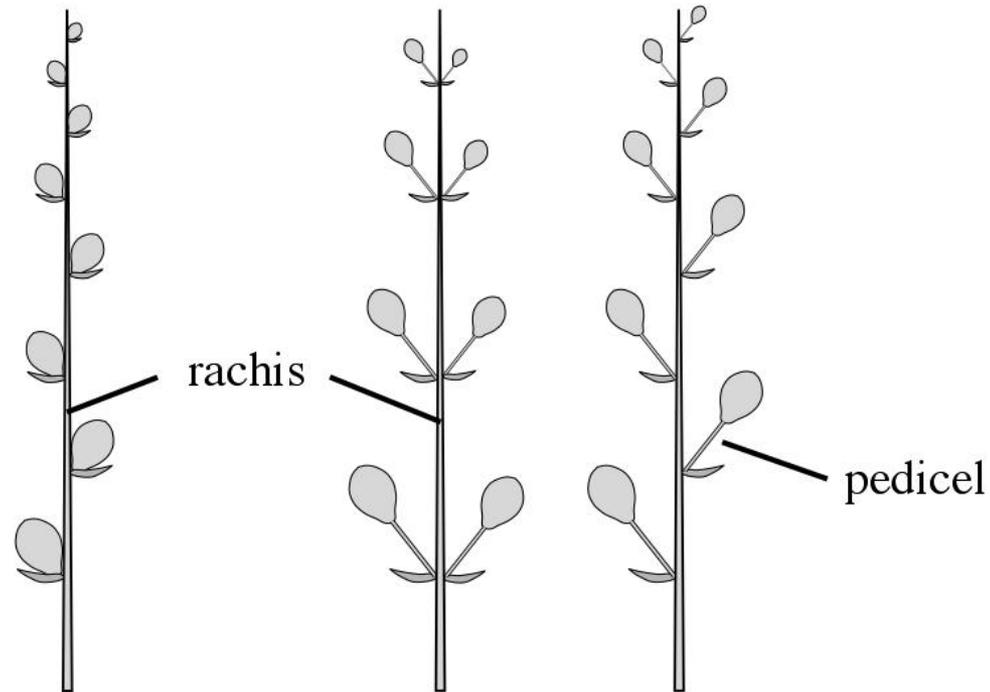
drepanium

-a monochasium in which the axes develop on only one side of each sequential axis; like a helicoid cyme, drepania typically appear coiled at least early in development.

(Drepania are treated as helicoid cymes in some terminology.)

Indeterminate inflorescences

- apical meristem of the primary inflorescence axis does not develop into a flower; typically, the basal flower matures first, with maturation occurring from base to apex

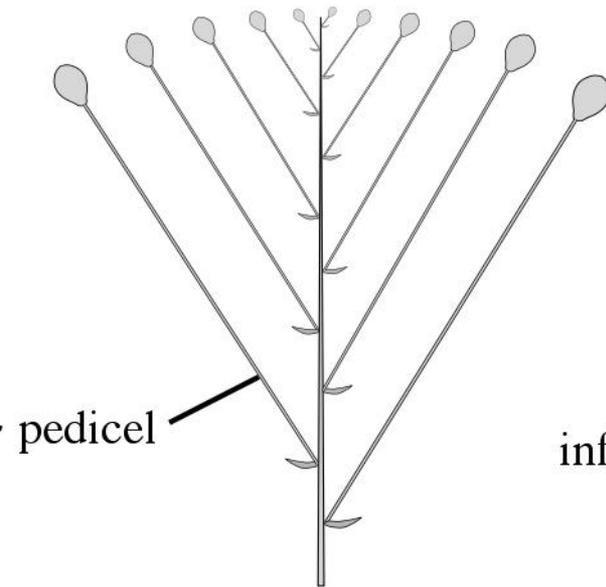


spike
-an indeterminate
inflorescence, consisting of a
single axis bearing sessile
flowers

raceme
-an indeterminate
inflorescence in which the
single axis bears pedicellate
flowers

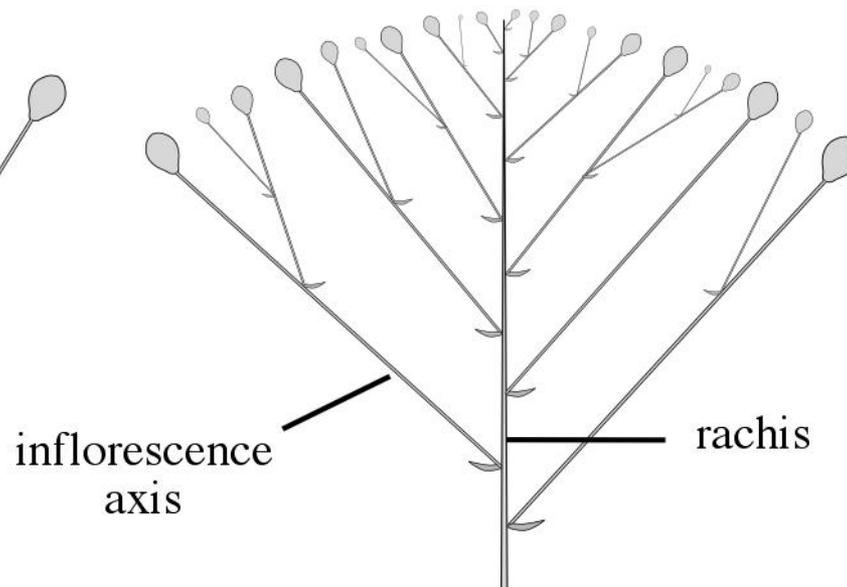
Indeterminate inflorescences

- apical meristem of the primary inflorescence axis does not develop into a flower; typically, the basal flower matures first, with maturation occurring from base to apex



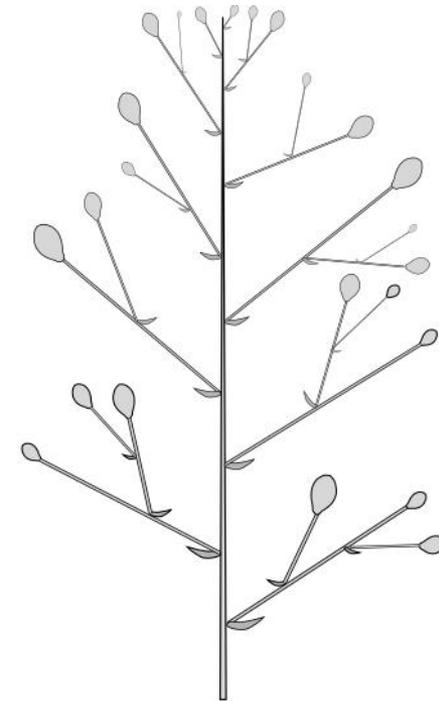
corymb (simple)

-an indeterminate inflorescence consisting of a single axis bearing pedicels, the flowers collectively flat-topped or convex



corymb (compound)

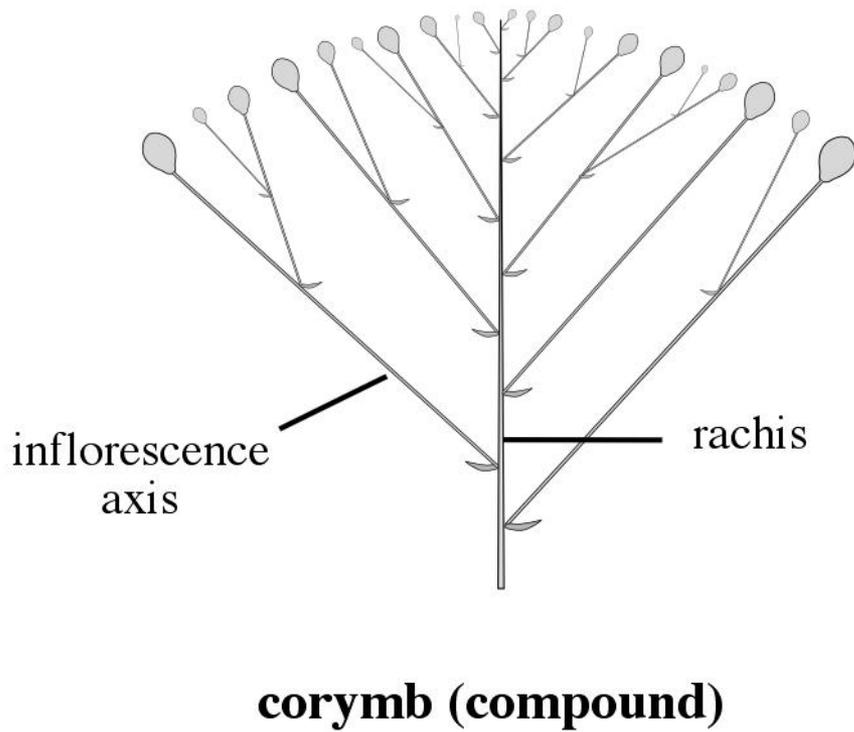
-an indeterminate inflorescence consisting of a single axis bearing branched, lateral axes, the flowers collectively flat-topped or convex



panicle

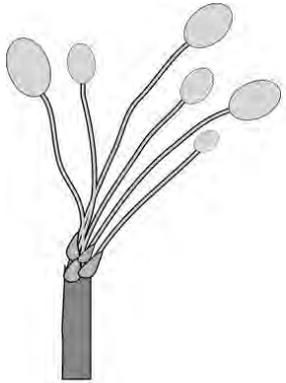
-a branched raceme, defined as an indeterminate inflorescence having several branched axes bearing pedicellate flowers

Indeterminate inflorescences:



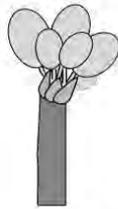
Sambucus nigra L. subsp. *caerulea* (Raf.) Bolli

Indeterminate or Determinate inflorescences:



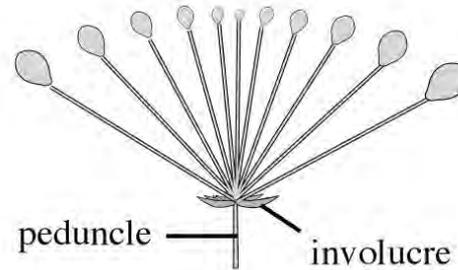
fascicle

-a racemelike or paniclelike inflorescence with pedicellate flowers in which internodes between flowers are very short



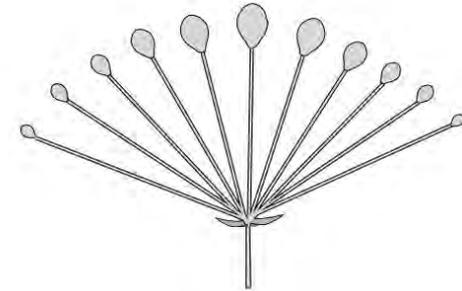
glomerule

-an inflorescence of sessile or subsessile flowers in which the internodes between flowers are very short



simple umbel (indeterminate)

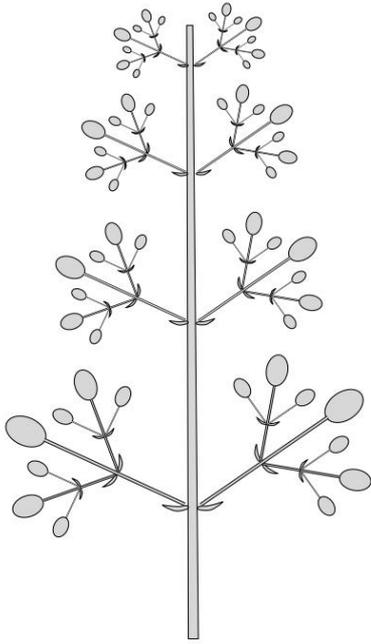
-a flat-topped or convex inflorescence with pedicels attached at one point to a peduncle; indeterminate if the flowers mature from outside to center



simple umbel (determinate)

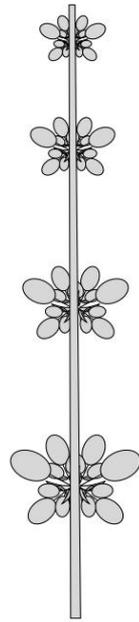
-a flat-topped or convex inflorescence with pedicels attached at one point to a peduncle; determinate if the flowers mature from center to outside

Secondary inflorescences:



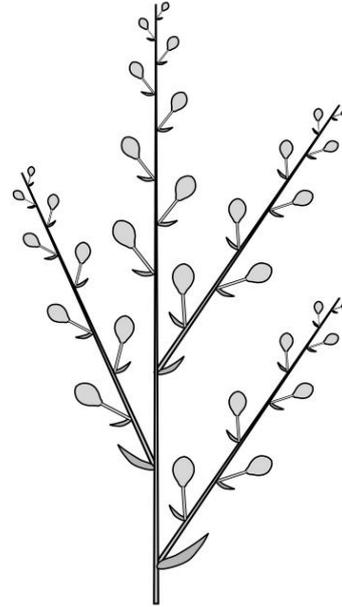
thyrsoid

-a raceme of cymes, in which the main axis is indeterminate but the opposite, lateral, unit inflorescences are pedicellate cymes, typically either simple dichasia, compound dichasia, or compound cymes, occasionally monochasial cymes.



verticillaster

-a “spike of opposite cymes,” similar to a thyrsoid in having an indeterminate main axis but differing in that the lateral cymes have very reduced to absent internodal axes and pedicels, giving a congested appearance



compound raceme

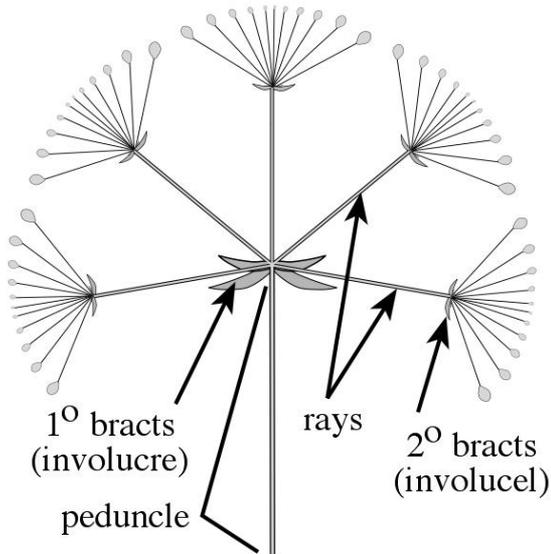
-a raceme of racemes; a central axis bearing raceme unit inflorescences



corymb of heads

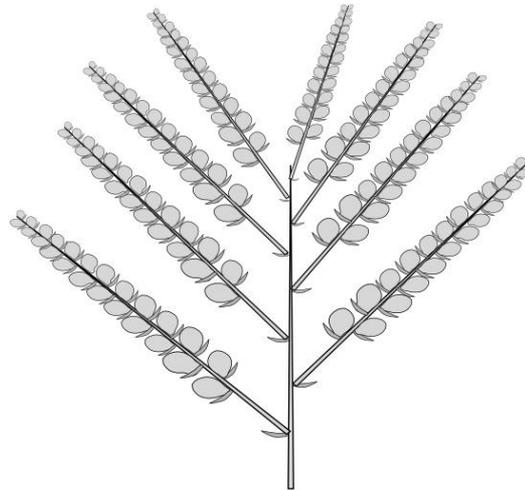
-a corymb-like inflorescence bearing heads instead of individual flowers

Secondary inflorescences:



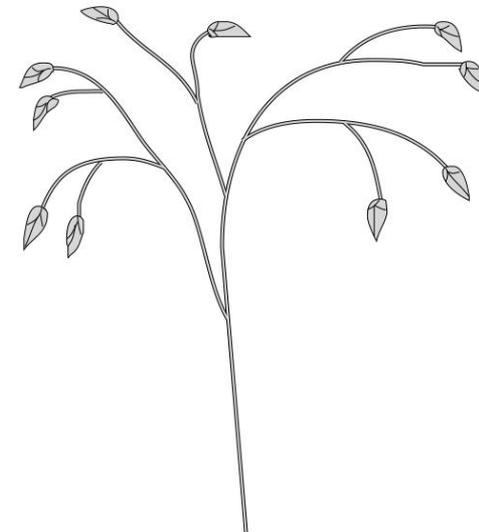
compound umbel (indeterminate)

-an umbel of umbels; a secondary inflorescence in which the peduncle bears secondary axes called rays that are attached at one point plus unit, simple umbels attached at the tip of the rays, as in many Apiaceae



raceme of spikes

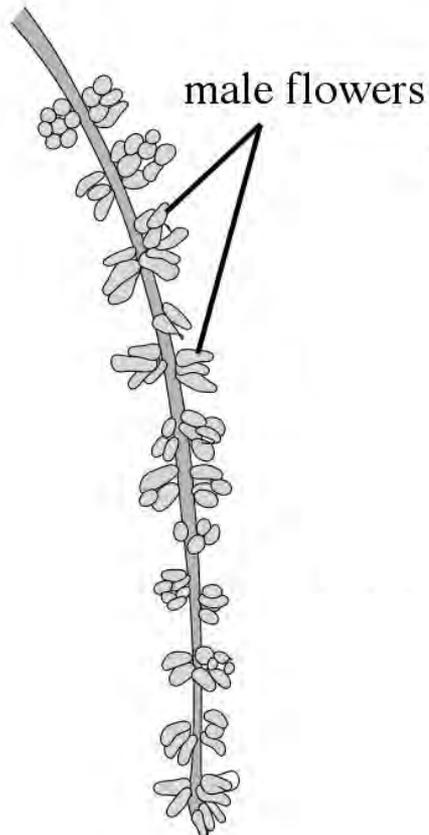
-a secondary inflorescence in which a central axis bears several spike unit inflorescences



panicle of spikelets

-a secondary inflorescence in which a panicle—like stem axes bear spikelets instead of flowers

Specialized inflorescences:



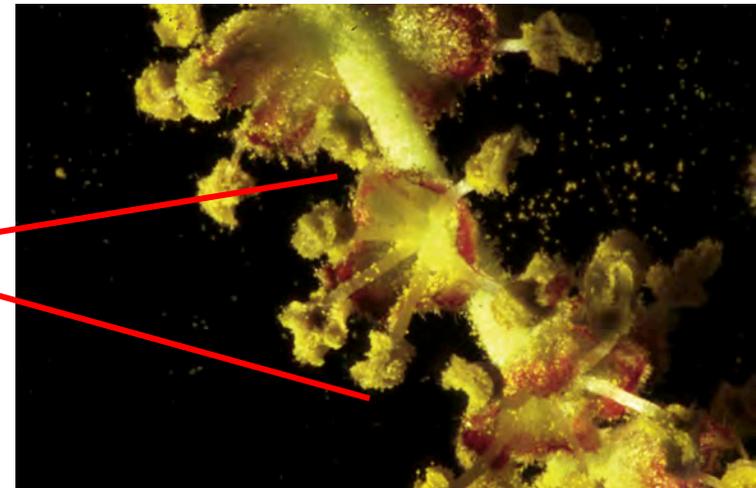
catkin/ament

-a unisexual, typically male spike or elongate axis that falls as a unit after flowering or fruiting, as in *Quercus*, *Salix*



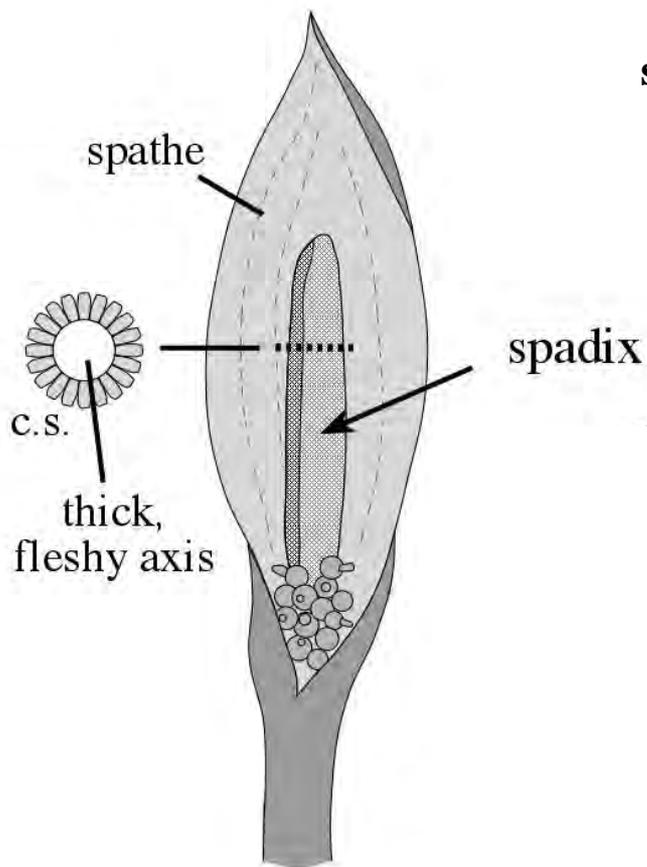
Quercus kelloggii Fagaceae

male
flower



Quercus suber Fagaceae

Specialized inflorescences:

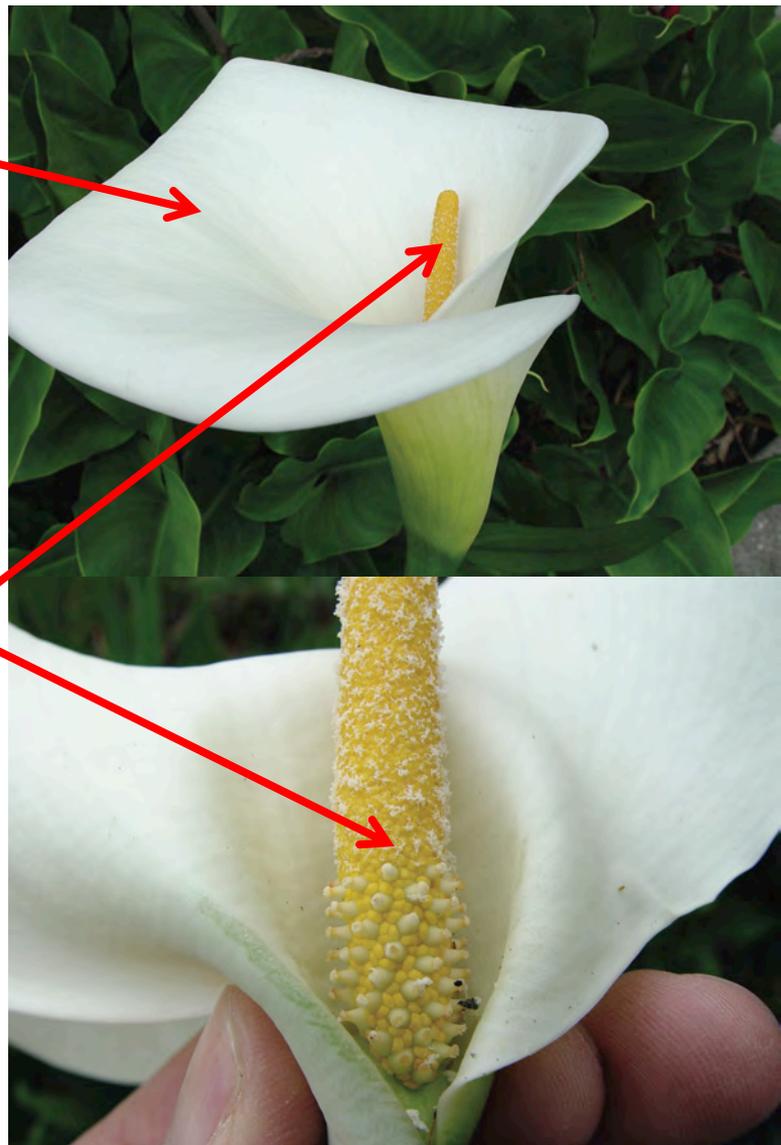


spadix

-a spike with a thickened or fleshy central axis, typically with congested flowers and usually subtended by a spathe, as in the Araceae

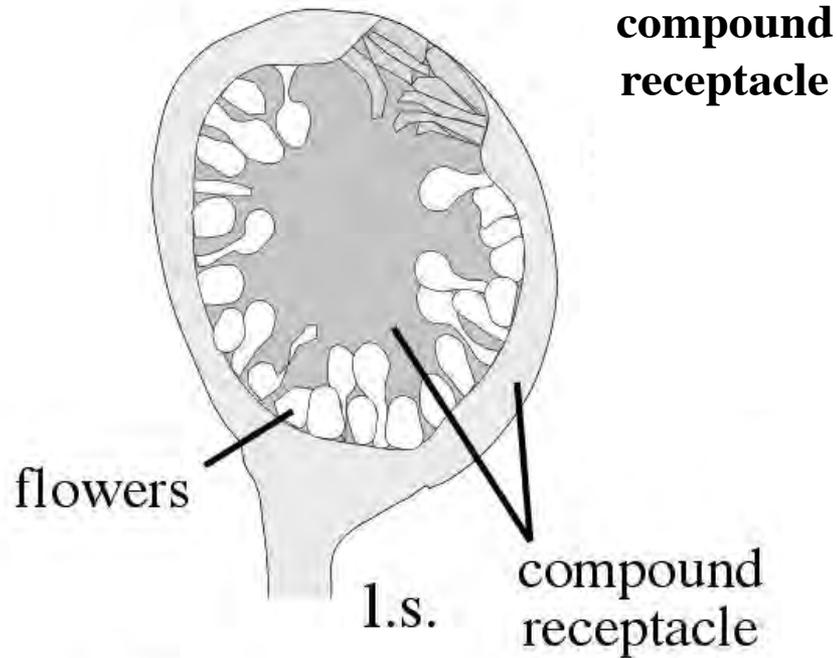
spathe

spadix



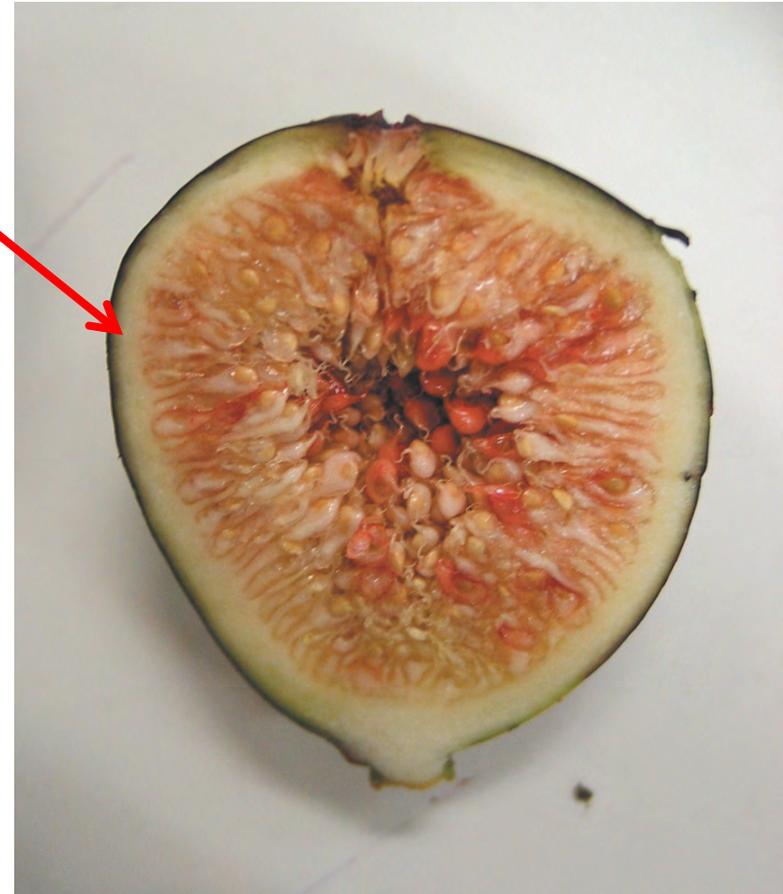
Zantedeschia aethiopica Araceae

Specialized inflorescences:



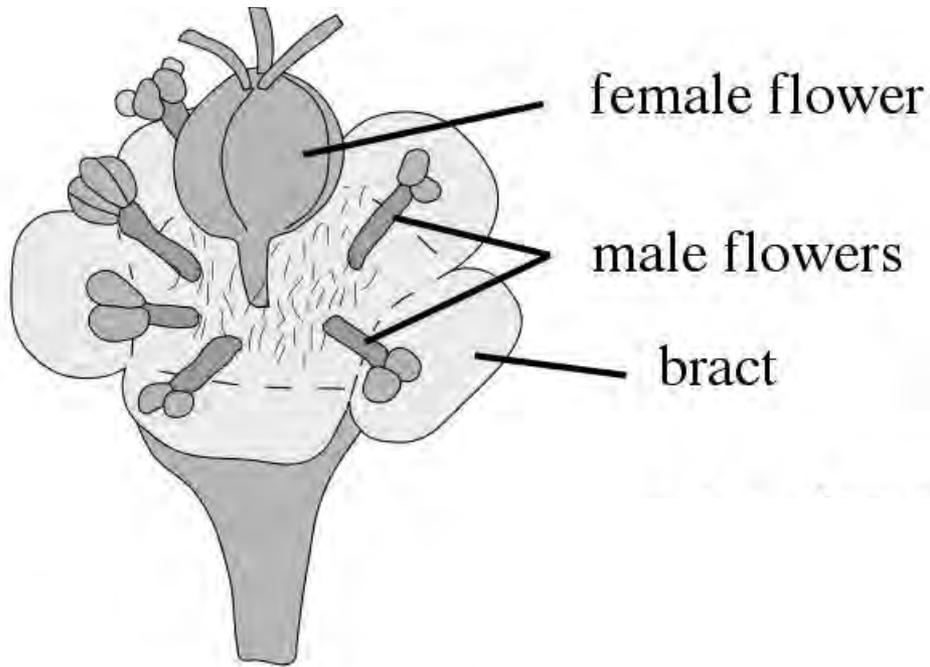
hypanthodium

-an inflorescence bearing numerous flowers on the inside of a convex or involuted compound receptacle, as in *Ficus*



Ficus rubiginosa Moraceae

Specialized inflorescences:

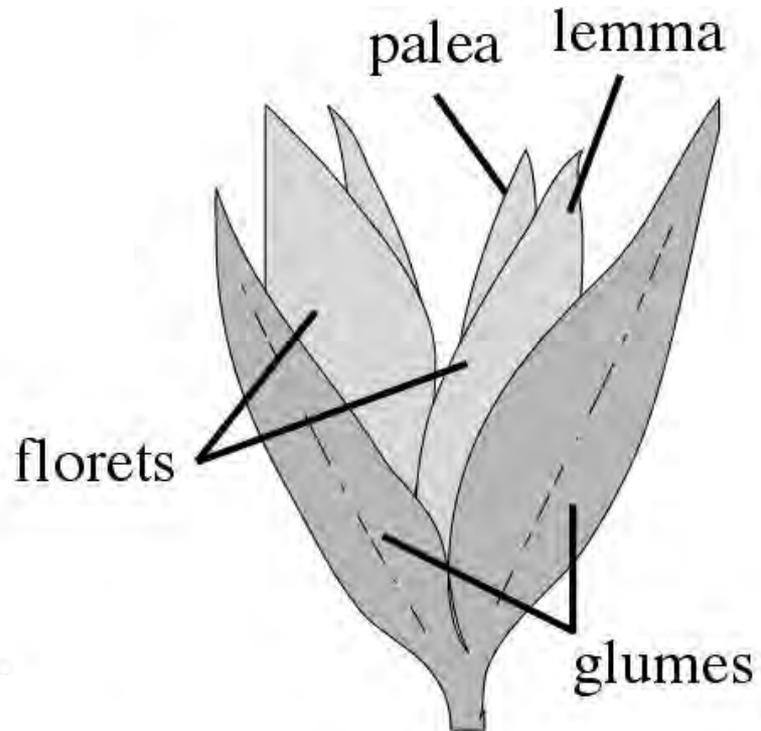


cyathium

-an inflorescence bearing small, unisexual flowers and subtended by an involucre (frequently with petaloid glands), the entire inflorescence resembling a single flower, as in *Euphorbia* and relatives



Specialized inflorescences:

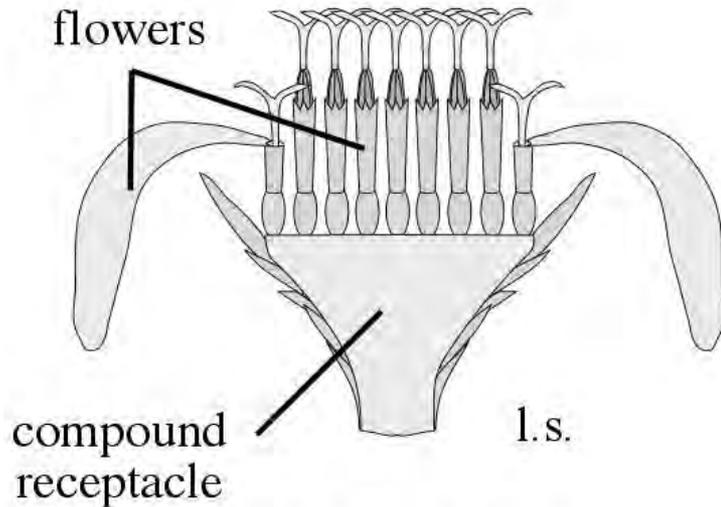
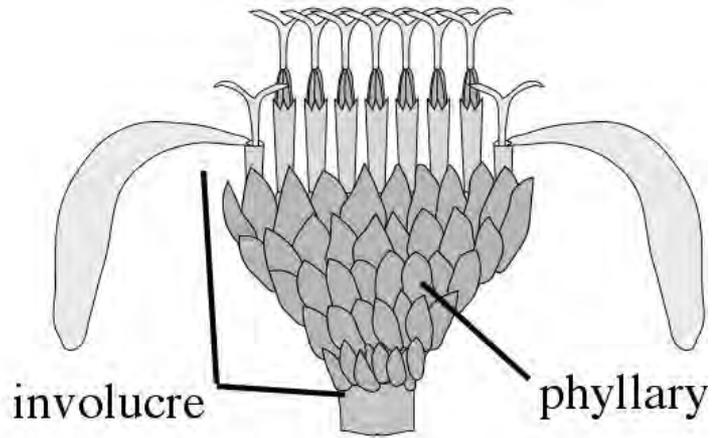


spikelet (grass)

-literally means a “small spike” and refers to the basic inflorescence unit in the Cyperaceae, the sedges, and Poaceae, the grasses



Specialized inflorescences:



head/capitulum

-a determinate or indeterminate, crowded group of sessile or subsessile flowers on a compound receptacle, often subtended by an involucre, typical of the Asteraceae and others



Fruit

**= mature ovary/ovaries plus accessory parts
(if any)**

Accessory parts

**= structures other than ovary attached to fruit
at maturity**

Pericarp

= fruit wall (mature ovary wall)

Pericarp layers

Endocarp = inner

Mesocarp = middle

Exocarp = outer

(Pericarp layers may not be present or may be only two)

Fruit Classification based on:

1) Simple, aggregate, or multiple

Simple = from 1 ovary of 1 flower

Aggregate = from many ovaries of 1 flower

Multiple = from many ovaries of many fls.

Fruit Classification

based on:

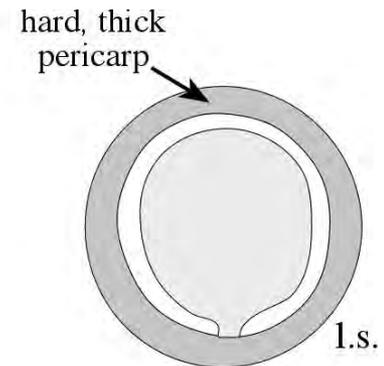
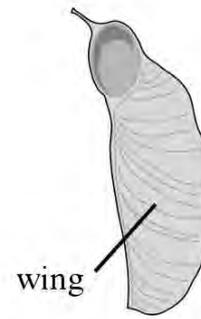
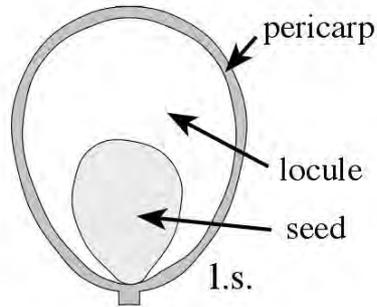
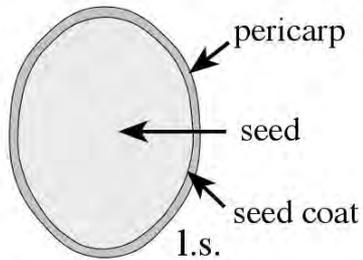
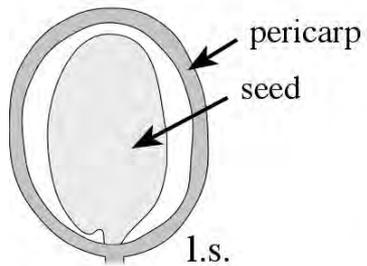
2) Dry versus fleshy

3) If dry, dehiscent versus indehiscent

4) Other features:

**ovary position,
pericarp layers,
carpel number,
locule number,
seed number,
placentation**

Simple dry, indehiscent fruit



achene

-one-seeded,
dry, indehiscent
fruit with seed
attached to the
pericarp at
one point only

grain / caryopsis

-one-seeded, dry,
indehiscent fruit
with the seed
coat adnate to
pericarp wall

utricle

-a small,
bladdery or
inflated, one-
seeded, dry fruit

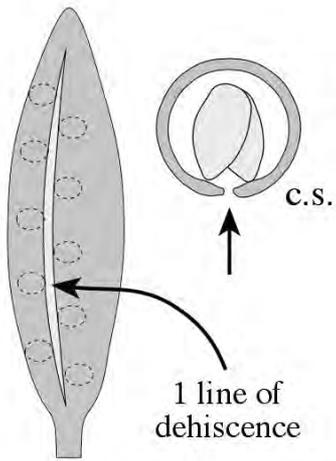
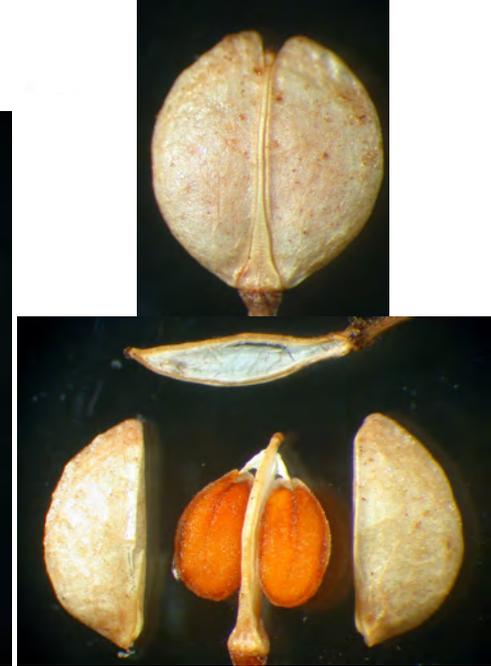
samara

-a winged, dry,
usually
indehiscent fruit

nut

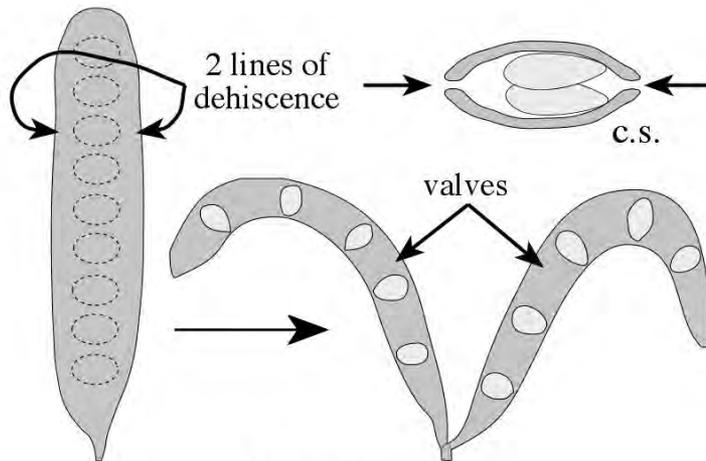
-a one-seeded,
dry indehiscent
fruit with a hard
pericarp

Simple Dry Dehiscent Fruits



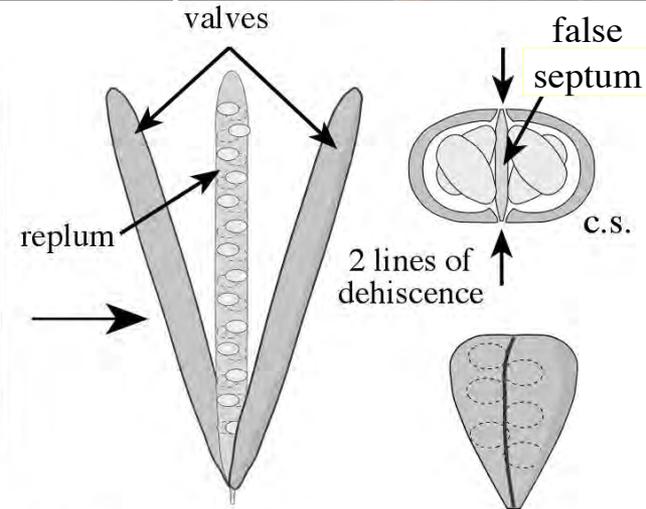
follicle

-a dry, dehiscent fruit derived from one carpel that splits along one suture



legume

-a dry, dehiscent fruit derived from one carpel that splits along two longitudinal sutures; diagnostic of Fabaceae

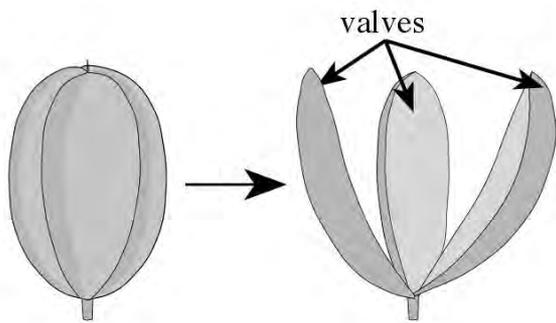


silique (long)

silicle (short)

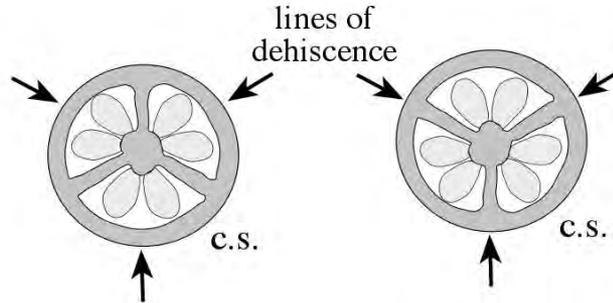
-dry, dehiscent fruits derived from a 2-carpeled ovary that dehisces along two sutures with an outer rim, the **replum**, and a persistent, thin partition, the **false septum**

Simple Dry Dehiscent Fruits



capsule

-generally dry (rarely fleshy), dehiscent fruits derived from compound (multicarpel) ovaries

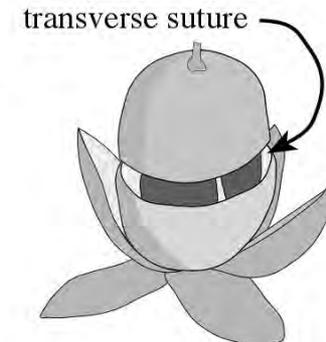


loculicidal capsule

-longitudinal lines of dehiscence radially aligned with the locules (or between the placentae, if septa absent)

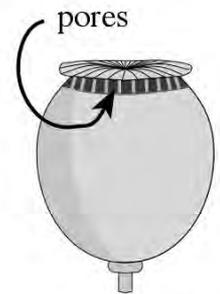
septicidal capsule

-longitudinal lines of dehiscence radially aligned with the ovary septa (or with the placentae, if septa are absent)



circumscissile capsule

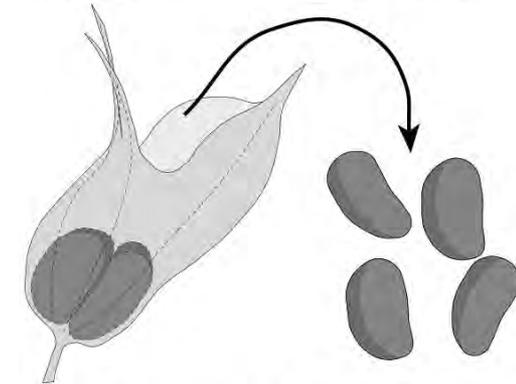
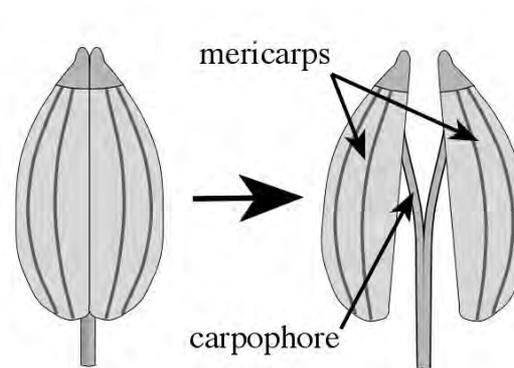
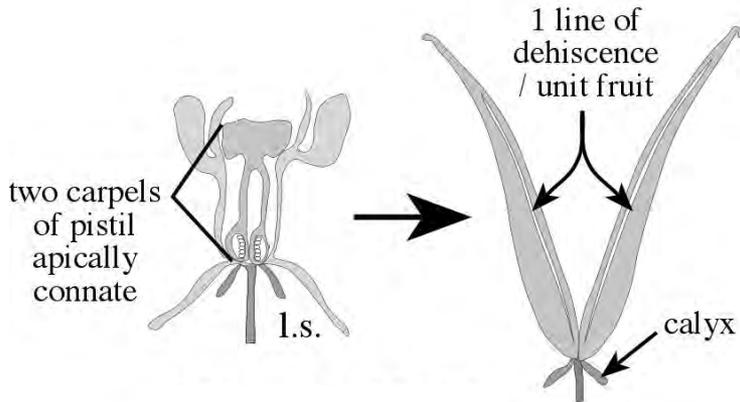
-with a transverse line of dehiscence, typically forming a terminal lid or operculum



poricidal capsule

-with dehiscence by means of pores, e.g., *Papaver*, poppy

Simple Dry Dehiscent Fruits



schizocarp of follicles

-a fruit in which the (generally two) carpels of a pistil split at maturity, each carpel developing into a unit follicle, as in *Asclepias*, milkweed

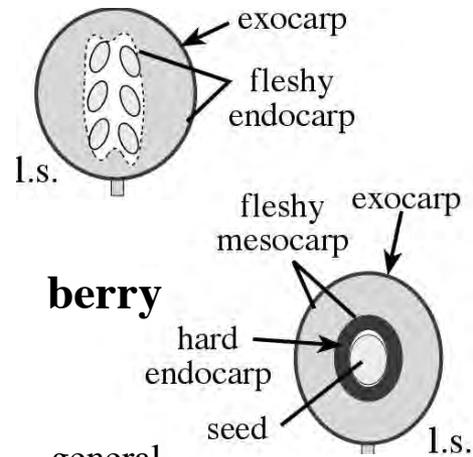
schizocarp of mericarps

-a fruit in which the carpels of a single ovary split during fruit maturation, each carpel developing into a unit mericarp, e.g., *Apiaceae*

schizocarp of nutlets

-a fruit in which a single ovary becomes lobed during development, the lobes developing at maturity into nutlets, which split off. E.g., *Boraginaceae*, most *Lamiaceae*, which have gynobasic styles

Simple fleshy fruit

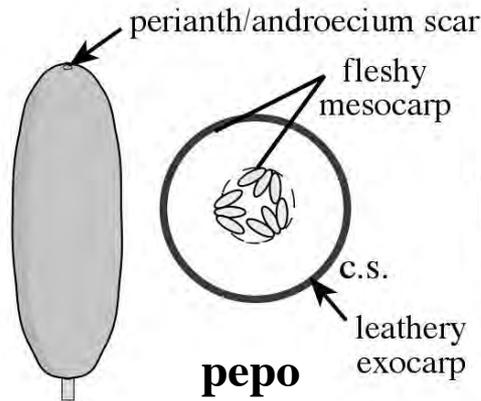


berry

-general term for a fruit with a succulent pericarp

drupe

-a fruit with a hard, stony endocarp and a fleshy mesocarp

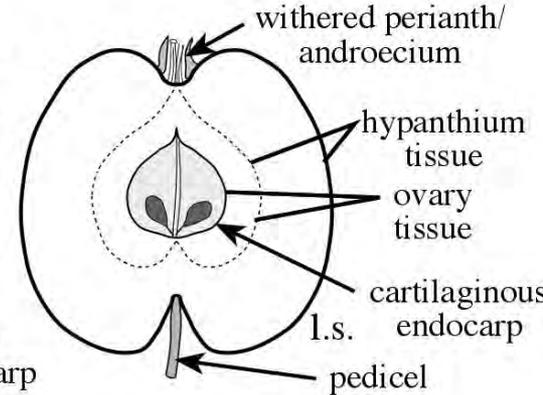


pepo

-nonseptate fleshy fruit with parietal placentation and a leathery exocarp derived from an inferior ovary, the fruit type of the Cucurbitaceae.

hesperidium

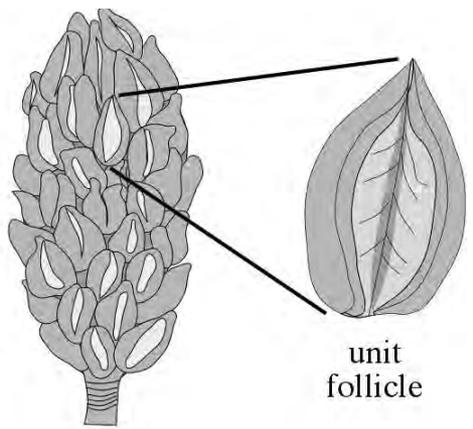
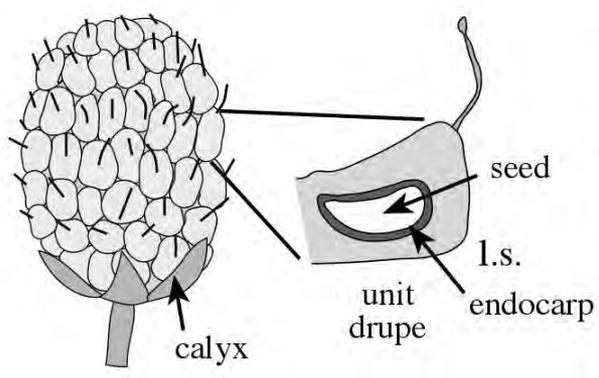
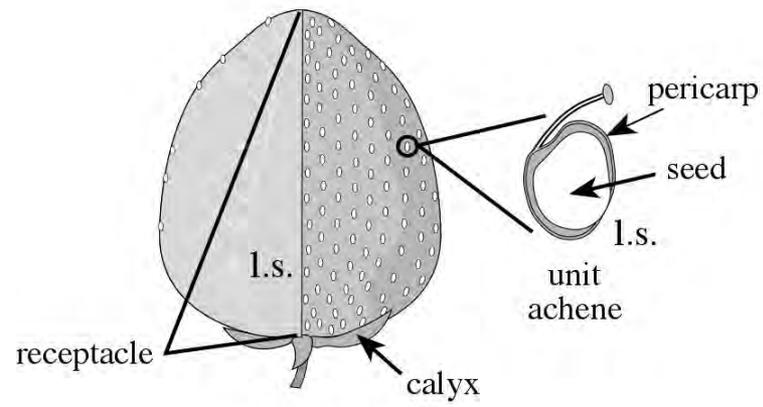
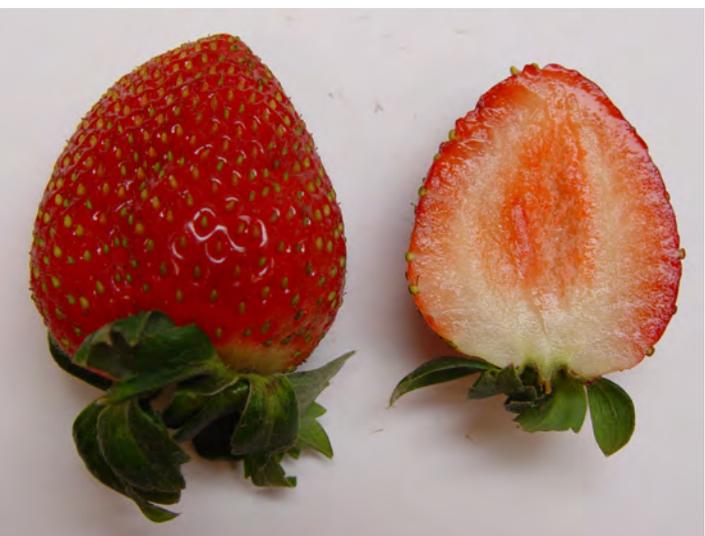
-a septate fleshy fruit with a thick-skinned, leathery outer pericarp wall and fleshy modified trichomes (juice sacs) arising from the inner walls, as in *Citrus*



pome

-a fleshy fruit with a cartilaginous endocarp derived from an inferior ovary, with most of the fleshy tissue derived from the outer, adnate hypanthial tissue, as in *Malus* (apple) and *Pyrus* (pear).

Aggregate Fruits



achenecetum

-an aggregate fruit of achenes
(*Fragaria* sp., *strawberry*, *Rosaceae*)

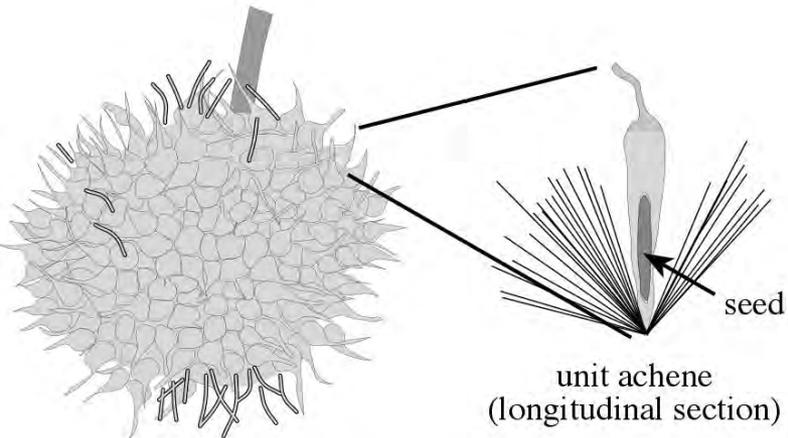
drupecetum

-an aggregate fruit of drupes
(*Rubus* sp., *blackberry*, *Rosaceae*)

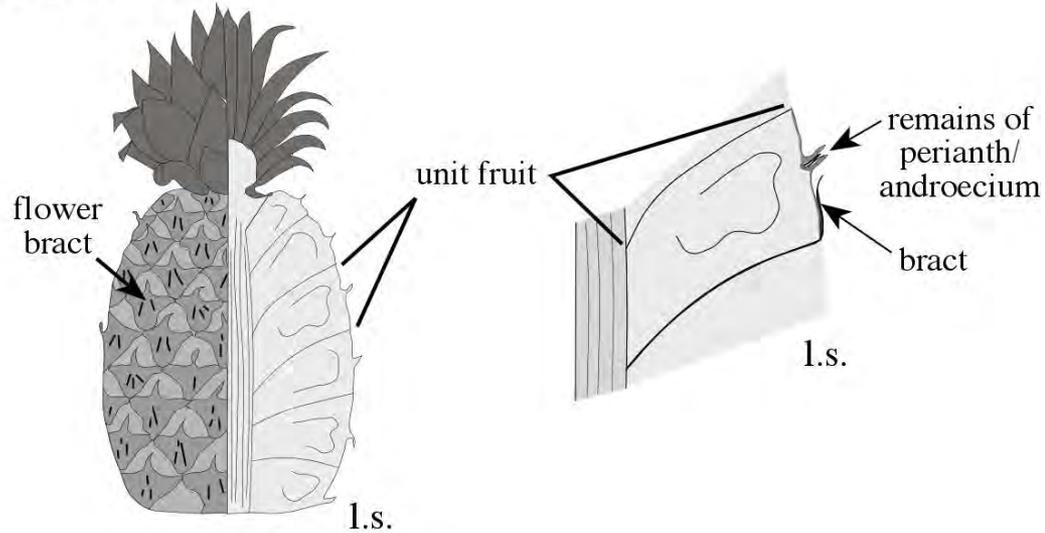
follicetum

-an aggregate fruit of follicles
(*Magnolia* sp., *magnolia*, *Magnoliaceae*)

Multiple Fruits

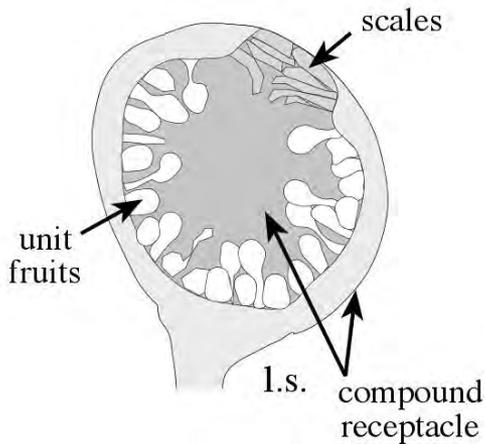


multiple fruit of achenes
(*Platanus racemosa*, sycamore, Platanaceae)



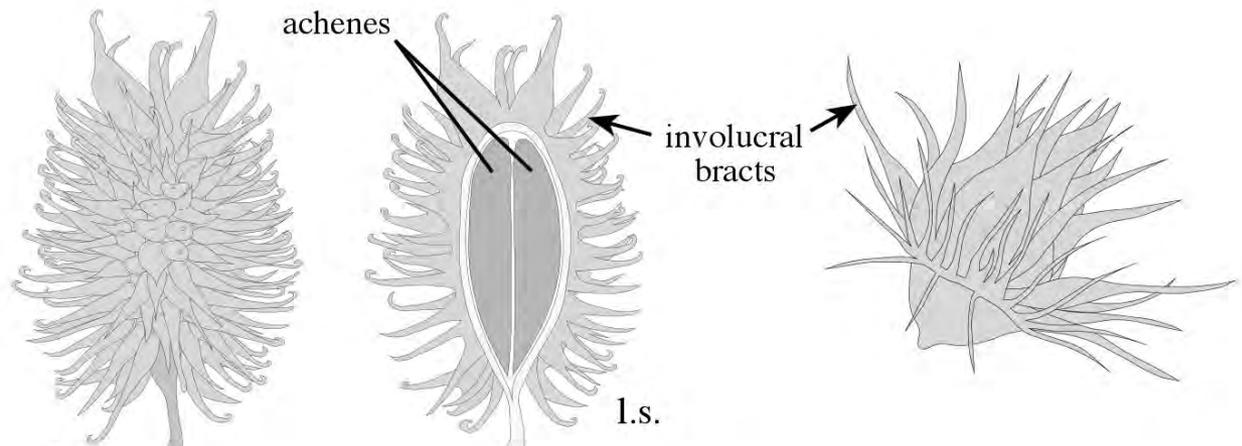
sorosis = multiple fruit of berries
(*Ananas comosus*, pineapple, Bromeliaceae)

Multiple Fruits



syconium

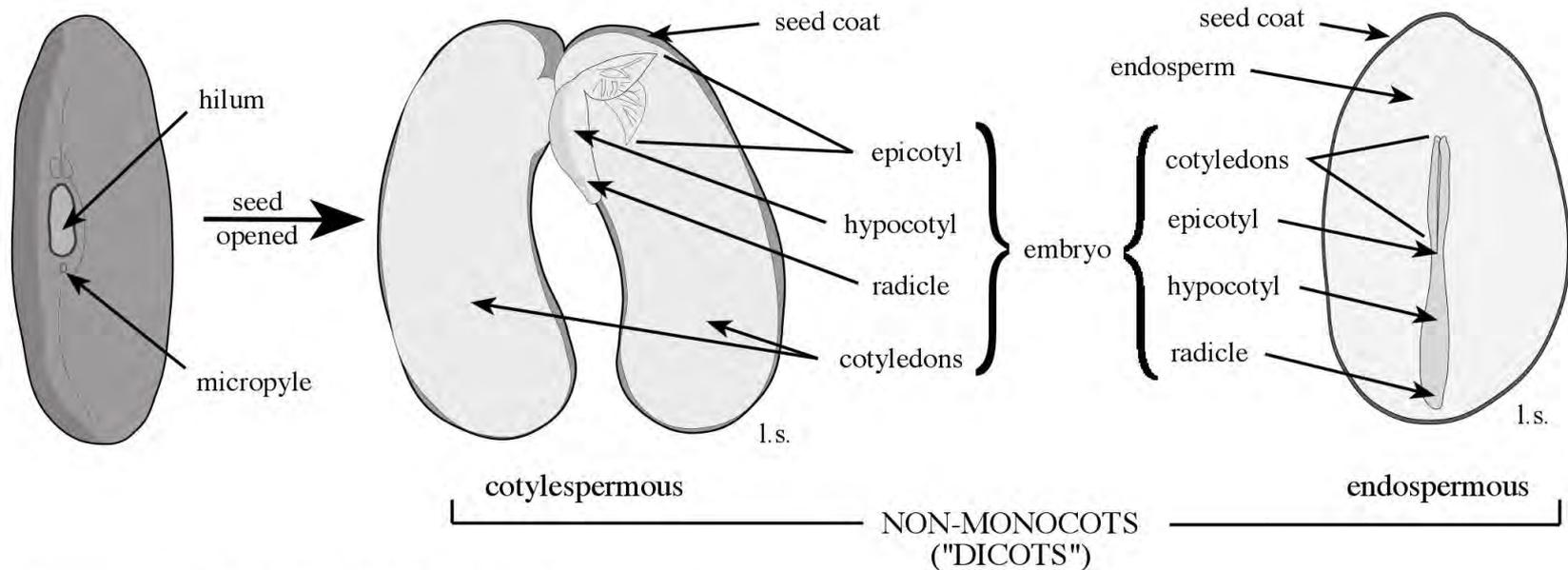
-a multiple fruit in which unit fruits are small achenes covering the surface of a fleshy, inverted compound receptacle, as in *Ficus*, fig.



bur

-a multiple fruit of achenes or grains surrounded by a prickly involucre, such as in *Cenchrus*, sandbur (Poaceae), or *Xanthium*, cocklebur (Asteraceae).

Seed Parts/Types



hilum- scar of attachment of funiculus

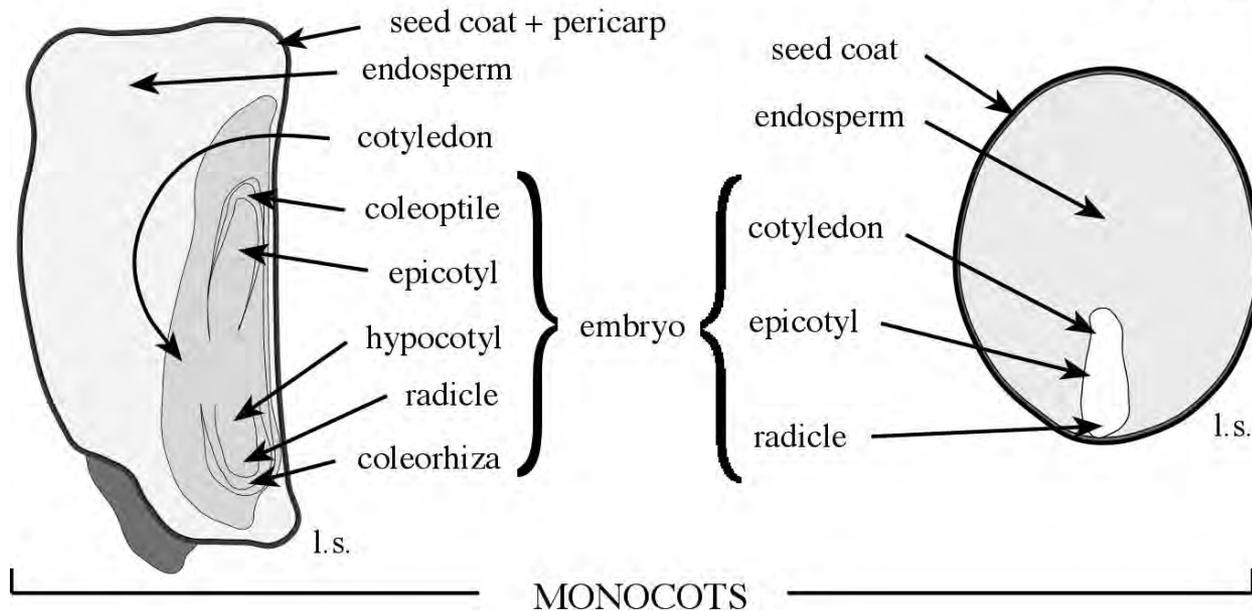
raphe – ridge on seed coat formed from adnate funiculus

cotyledonous – nutritive tissue in cotyledons (e.g., beans, peas)

endospermous – nutritive tissue in endosperm

exalbuminous – no endosperm deposited (e.g., orchid seeds)

perispermous – nutritive tissue in nucellus



hilum- scar of attachment of funiculus

raphe – ridge on seed coat formed from adnate funiculus

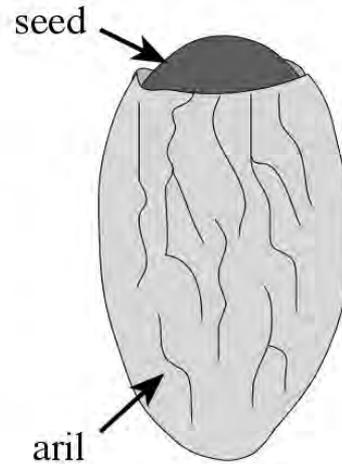
cotyledonous – nutritive tissue in cotyledons (e.g., beans, peas)

endospermous – nutritive tissue in endosperm

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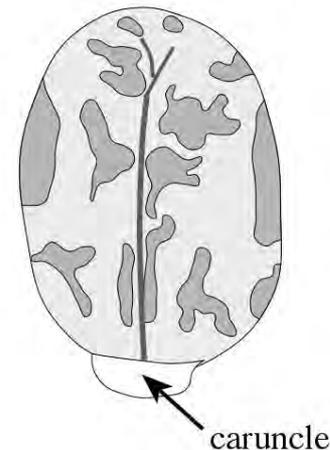
perispermous – nutritive tissue in nucellus

aril - a fleshy outgrowth of the funiculus, raphe, or integuments (but separate from the integuments) that generally functions in animal seed dispersal



Taxus, yew Taxaceae

caruncle/strophiole – a fleshy outgrowth at the base of the seed; function in animal seed dispersal



Ricinus communis, castor-bean Euphorbiaceae

Fruit and seed dispersal

Diaspore – dispersal unit (seeds and/or fruits)

anemochory – dispersal by wind (e.g., samaras, achene w/pappus)

autochory – self dispersal

explosively dehiscent fruits (e.g., *Ceanothus*)

hypogeous fruits –plant themselves (e.g., *Arachis*, peanut)

hydrochory – water dispersal (e.g., *Cocos nucifera*, coconut)

zoochory – dispersal by animals

myrmecochory – ant dispersal (e.g., *Viola*, violet; seeds w/caruncle)

exozoic – diaspore attached to animal (e.g., burs)

endozoic – diaspore eaten, passes through gut (fleshy fruits)

atelochoy – absence of specialized dispersal

Wind Dispersal: Russian Thistle (*Salsola* sp.; introduced)

<http://rebrn.com/re/tumbleweed-migration-2684859>