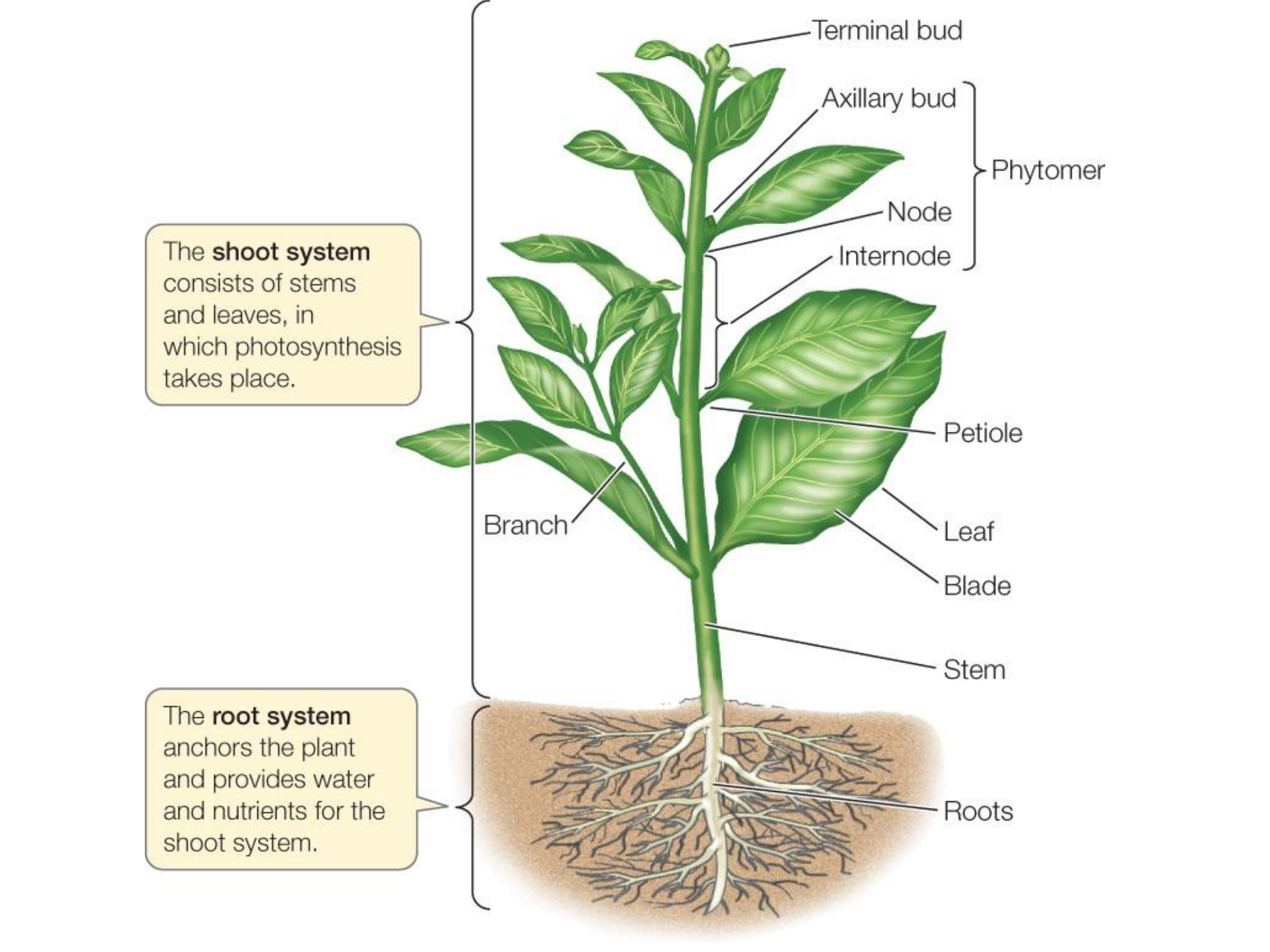
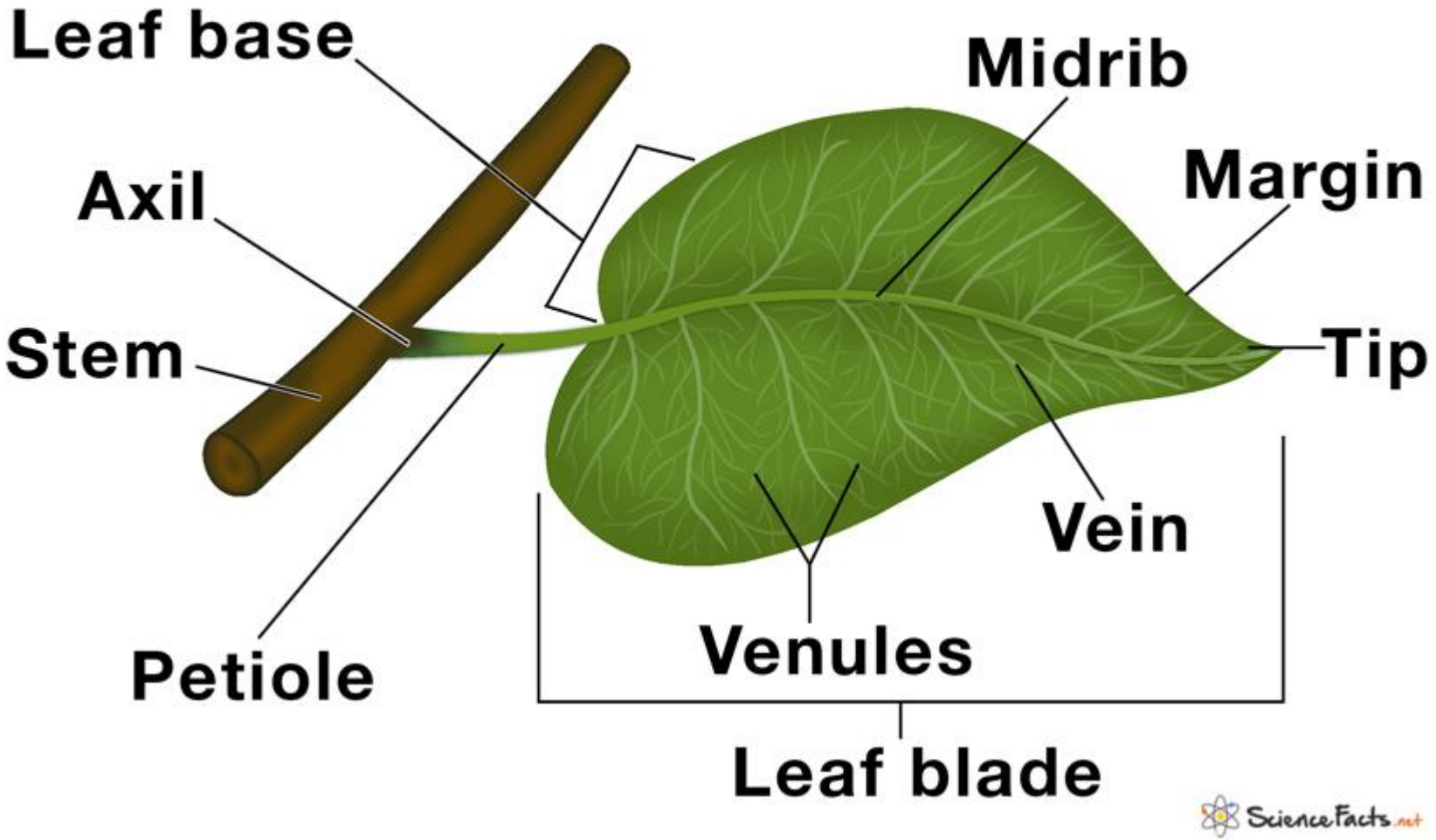
Morphology and anatomical structure of the leaf


Terminal bud
Axillary bud
Phytomer
Node
Internode
The **shoot system** consists of stems and leaves, in which photosynthesis takes place.
Petiole
Branch
Leaf
Blade
Stem
The **root system** anchors the plant and provides water and nutrients for the shoot system.
Roots

Parts of a Leaf



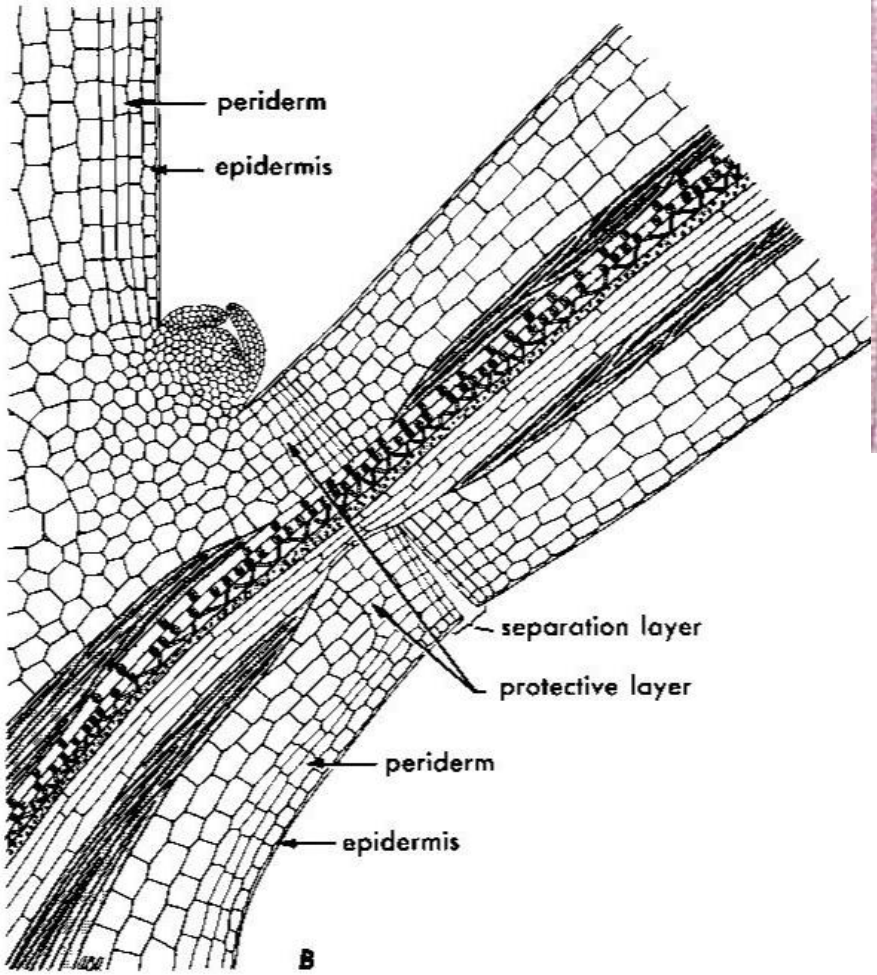
In annual plants, the life span of the leaf is approximately equal to the life span of the stem

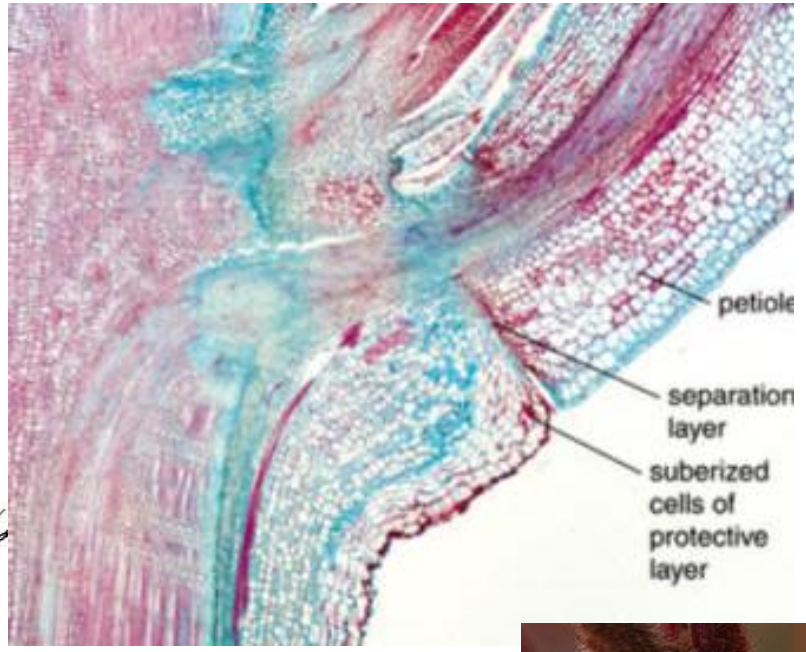
Welwitschia mirabilis, in which the leaf is a permanent organ and lives 90-100 years.

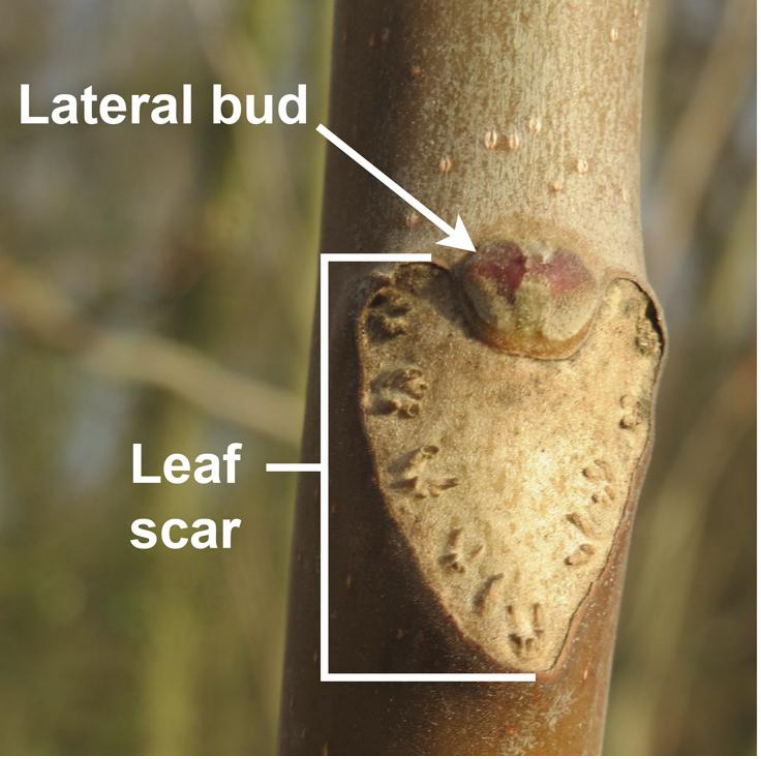
In perennial plants, leaves are temporary organs that usually live only one growing season.

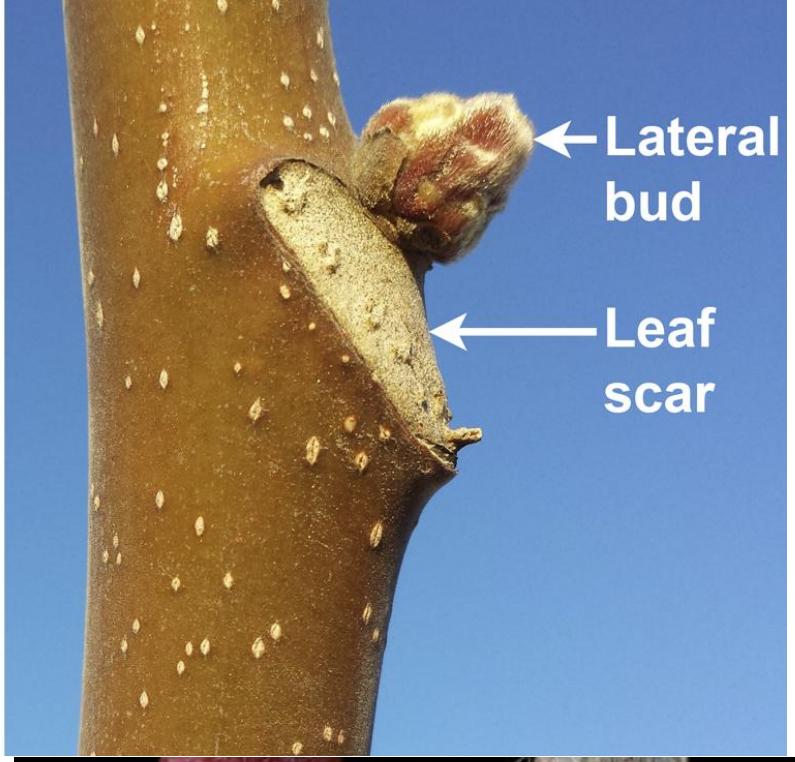
In evergreen plants, the leaf functions for 1-5 years

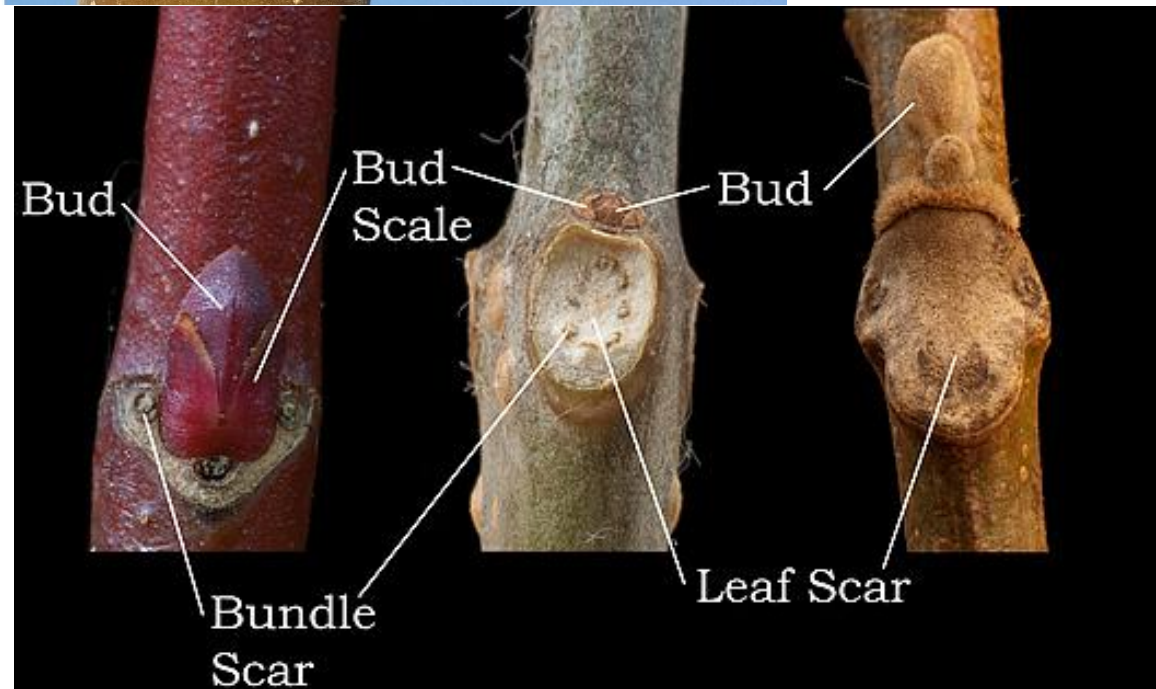
Leaf abscission zone



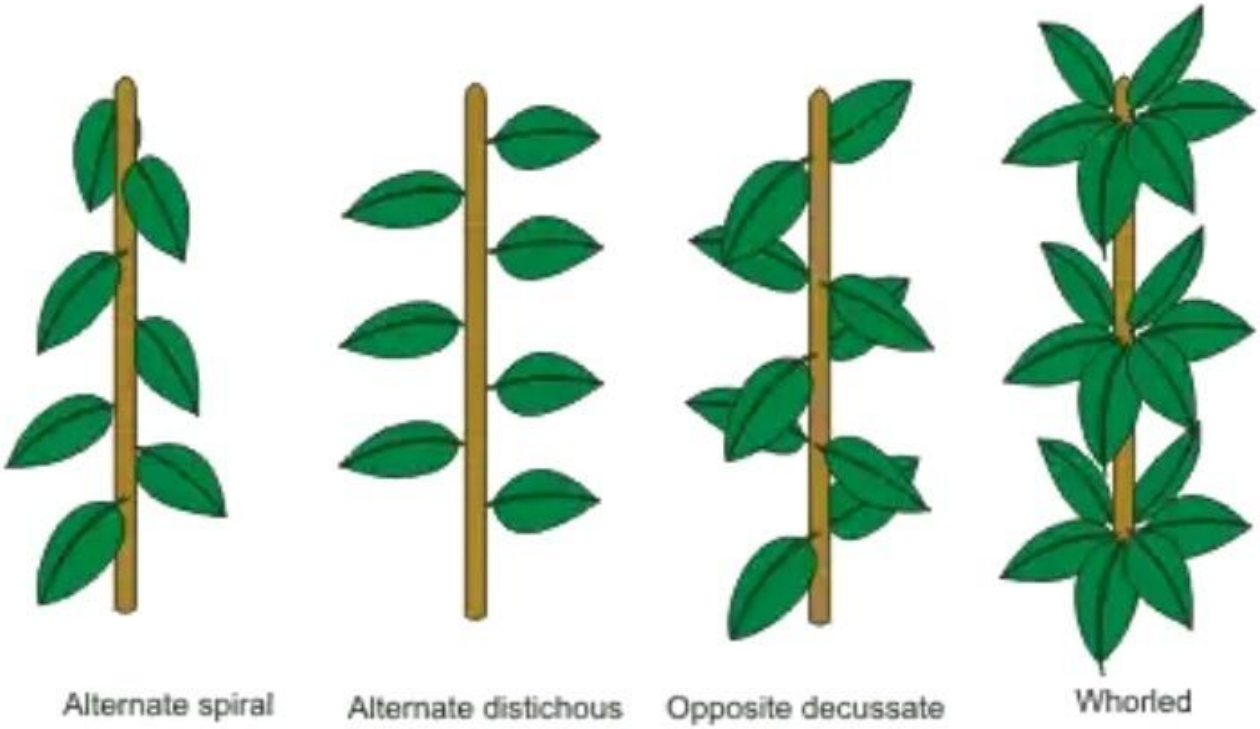


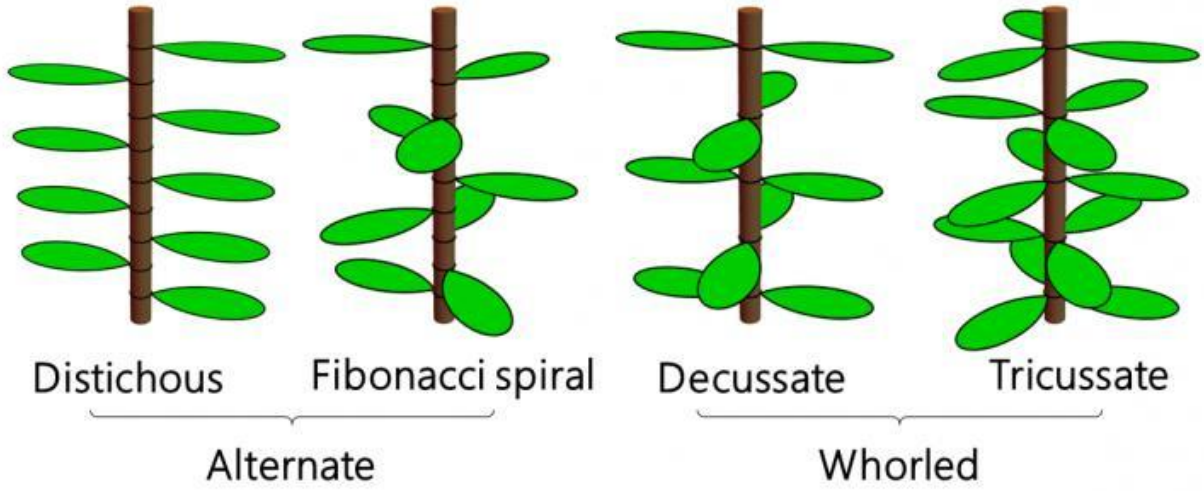

Lateral bud
Leaf scar


Lateral bud
Leaf scar

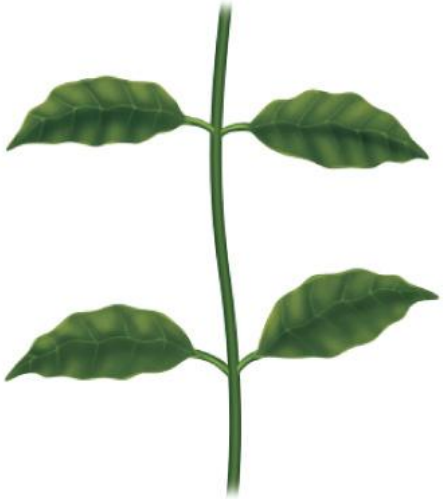

Bud
Bud Scale
Bud
Bundle Scar
Leaf Scar

The arrangement of leaves





Alternate



Opposite

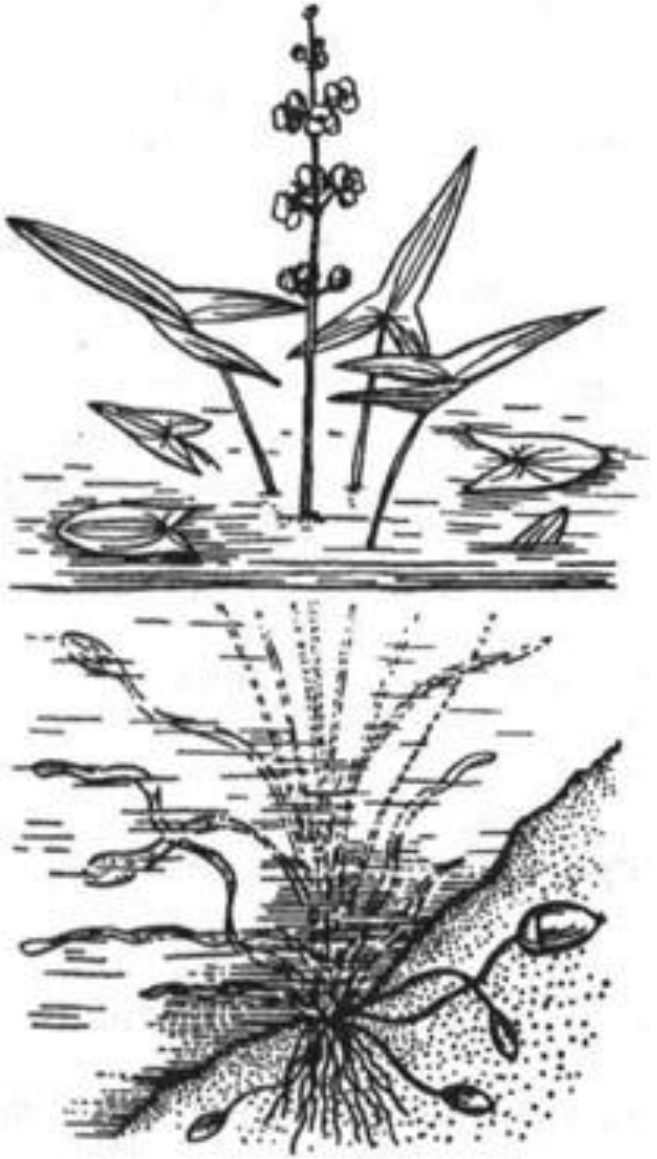
Whorled

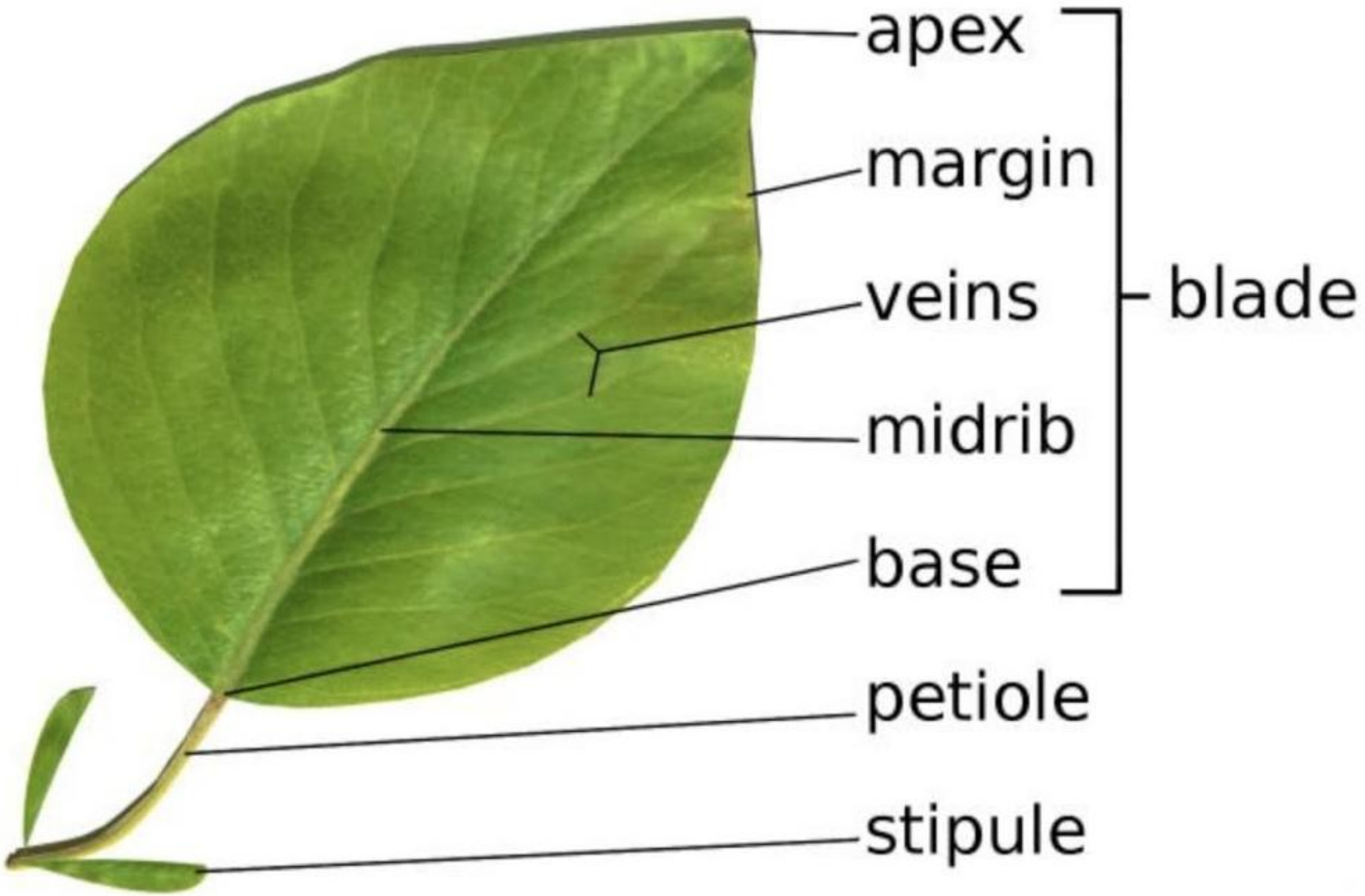

normophylls
cataphylls
hypsophylls

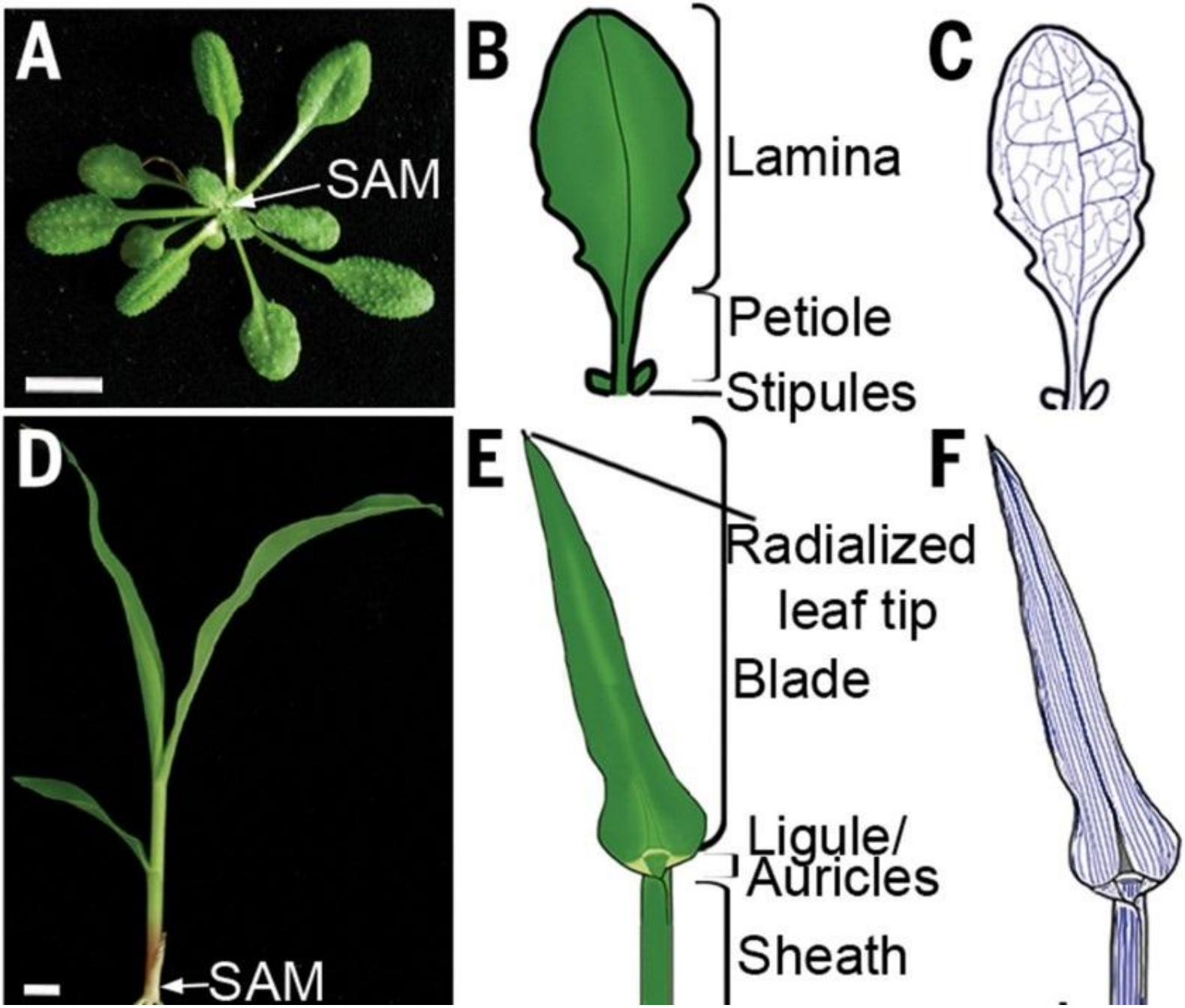
The heterophylly

244. Batrachium aquatile E. Meyer. Gemeiner Wasserranunkel.

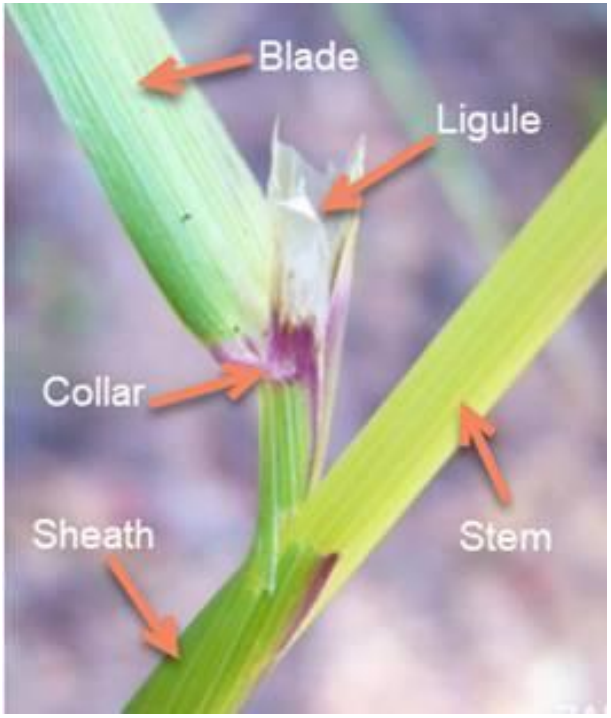
Sagittaria sagittifolia




apex
margin
veins
midrib
base
petiole
stipule
blade

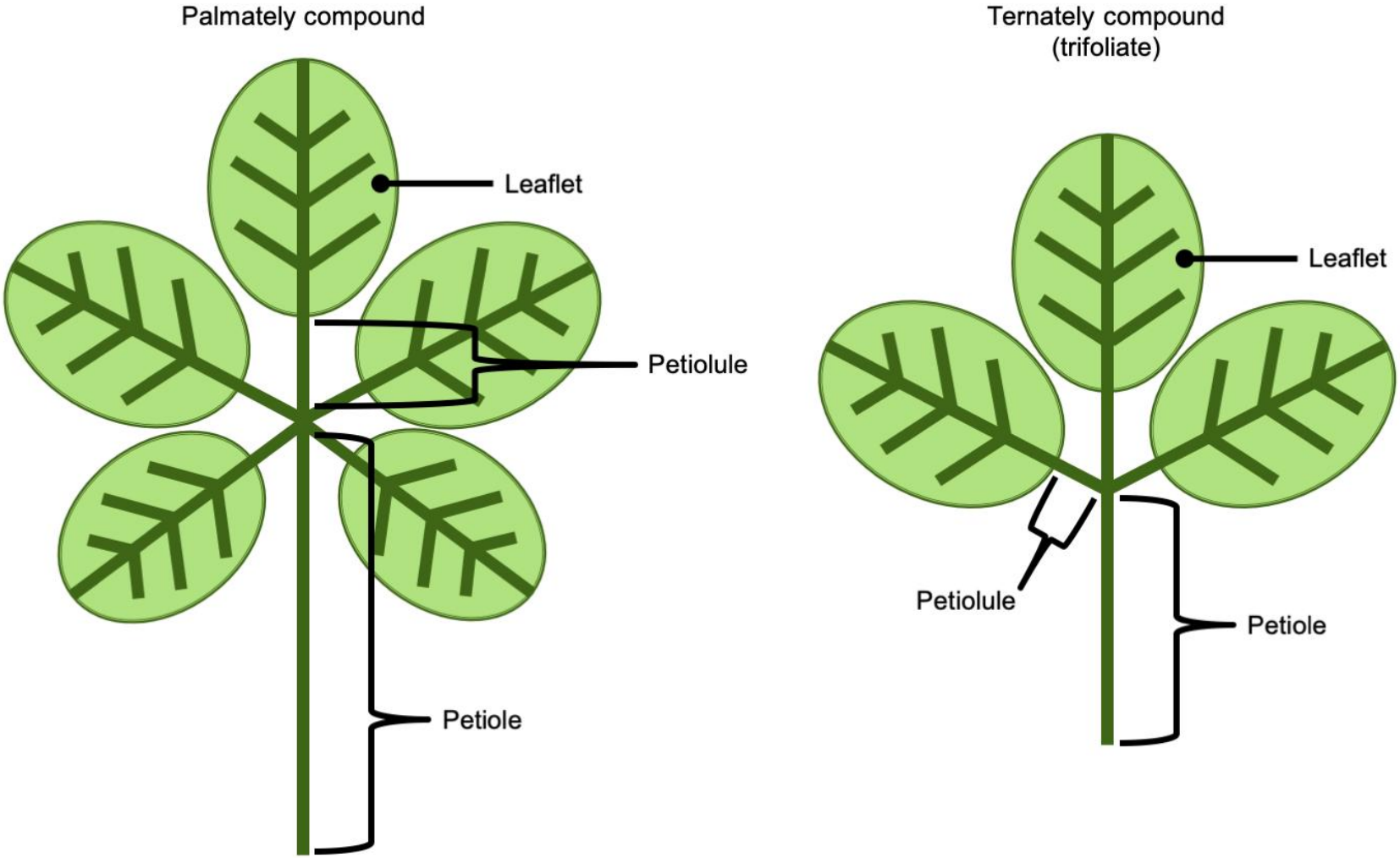

A
SAM
B
Lamina
Petiole
Stipules
C
D
SAM
E
Radialized
leaf tip
Blade
Ligule/
Auricles
Sheath
F

The leaf with stipules

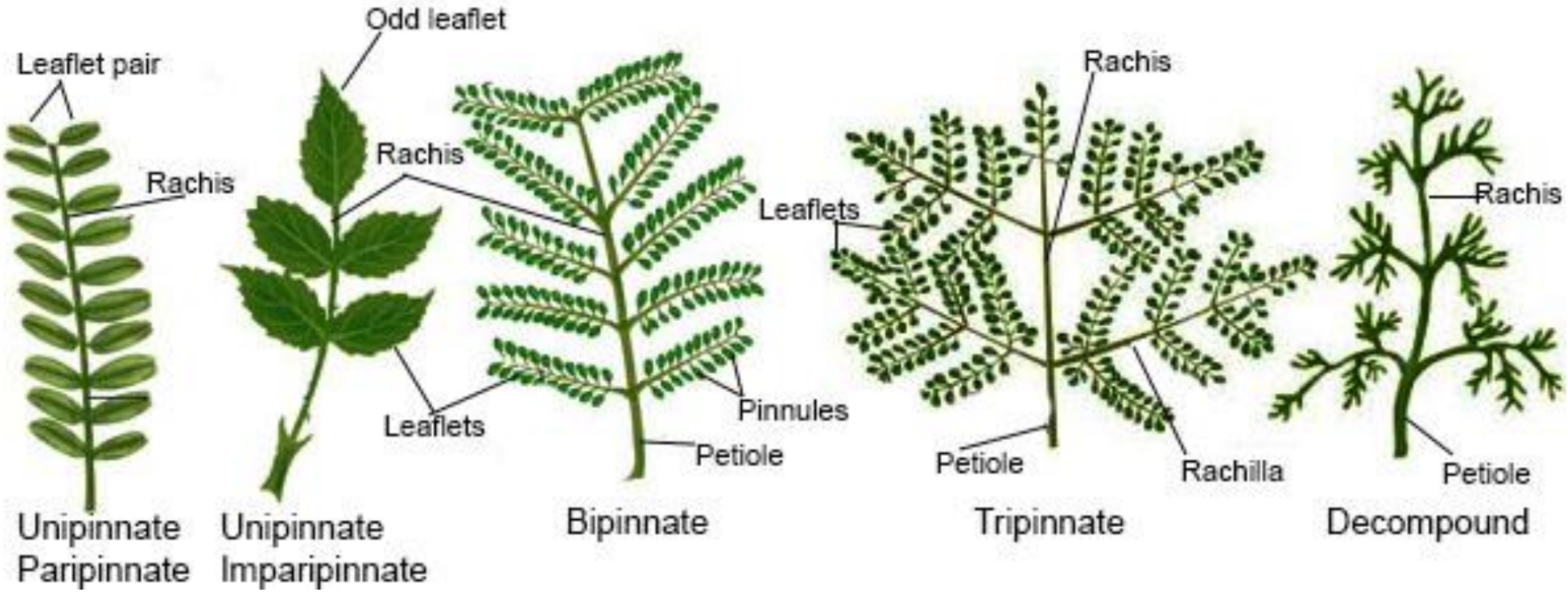


The leaf with sheath

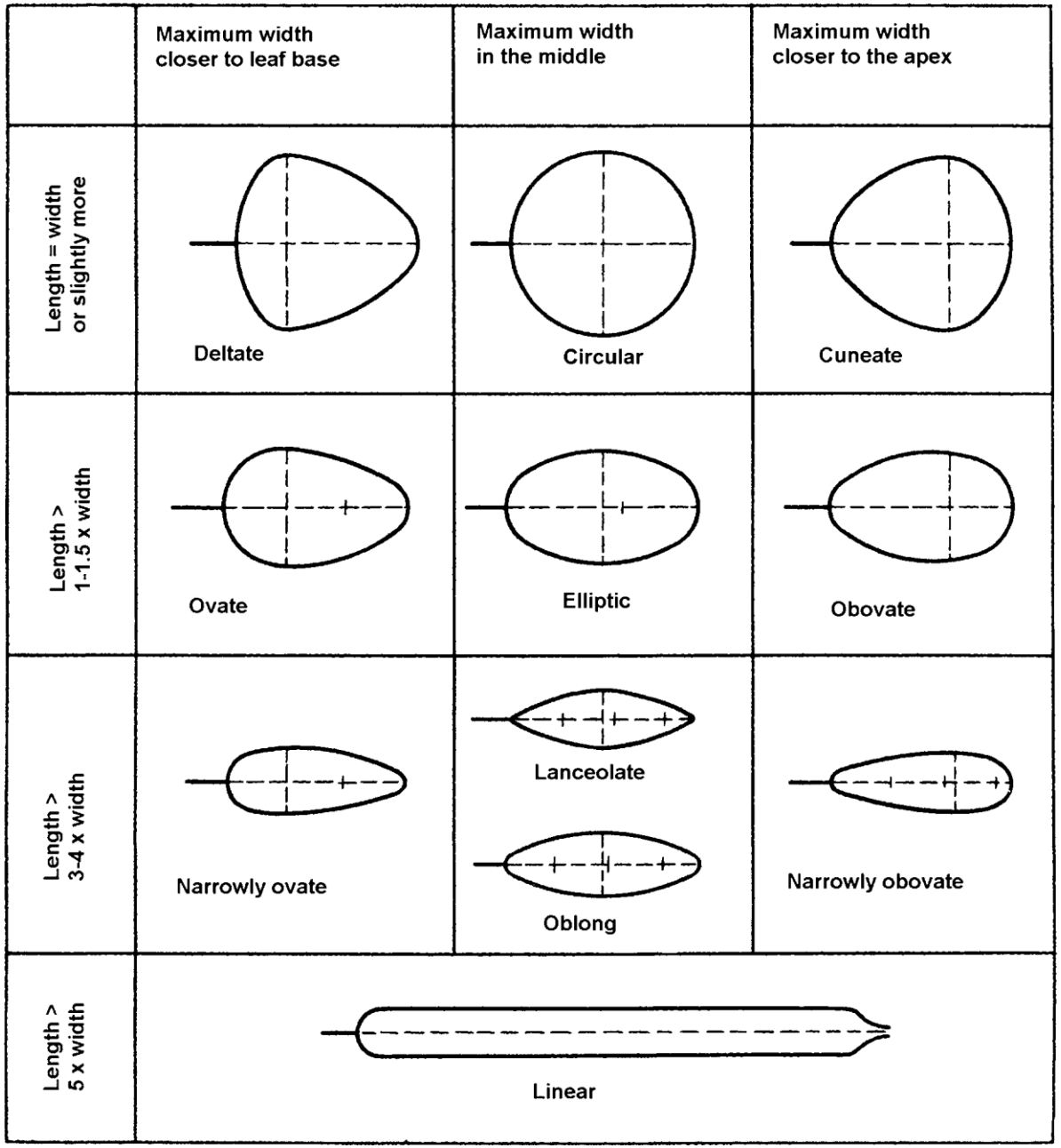
The leaf with ocrea

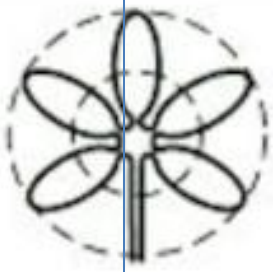
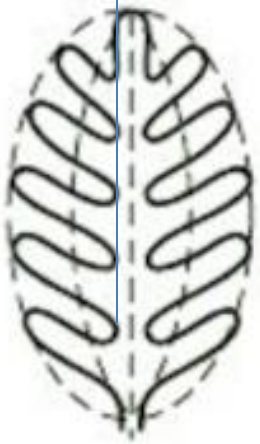

Palmately compound
Leaflet
Petiolule
Petiole
Ternately compound
(trifoliate)
Leaflet
Petiolule
Petiole

Pinnately compound leaf

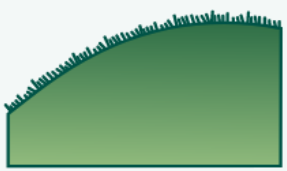


Leaf shapes.


Maximum width closer to leaf base
Maximum width in the middle
Maximum width closer to the apex
Length = width or slightly more
Length > 1-1.5 x width
Length > 3-4 x width
Length > 5 x width
Deltate
Circular
Cuneate
Ovate
Elliptic
Obovate
Lanceolate
Narrowly ovate
Oblong
Narrowly obovate
Linear

	Lobes (segmented less then half the width of the half blade)	**Partite** (segmented more then half the width of the half blade)	**Dissected** (segmented to the middle of the vein)
Trifoliate			
Palmately			
Pinnately			

MARGIN

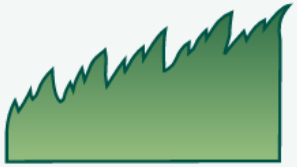


Ciliate
with fine hairs

Crenate
with rounded teeth

Dentate
with symmetrical teeth

Denticulate
with fine dentition



Doubly Serrate
serrate with sub-teeth

Entire
even, smooth throughout

Lobate
indented, but not to midline

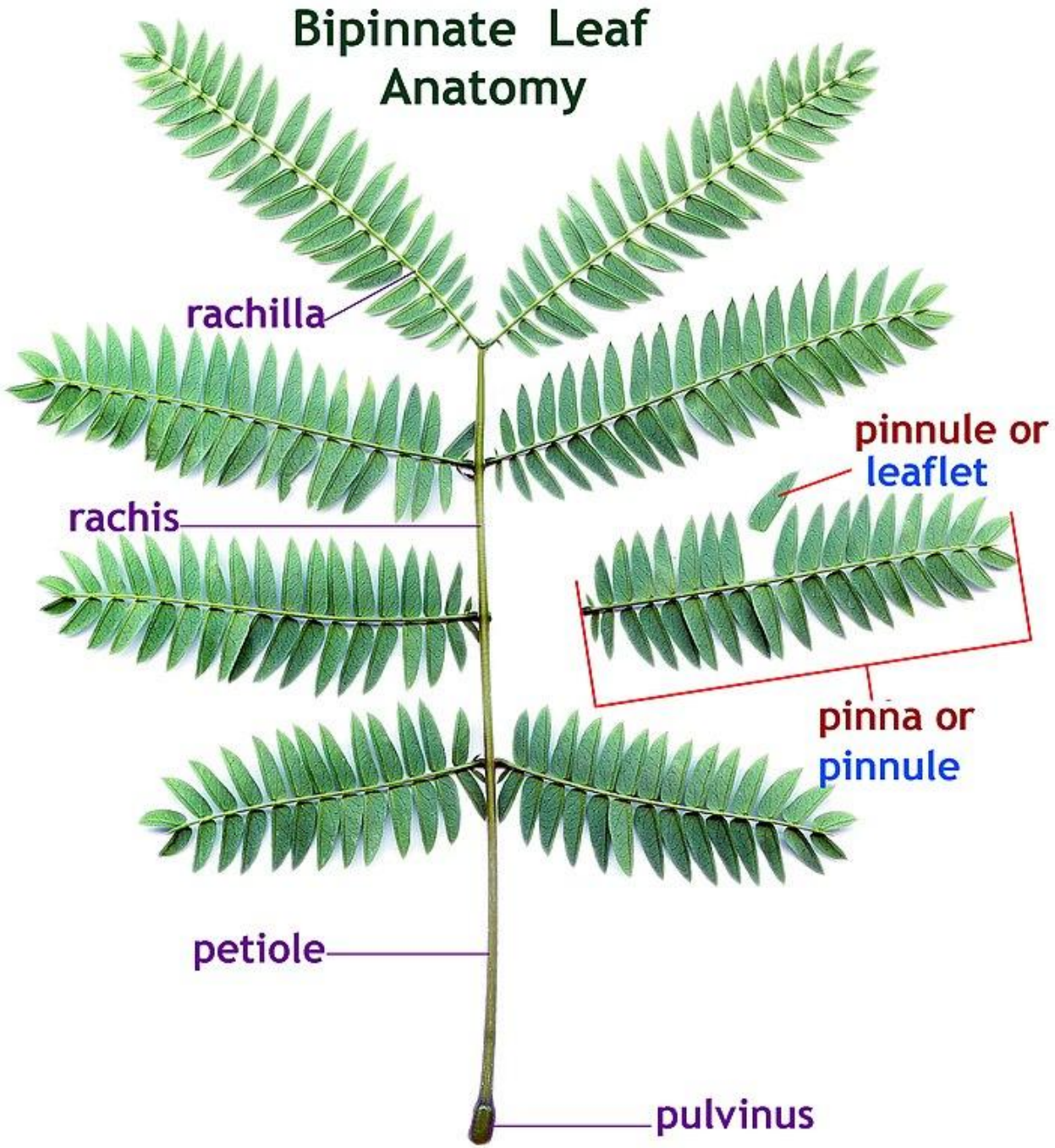
Serrate
teeth forward-pointing

Serrulate
with fine serration

Sinuate
with wave-like indentations

Spiny
with sharp stiff points

Undulate
widely wavy


Bipinnate Leaf
Anatomy
rachilla
pinnule or
leaflet
rachis
pinna or
pinnule
petiole
pulvinus

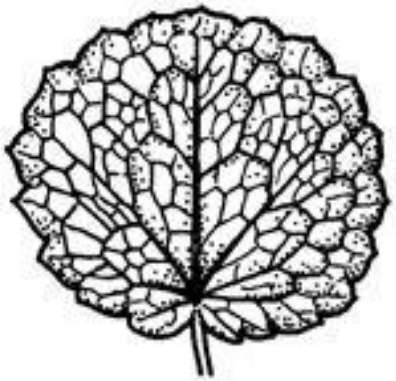
VENATION

ARCUATE

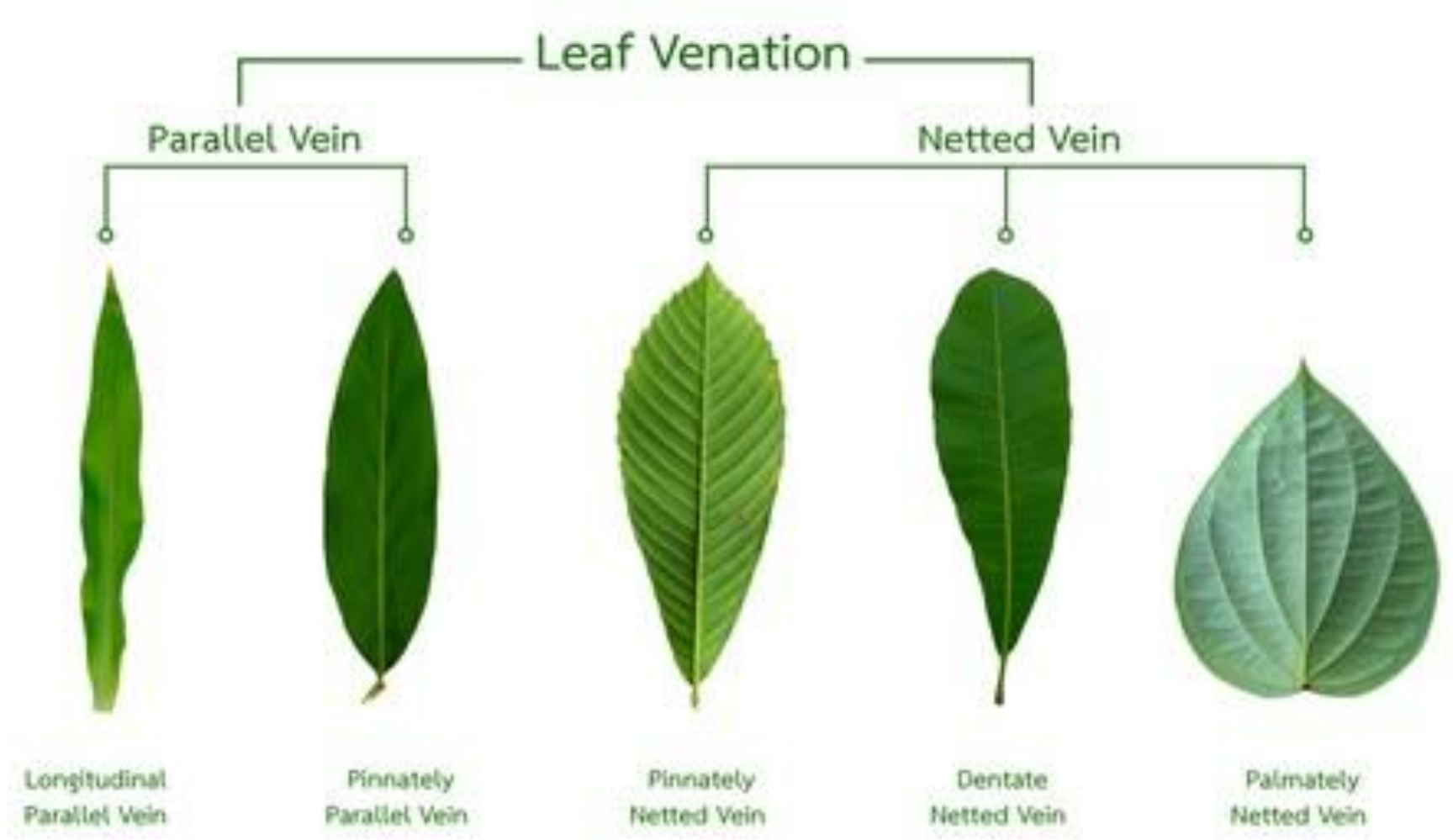
PALMATE

PARALLEL

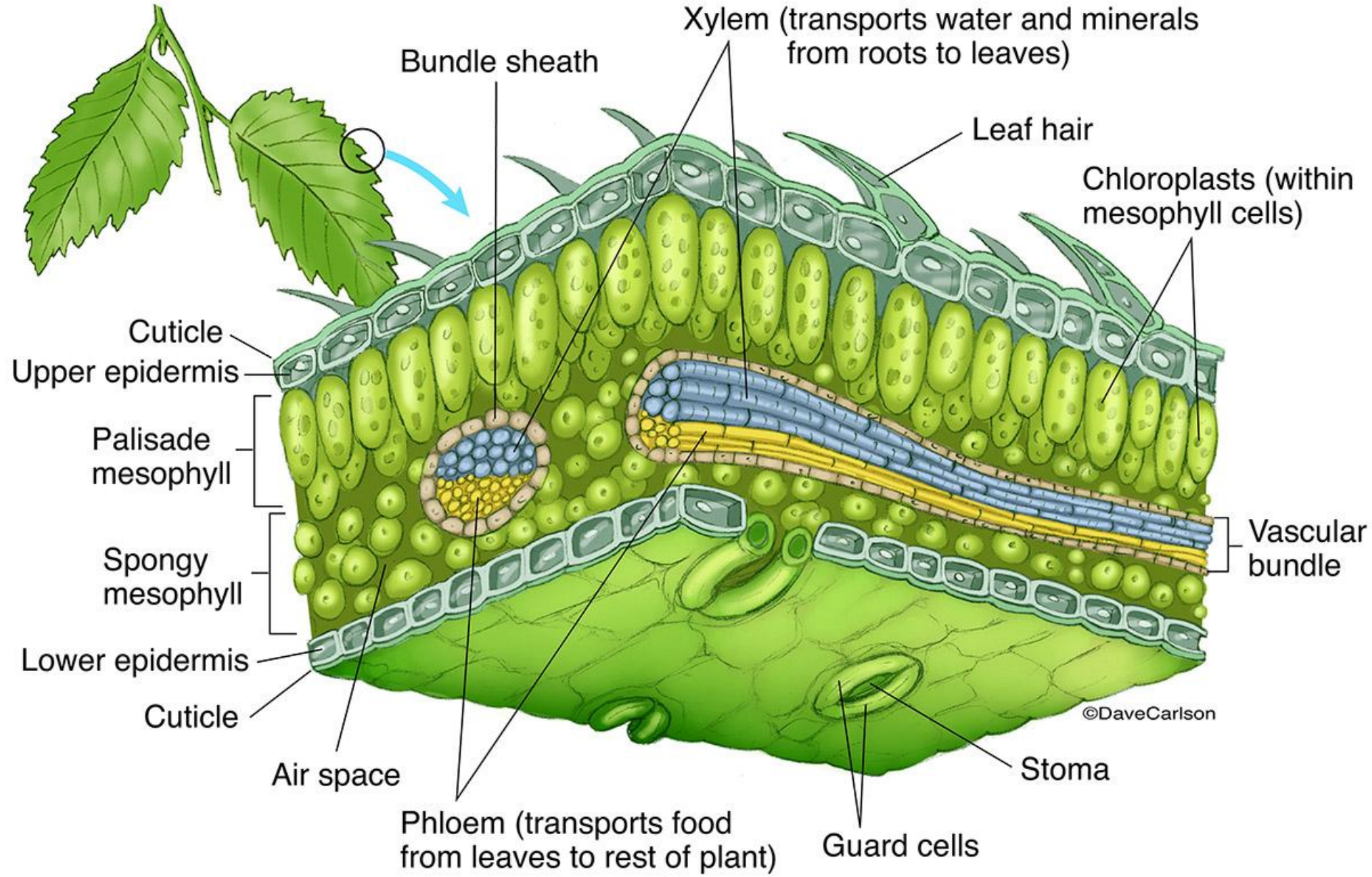
PINNATE

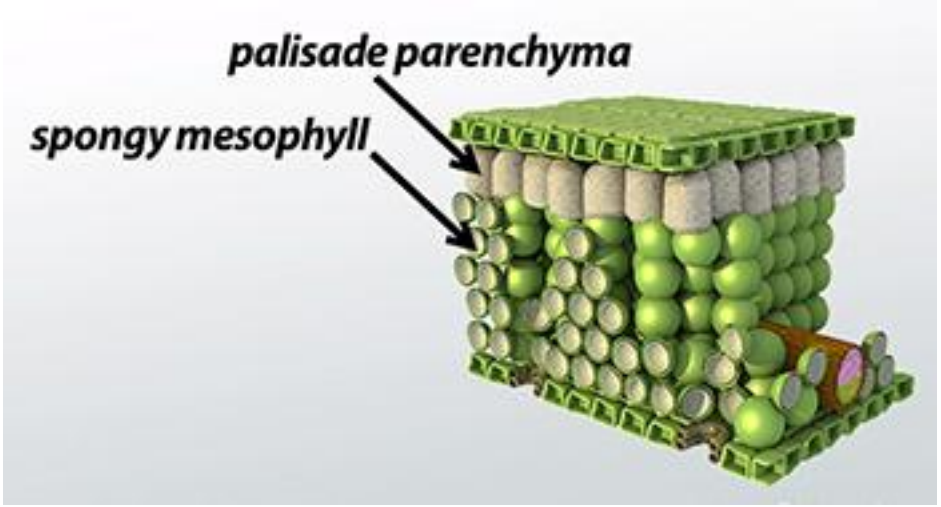


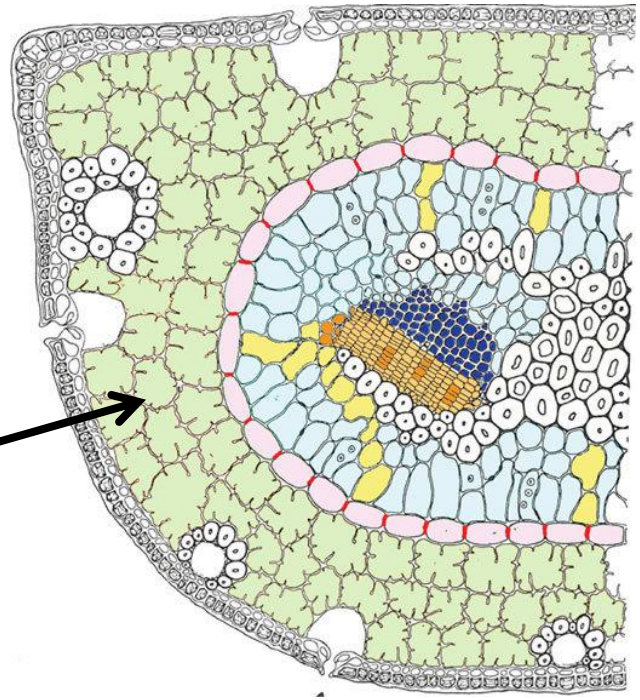
RETICULATE


Leaf Venation
Parallel Vein
Netted Vein
Longitudinal Parallel Vein
Pinnately Parallel Vein
Pinnately Netted Vein
Dentate Netted Vein
Palmately Netted Vein

Anatomical structure of the leaf.



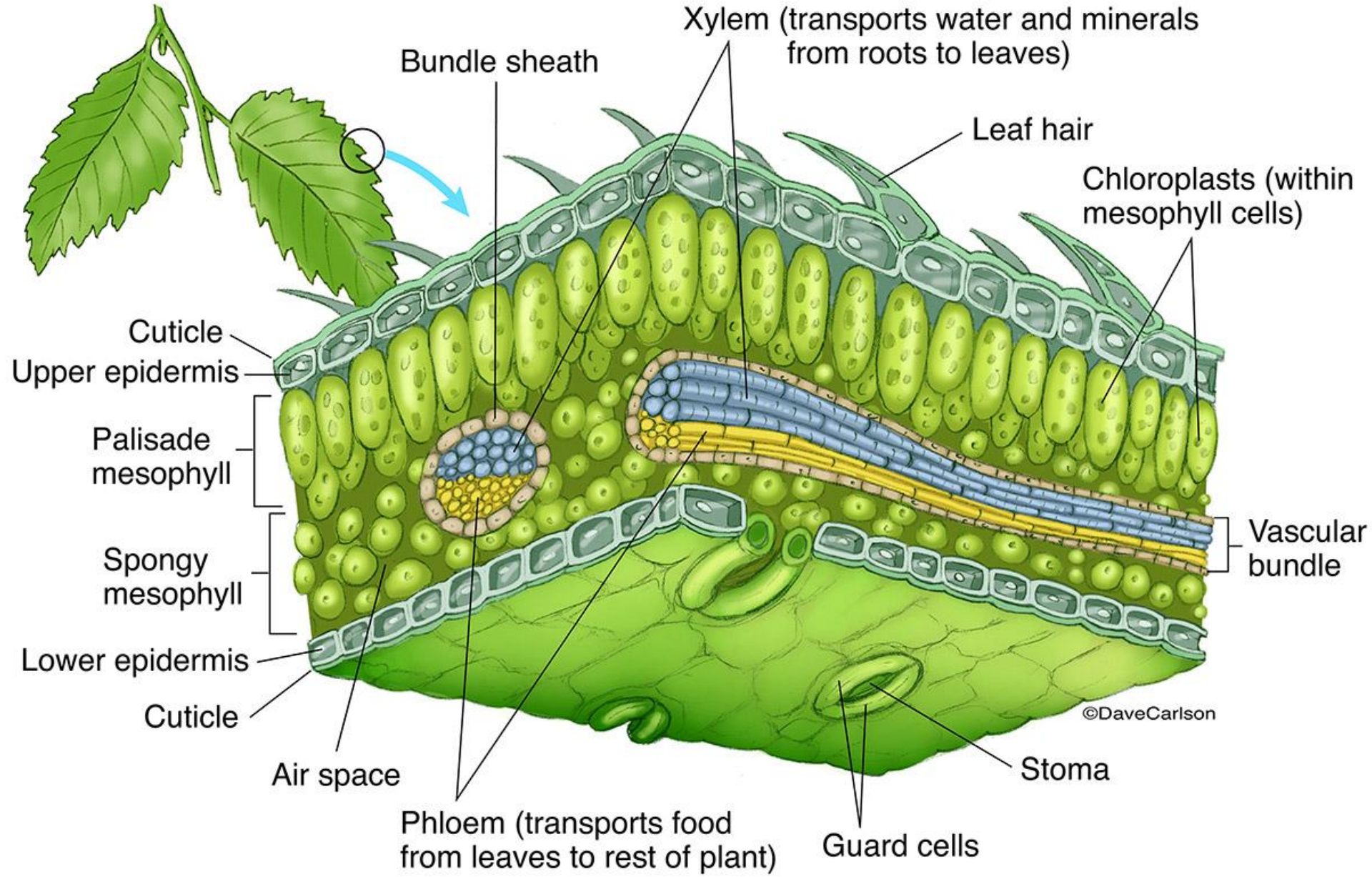




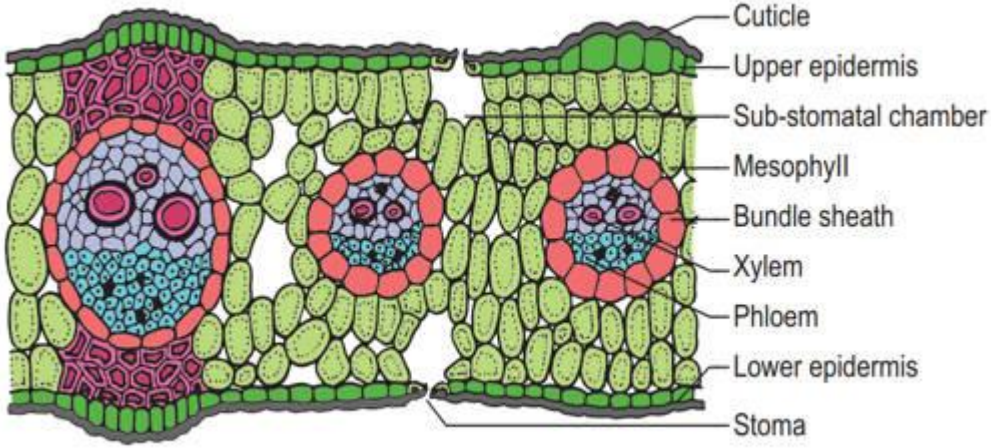
infolded mesophyll

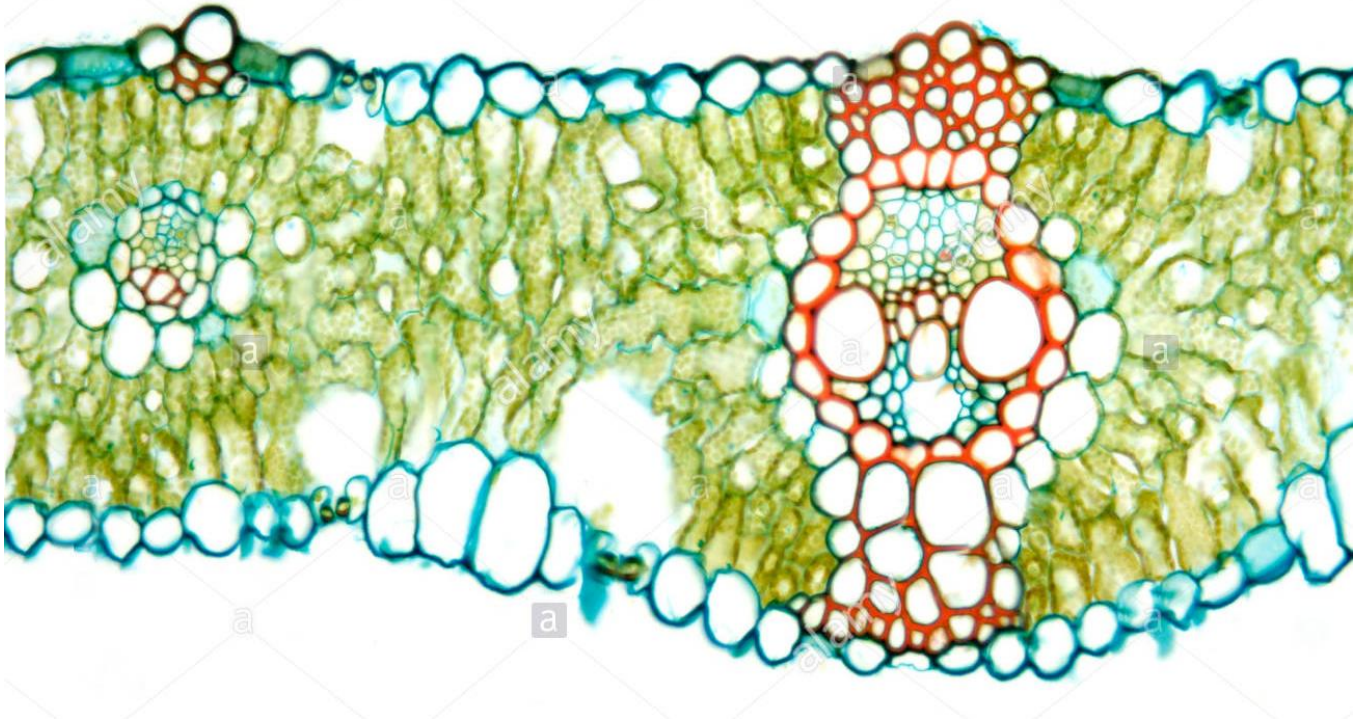
Dorsoventral leaf

Anatomical structure of the dorsoventral leaf.

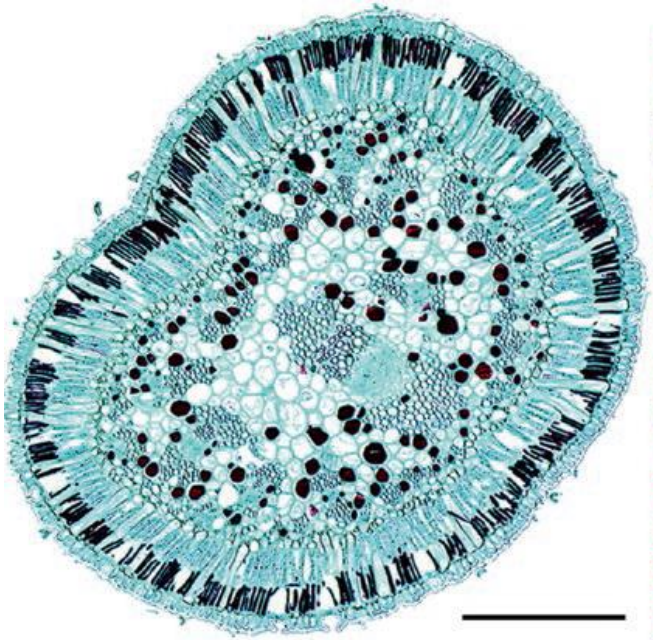


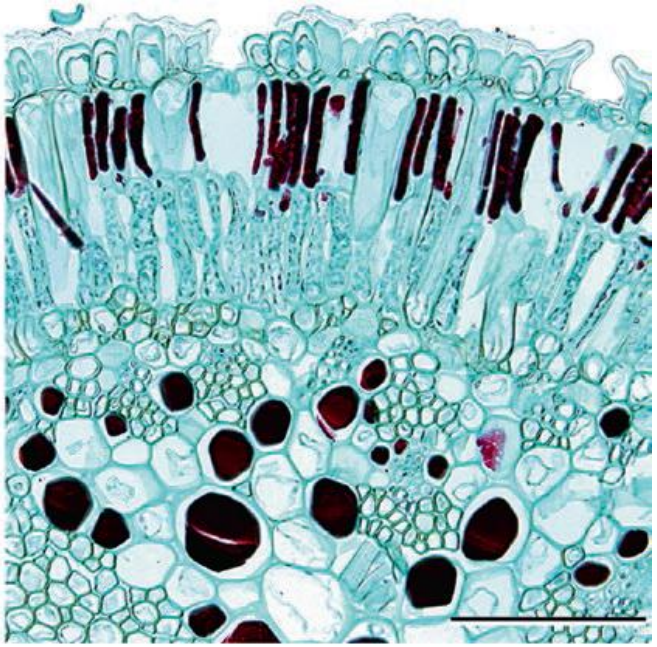
Isolateral leaves

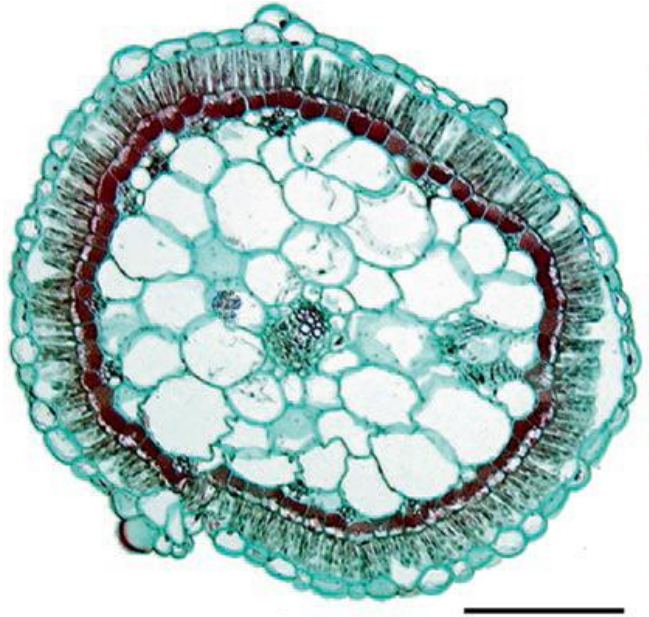

Cuticle
Upper epidermis
Sub-stomatal chamber
Mesophyll
Bundle sheath
Xylem
Phloem
Lower epidermis
Stoma

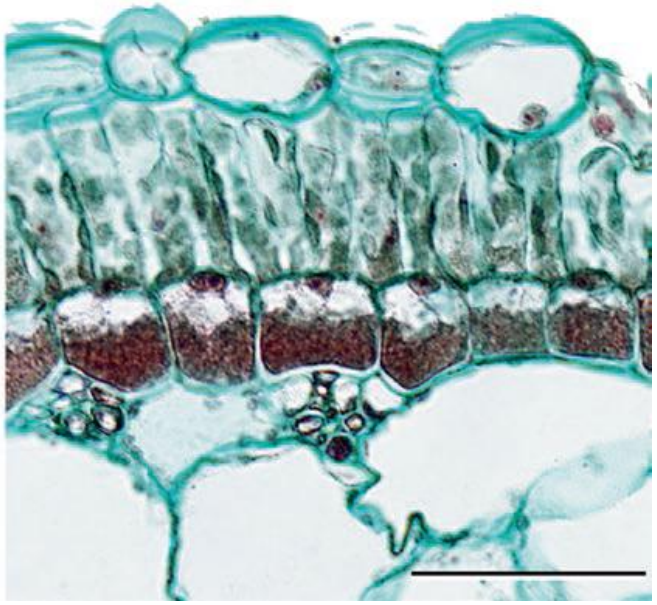


Radial leaves

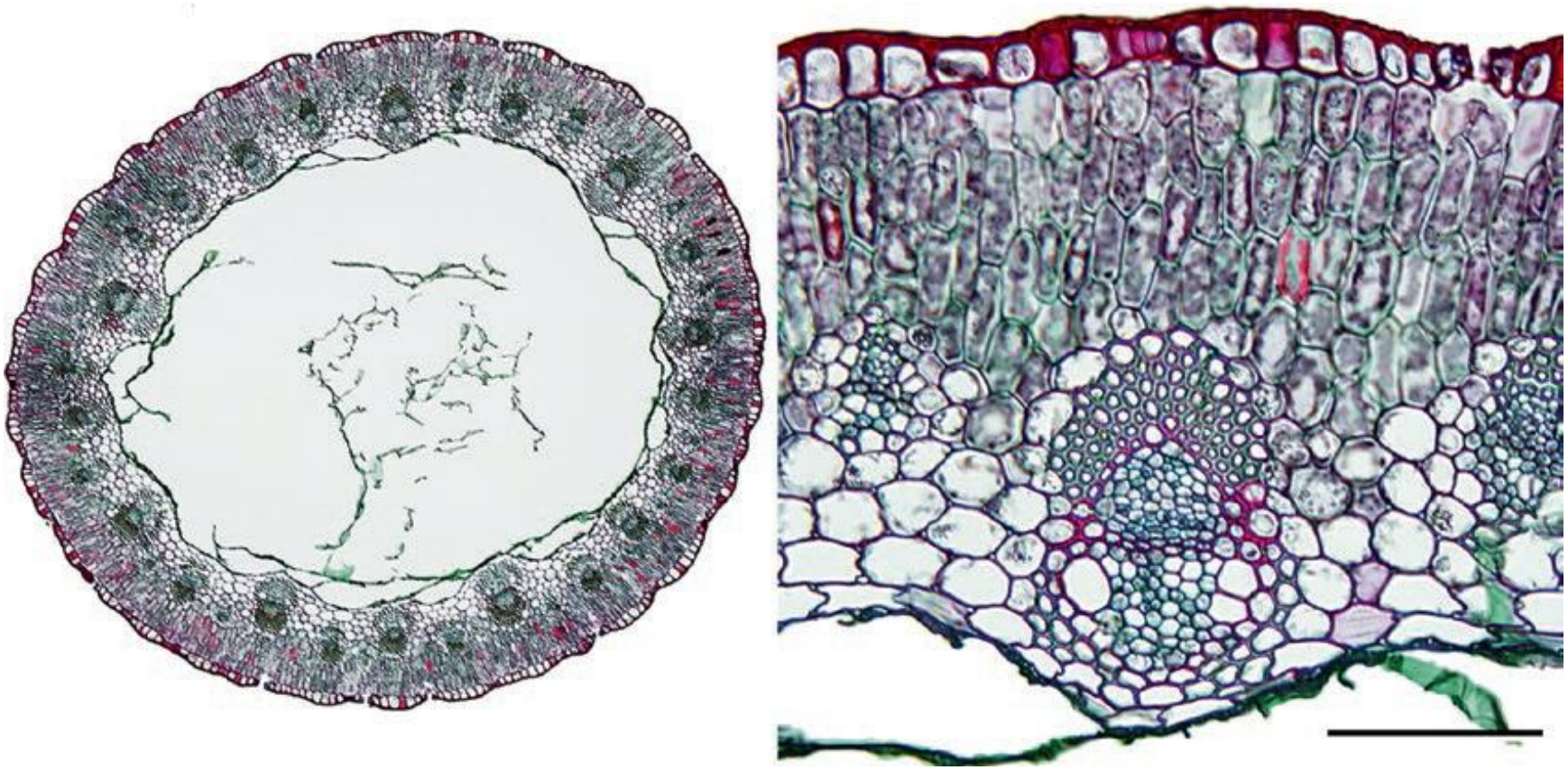






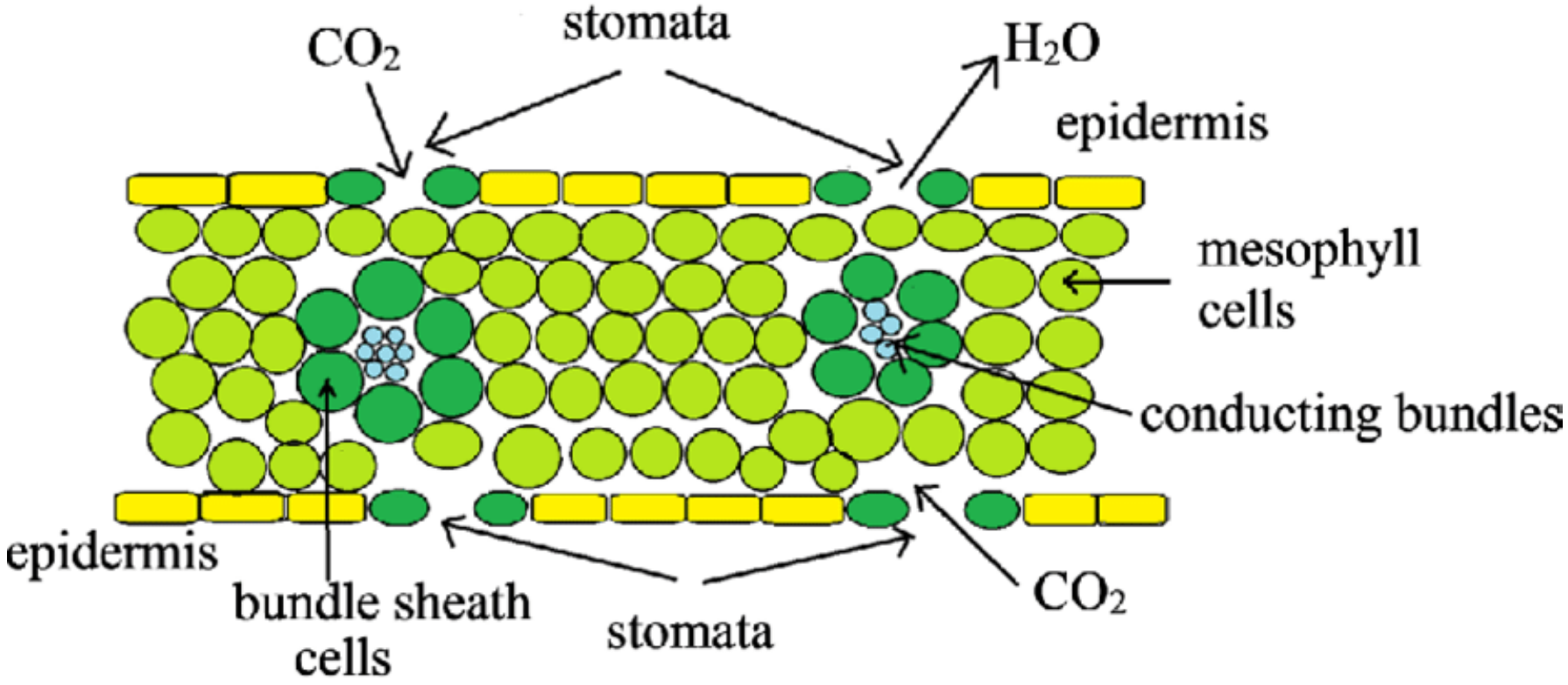


Eudicot centric leaves. m, n Sweet hakea (*Hakea drupacea*) has a double layer of palisade parenchyma surrounding a central core of parenchyma with small vascular bundles scattered throughout. o, p The saltwort (*Salsola* sp.) centric leaf has a single layer of palisade cells to the exterior of a dense bundle sheath. Scattered minor bundles lie just inside the bundle sheath. A larger major bundle sits at the center of the water-storing parenchyma.
Scale bars = 250 µm in m, 100 µm in n and o, and 25 µm in p (m–p RR Wise)

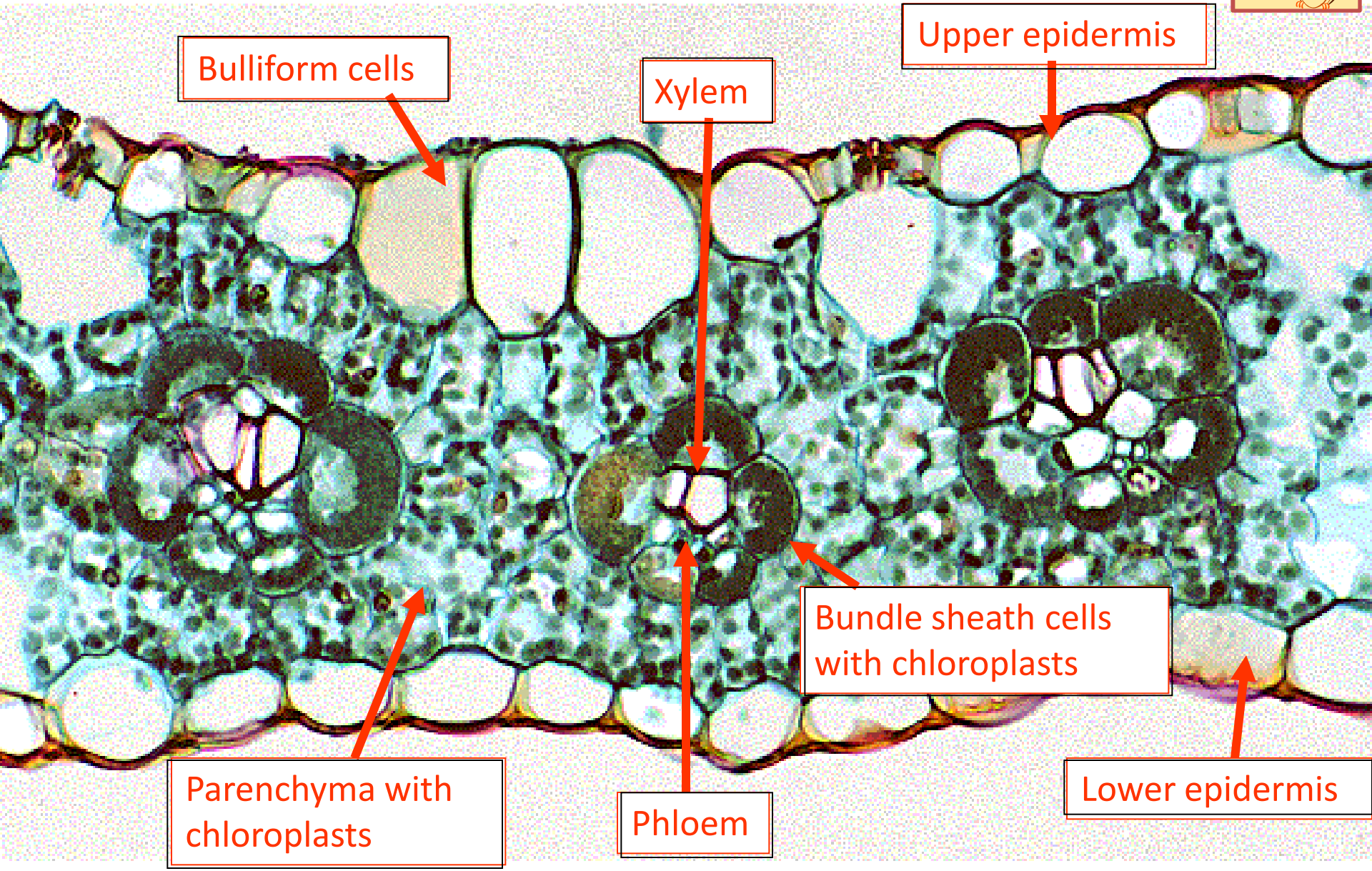


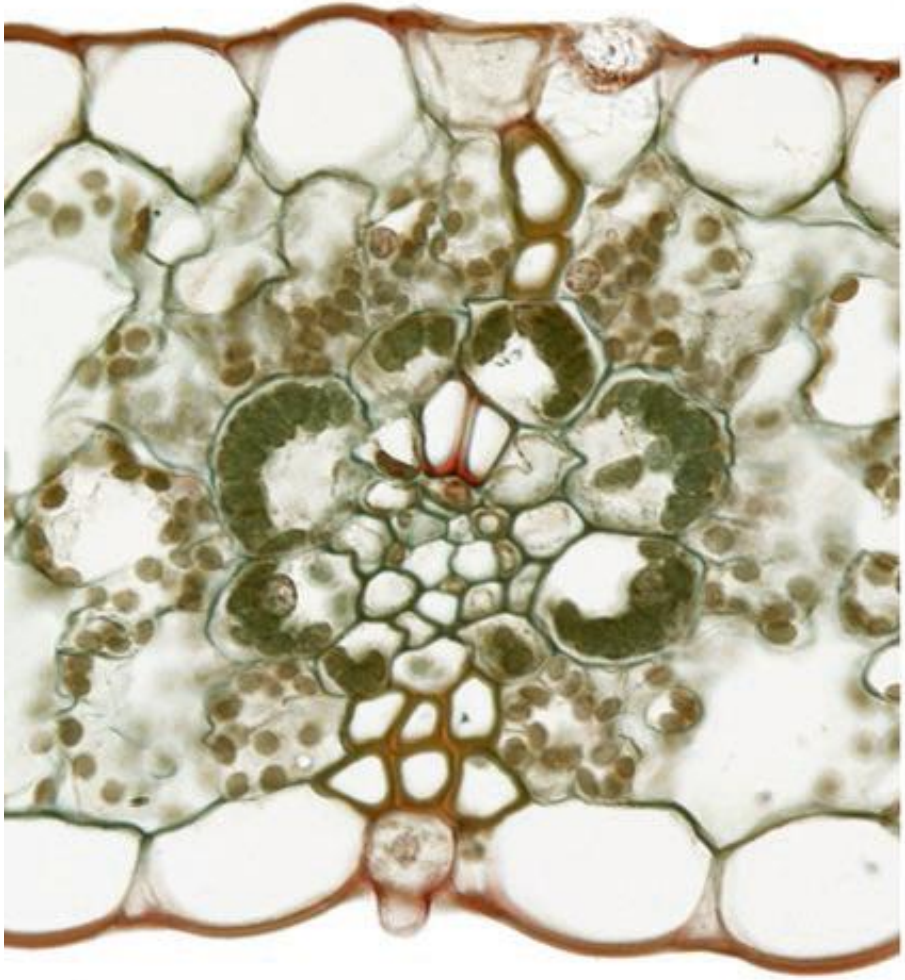
q, r Tubular leaf of bulrush (*Juncus* sp.). Scale bars = 250 μm in q and 50 μm in r (q, r RR Wise)

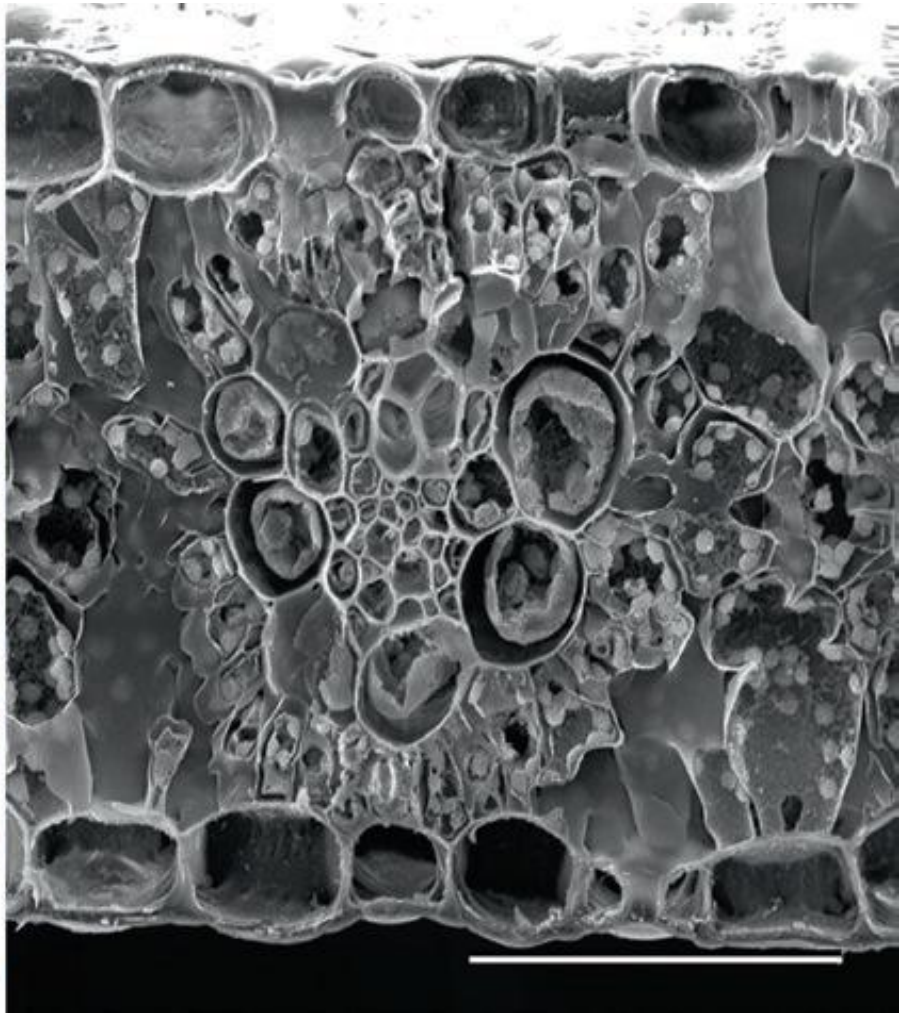
Leaf with Kranz anatomy structure



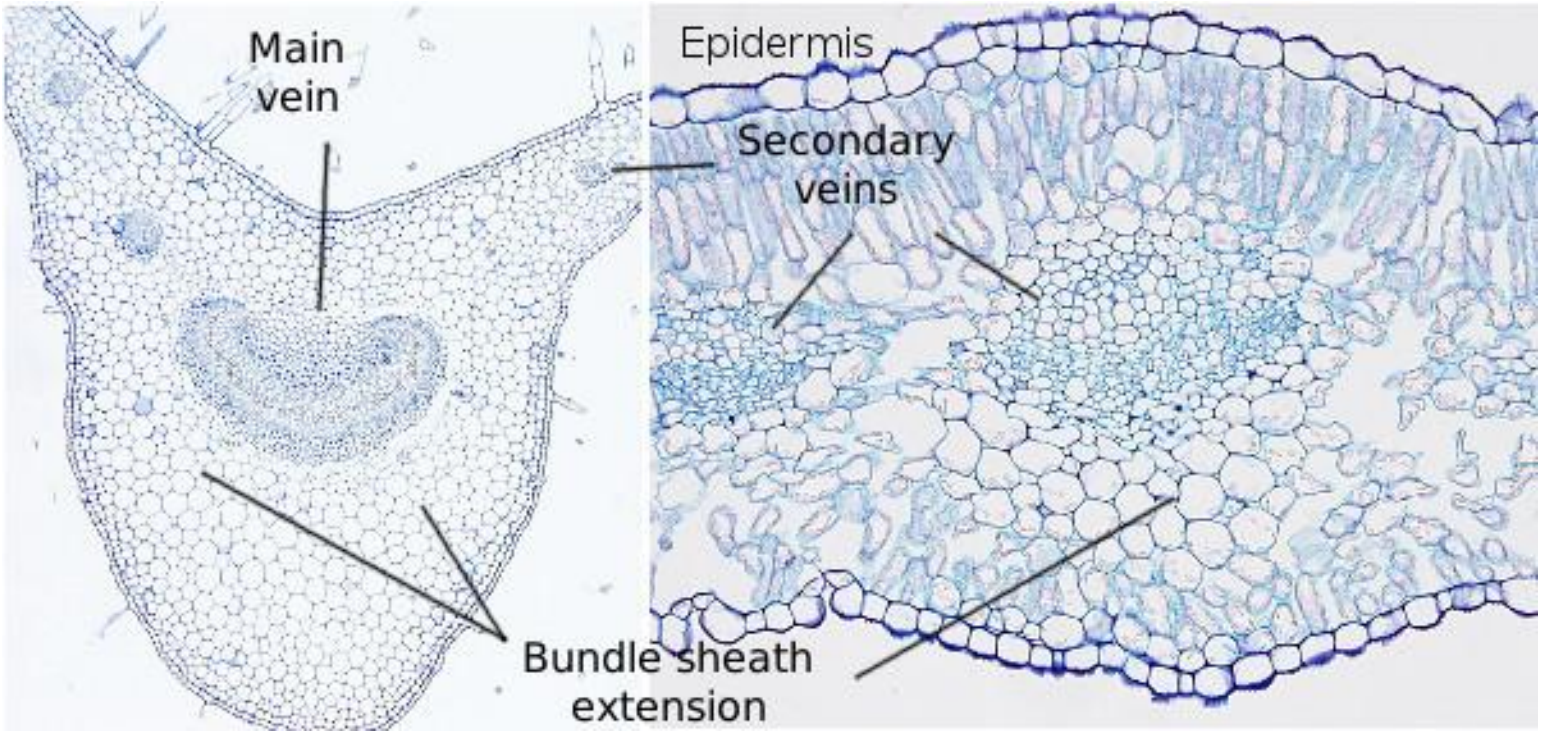
Leaf cross section of *Zea mays* (corn), monocotyledon, C4 plant

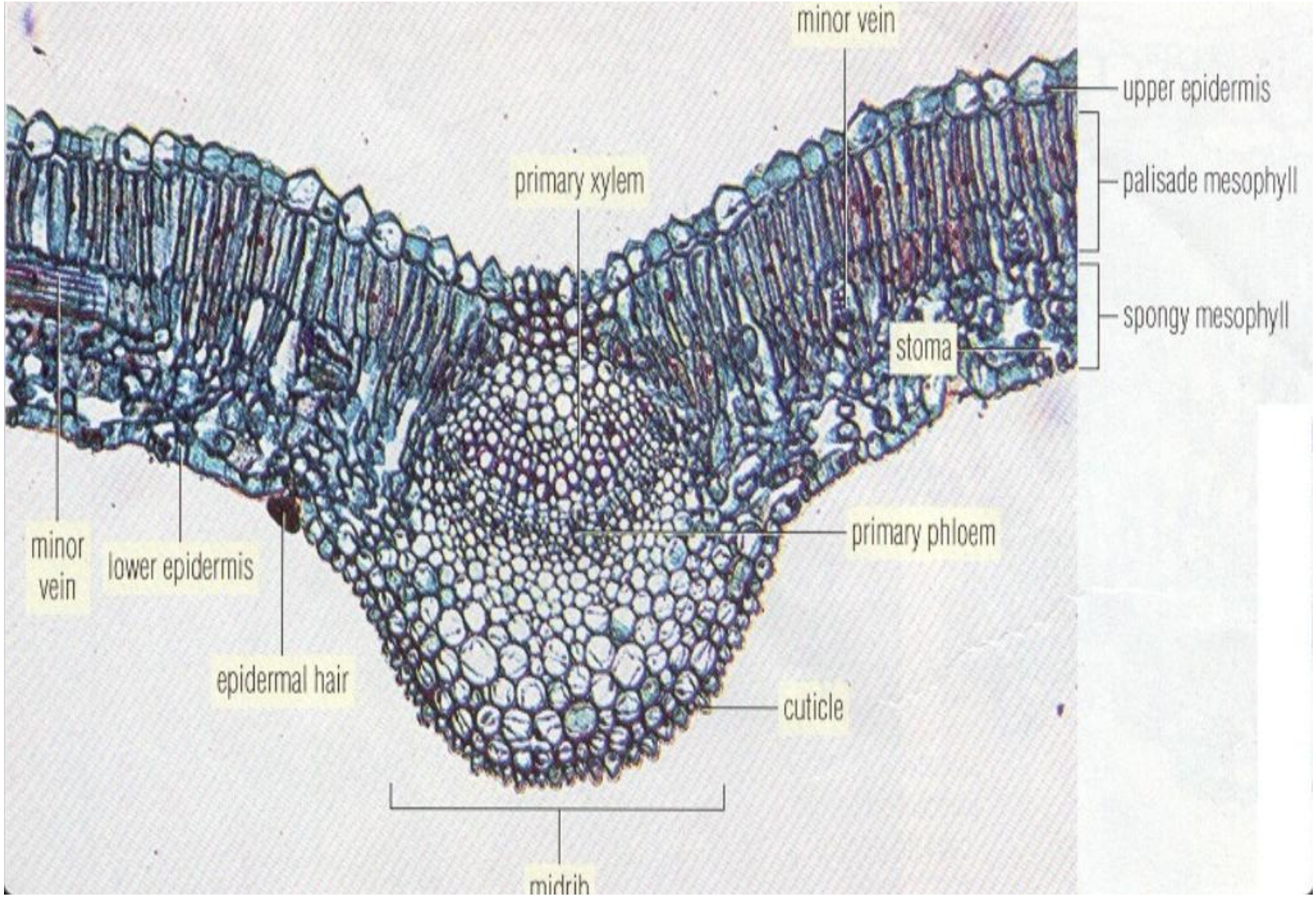


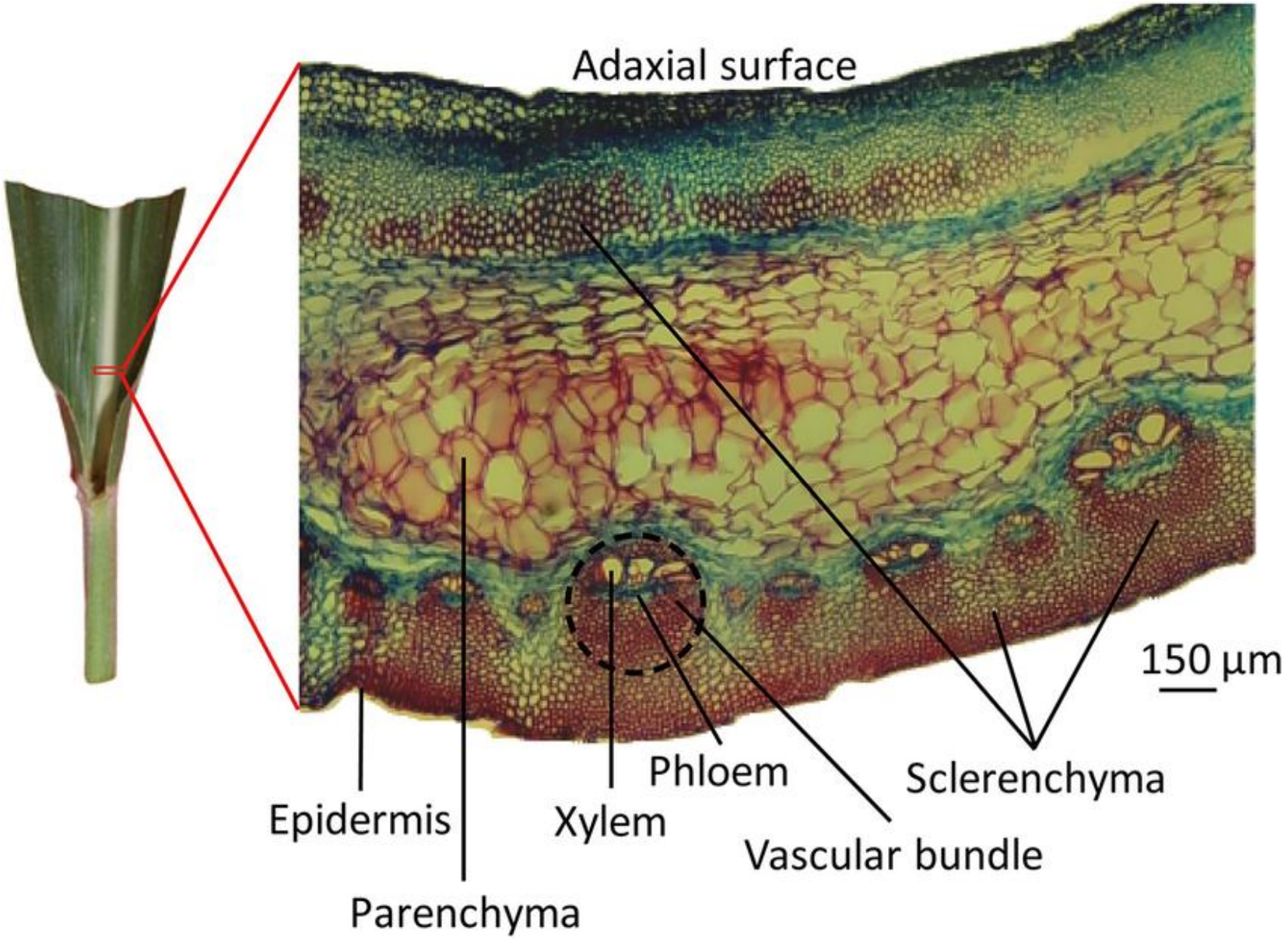


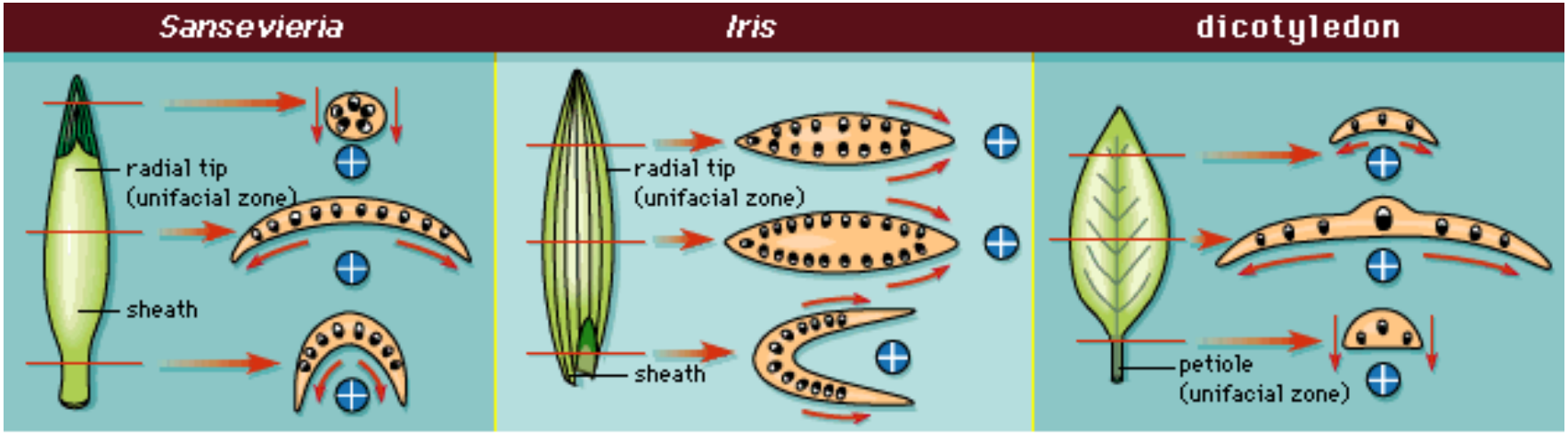


Leaf cross section of *Zea mays*


Main vein
Epidermis
Secondary veins
Bundle sheath extension

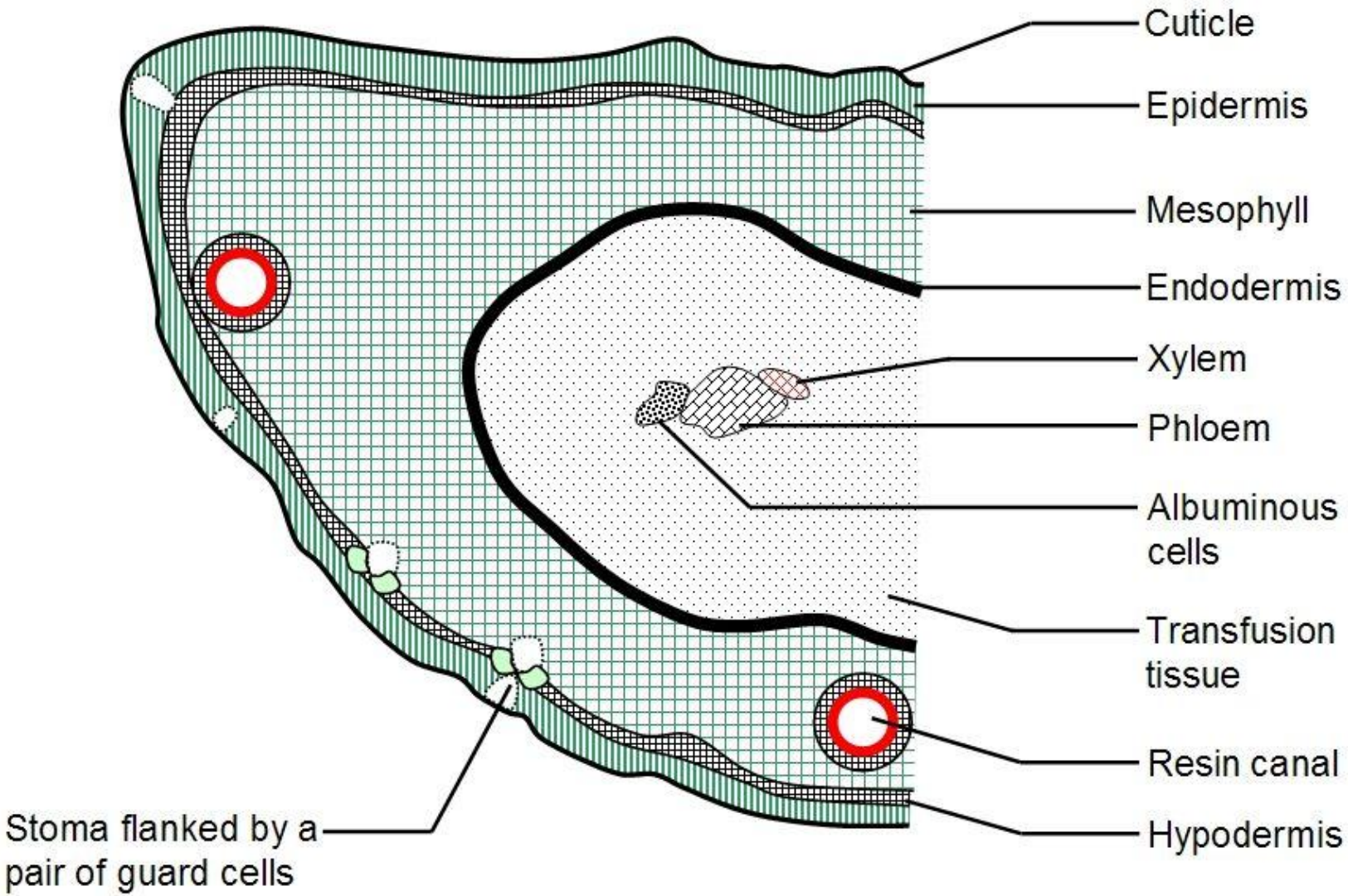

minor vein
upper epidermis
palisade mesophyll
primary xylem
spongy mesophyll
stoma
primary phloem
minor vein
lower epidermis
epidermal hair
cuticle
midrib


Adaxial surface
150 µm
Epidermis
Parenchyma
Xylem
Phloem
Vascular bundle
Sclerenchyma

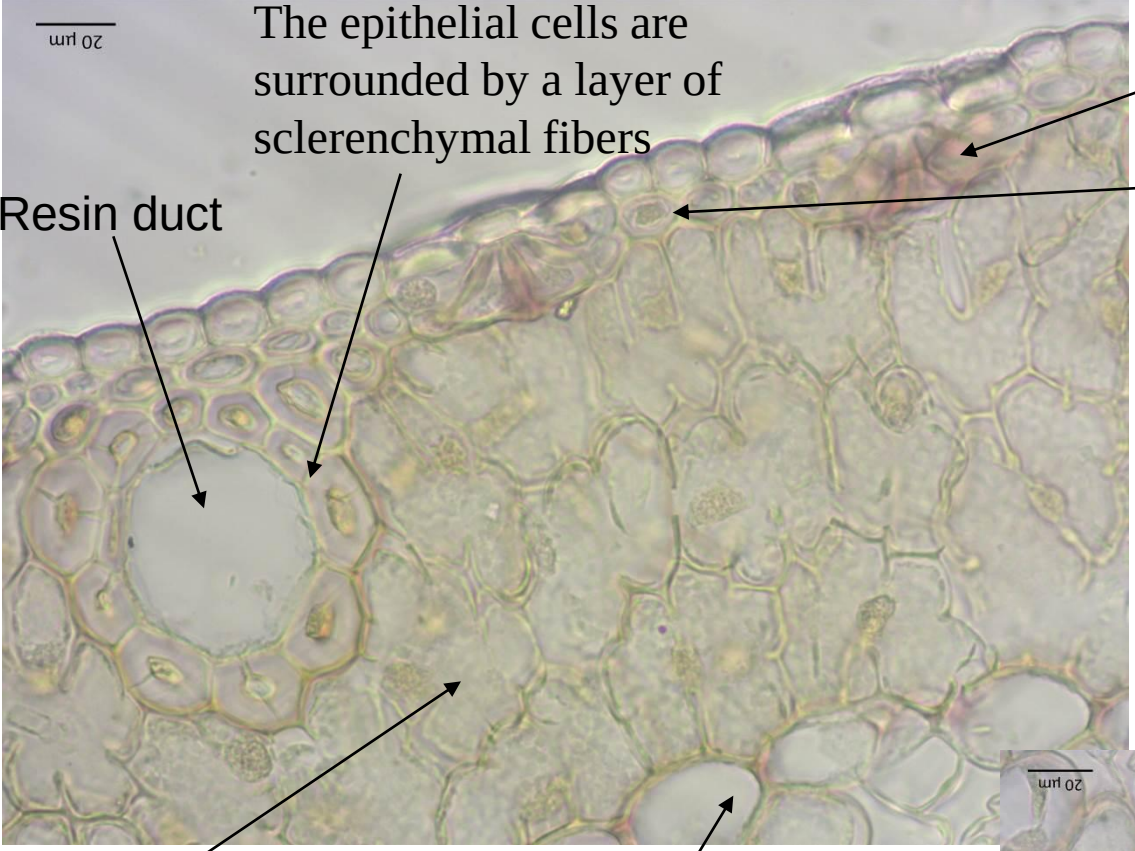


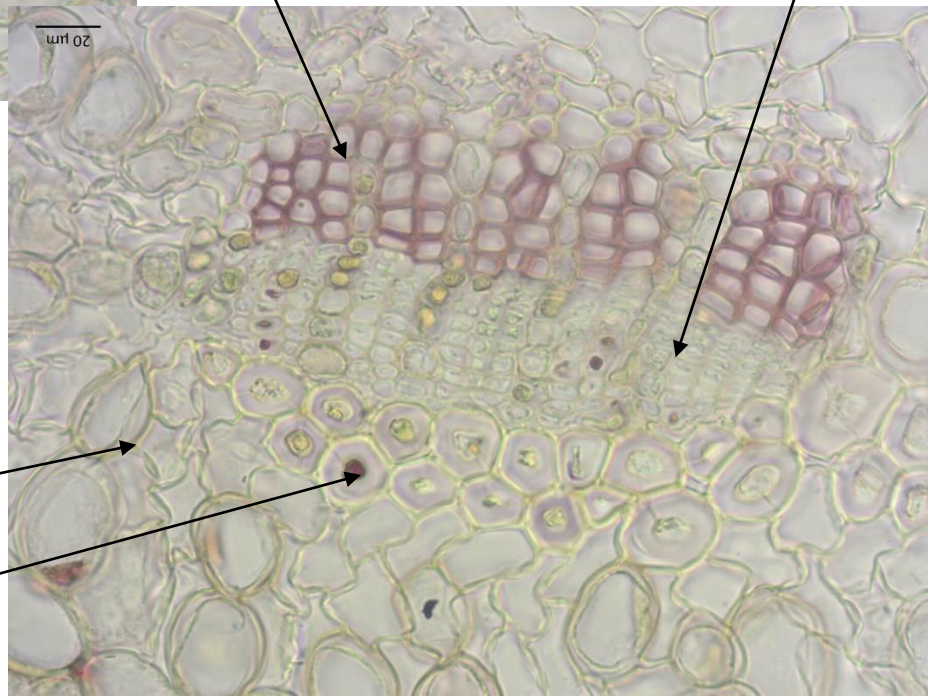
In *Sansevieria*, apical and marginal growth cease early in leaf development in favour of radial development from a meristem on the face of the leaf nearest to the stem (adaxial meristem). Cell division from marginal meristems pushes the direction of lamina development outward (middle transection) and then from adaxial meristems into a collarlike structure (topmost transection). At the base of the *Iris* leaf, cell division takes place in both directions, during which the leaf begins to encircle the stem. Marginal growth in the upper part of the developing leaf is suppressed in favour of development from adaxial meristems. Radial development does not take place. In many dicotyledenous plants, a peglike protuberance develops near the origin of the leaf, which is often flattened on the adaxial side. Apical growth ceases early in favour of elongation of the central leaf axis at the two margins (middle transection), during which the lamina expands laterally. Throughout, vascular bundles are the shaded circles, xylem is shown in black, phloem in white, and stem placement in relation to the leaf is shown by a blue circle divided by a white cross. Direction of growth is indicated by arrows.

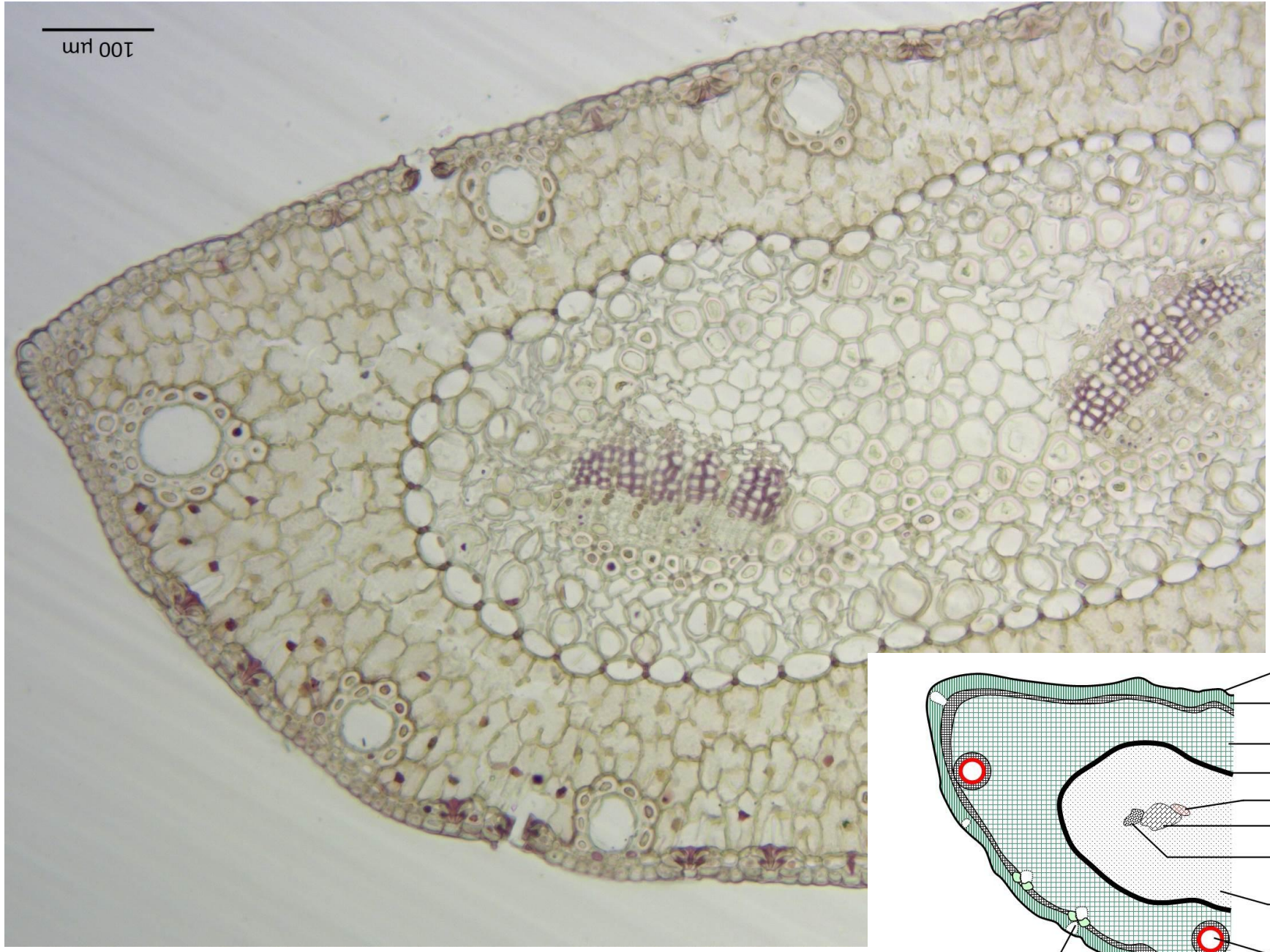
The structure of the leaf of conifers



Pinus sylvestris – leaf T.S. – tissue plan


20 µm
The epithelial cells are surrounded by a layer of sclerenchymal fibers
Stomata
Hypodermis
Resin duct
The folded parenchyma
Endoderm with Caspari spots


20 µm
Xylem
Phloem
Transfusion tissue
Sclerenchyma bands



Pinus sylvestris – leaf T.S. – tissue plan

https://www.youtube.com/watch?v=7xN4vyxeDTQ&t=21s