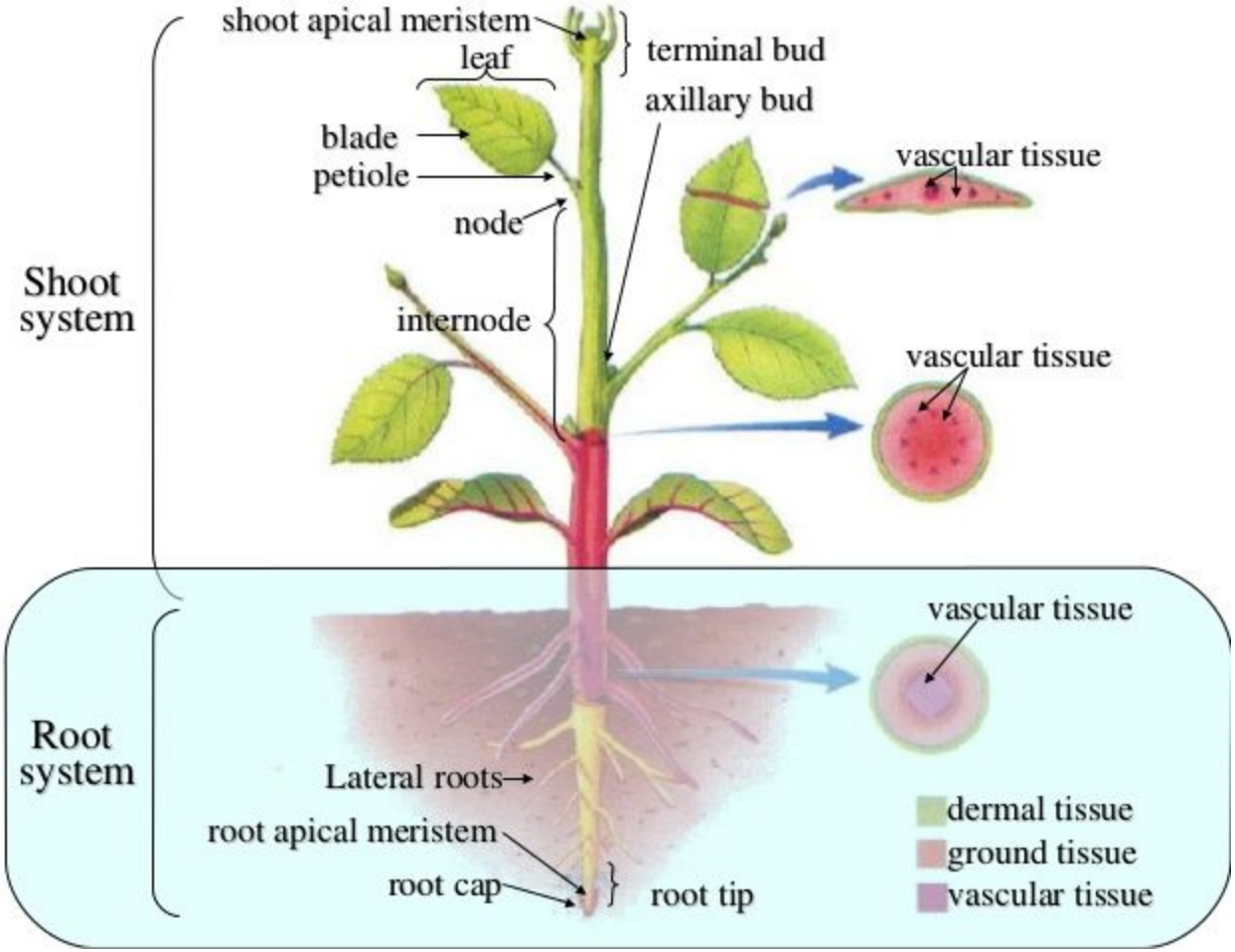
Plant Form and Function

Learning objectives

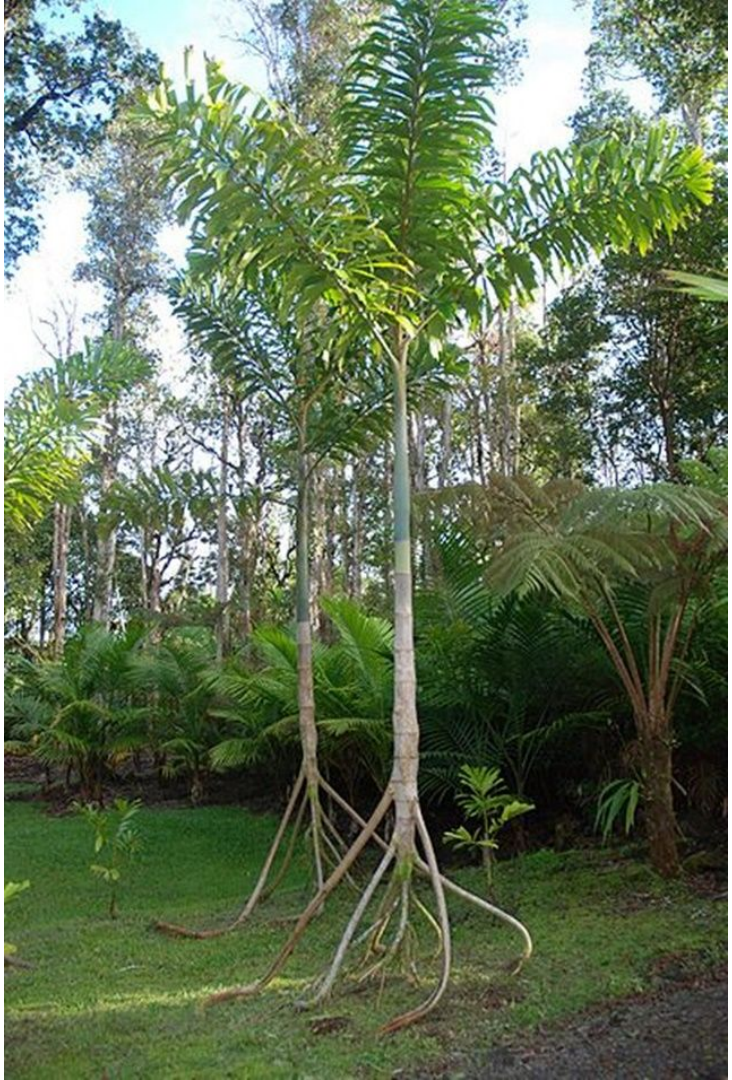
- Understand general plant anatomy
- Explore differences separating major groups of plants
- Understand the mechanisms plants use to transport water and nutrients


shoot apical meristem
leaf
terminal bud
axillary bud
blade
petiole
node
internode
vascular tissue
vascular tissue
Shoot system
vascular tissue
Root system
Lateral roots
root apical meristem
root cap
root tip
dermal tissue
ground tissue
vascular tissue

Stems

Roots

Specialized Roots

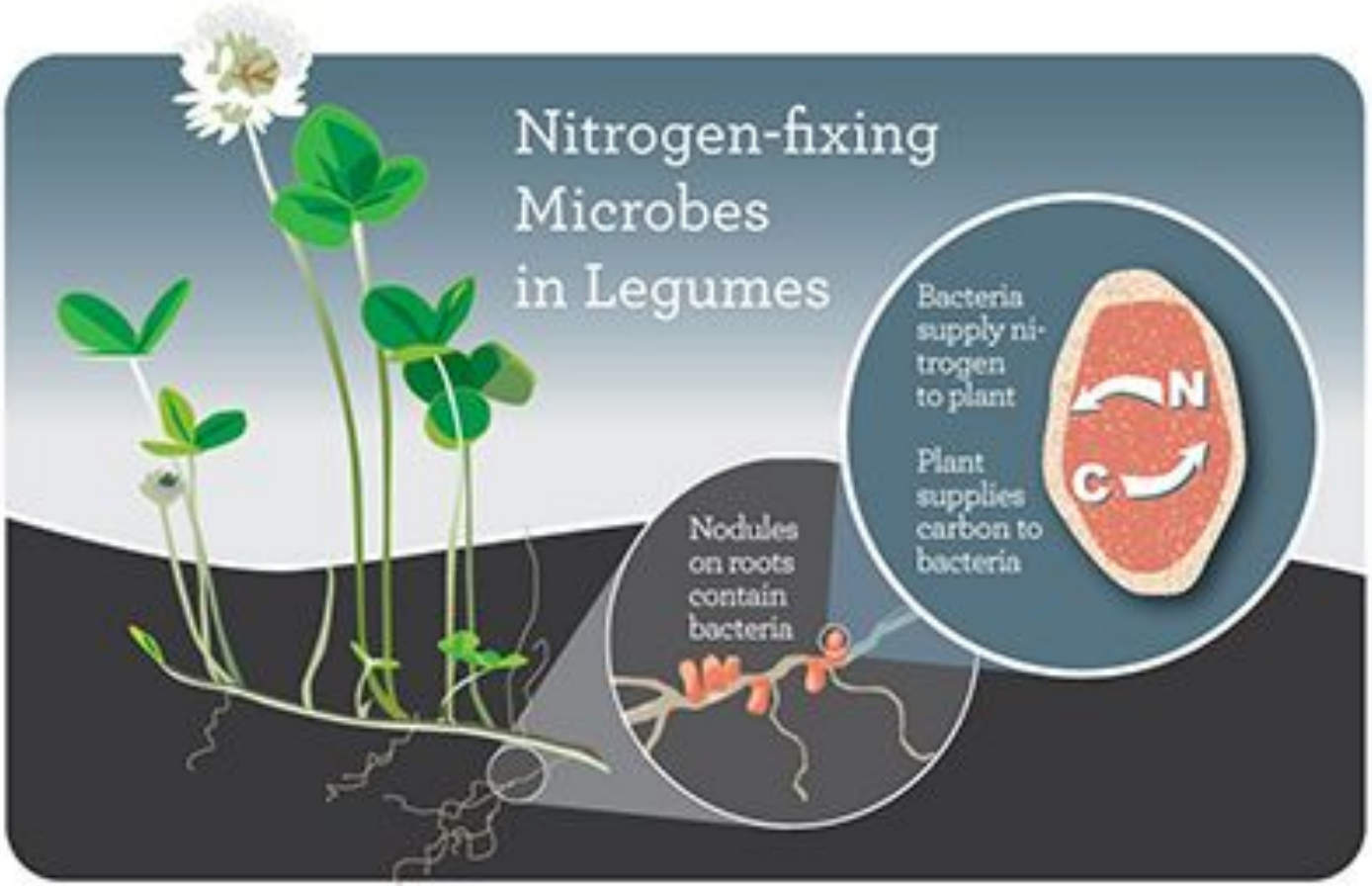


Specialized Stems

Key Concepts

Leaves and Roots absorb Essential Elements

Some plants have nitrogen fixing bacteria that “fix” nitrogen from the air: Legumes


Nitrogen-fixing Microbes in Legumes
Bacteria supply nitrogen to plant
Plant supplies carbon to bacteria
N
C
Nodules on roots contain bacteria

Key Concepts

Leaves and Roots absorb Essential Elements

Plants Require 9 macronutrients and 7 micronutrients

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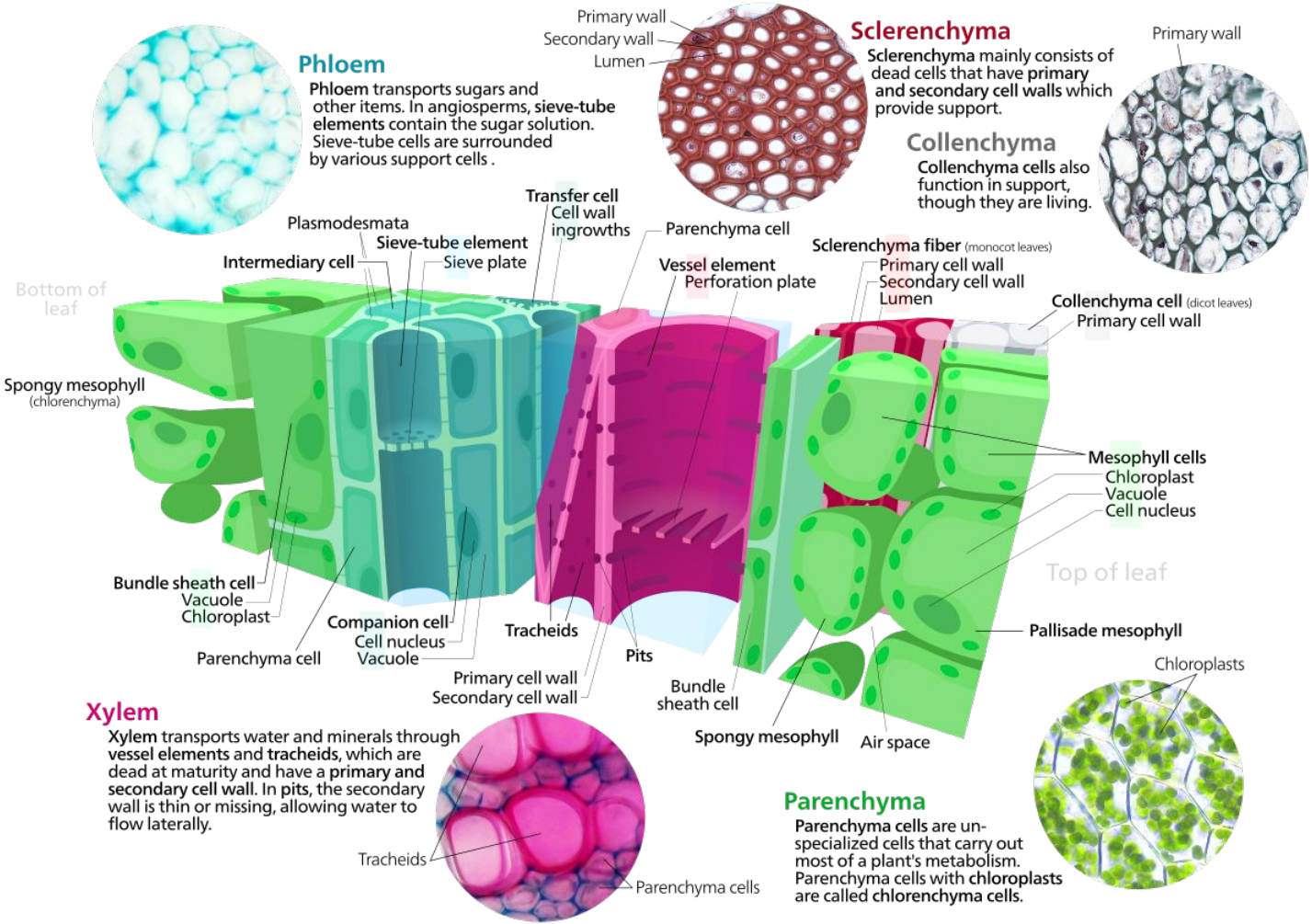
Macros: **Carbon**, **Oxygen**, **Hydrogen**, **Nitrogen**, Potassium, Calcium, Magnesium, Phosphorus, and Sulphur

Plant Tissue Types

Plant Tissue Types

Ground Tissues	Most of the body of herbaceous plants Parenchyma, Collenchyma, and sclerenchyma

Ground Tissues	
Parenchyma	Live at maturity, continue to divide, vital functions like gas exchange and storage


Phloem
Phloem transports sugars and other items. In angiosperms, sieve-tube elements contain the sugar solution. Sieve-tube cells are surrounded by various support cells .
Primary wall
Secondary wall
Lumen
Sclerenchyma
Sclerenchyma mainly consists of dead cells that have primary and secondary cell walls which provide support.
Primary wall
Collenchyma
Collenchyma cells also function in support, though they are living.
Transfer cell
Cell wall ingrowths
Plasmodesmata
Sieve-tube element
Intermediary cell
Sieve plate
Parenchyma cell
Vessel element
Perforation plate
Sclerenchyma fiber (monocot leaves)
Primary cell wall
Secondary cell wall
Lumen
Collenchyma cell (dicot leaves)
Primary cell wall
Bottom of leaf
Spongy mesophyll (chlorenchyma)
Mesophyll cells
Chloroplast
Vacuole
Cell nucleus
Top of leaf
Bundle sheath cell
Vacuole
Chloroplast
Parenchyma cell
Companion cell
Cell nucleus
Vacuole
Tracheids
Pits
Primary cell wall
Secondary cell wall
Bundle sheath cell
Spongy mesophyll
Air space
Pallisade mesophyll
Chloroplasts
Xylem
Xylem transports water and minerals through vessel elements and tracheids, which are dead at maturity and have a primary and secondary cell wall. In pits, the secondary wall is thin or missing, allowing water to flow laterally.
Tracheids
Parenchyma cells
Parenchyma
Parenchyma cells are un-specialized cells that carry out most of a plant's metabolism. Parenchyma cells with chloroplasts are called chlorenchyma cells.

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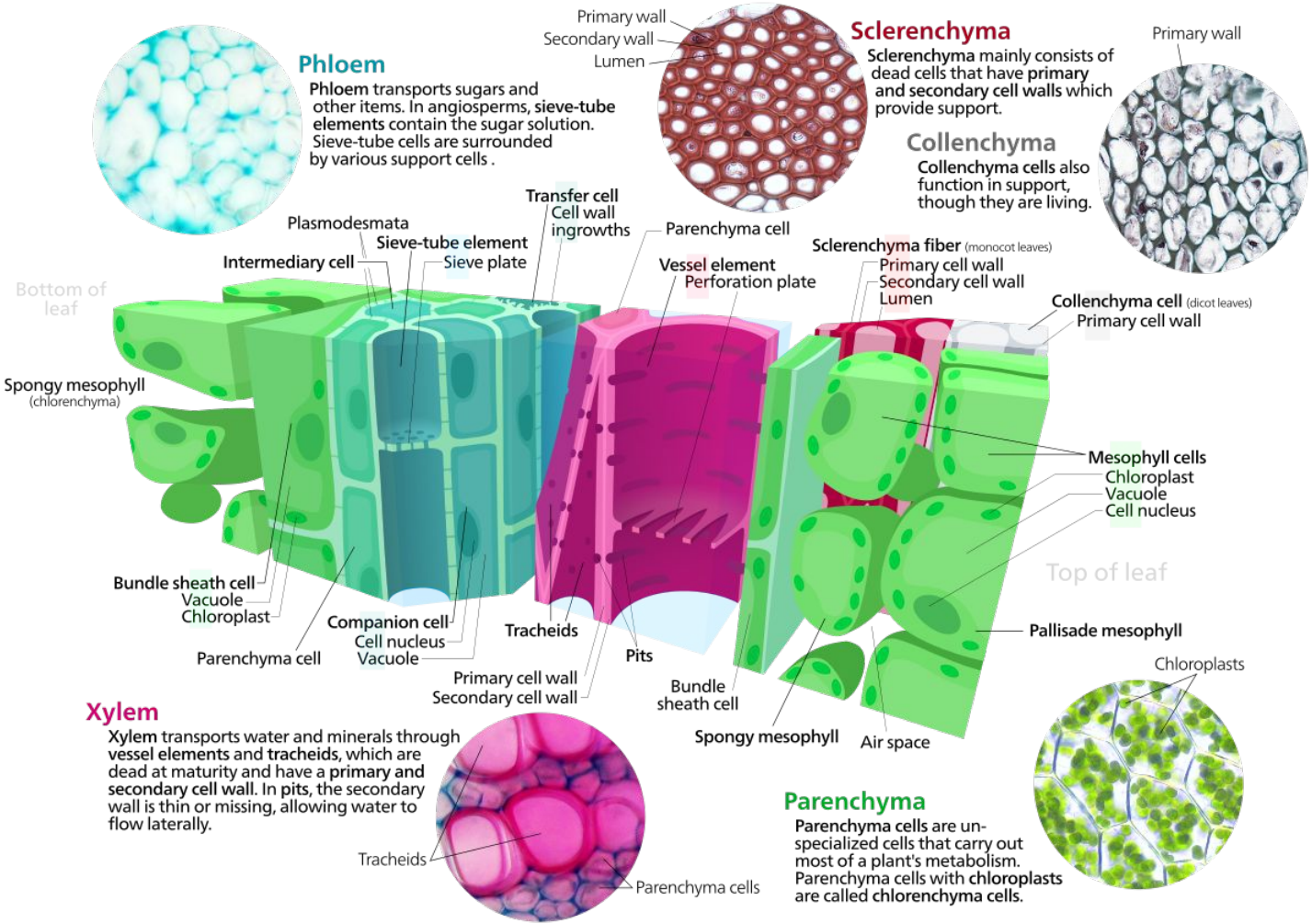
Collenchyma	Elongated living cells that stretch as cell grows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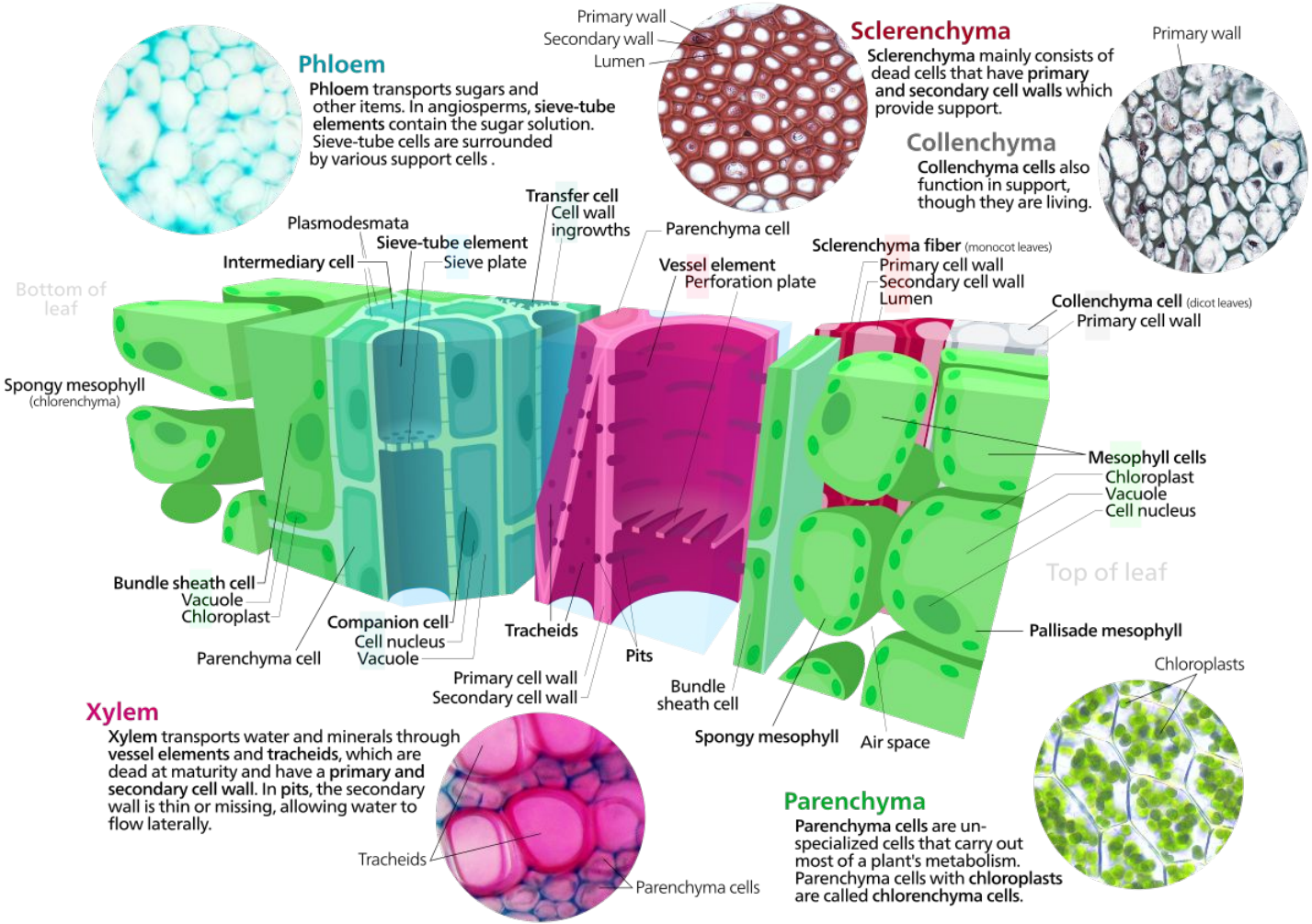
Sclerenchyma	Cells that provide inelastic support and add strength to the plant. Secondary walls may contain lignin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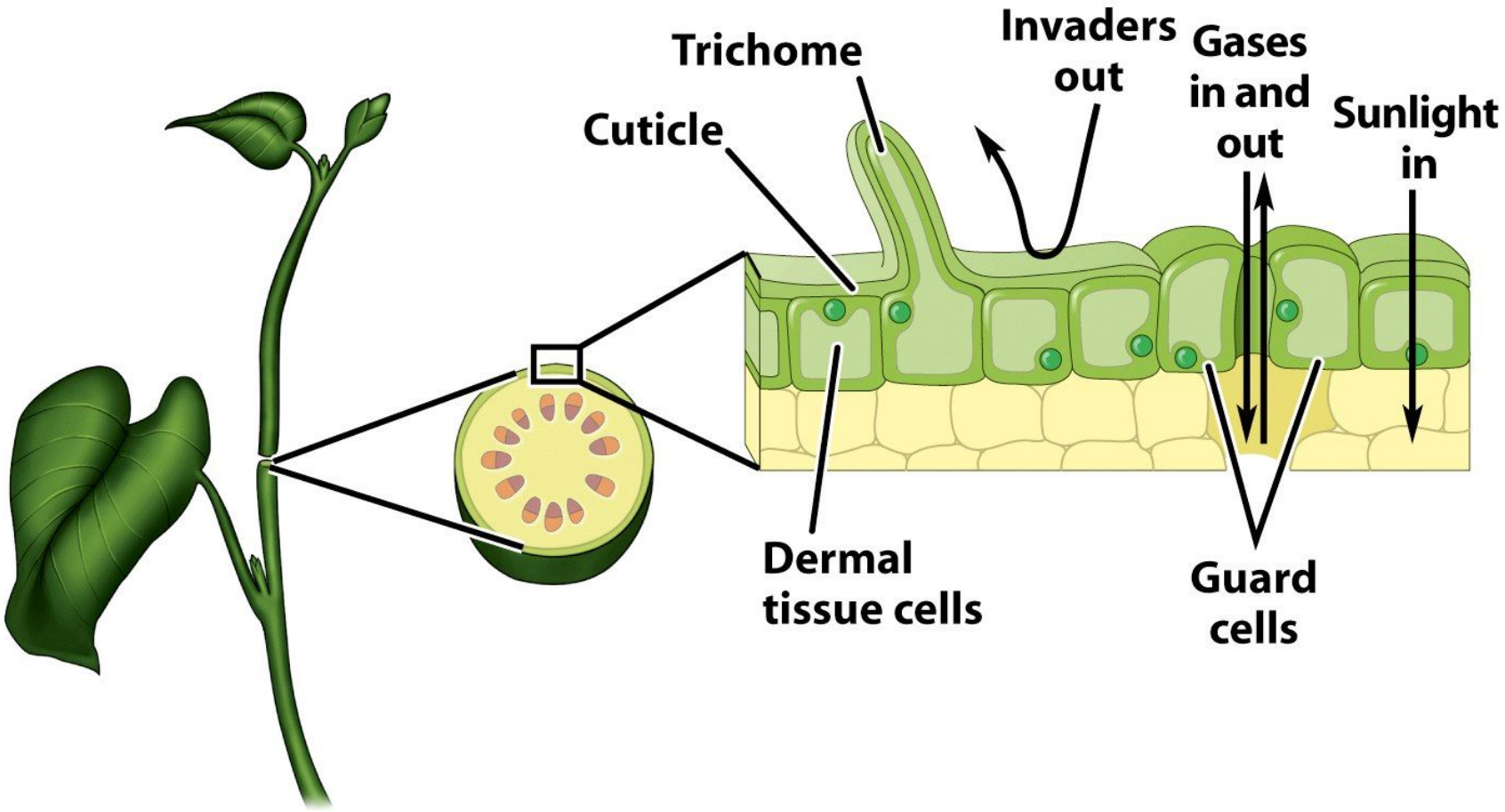
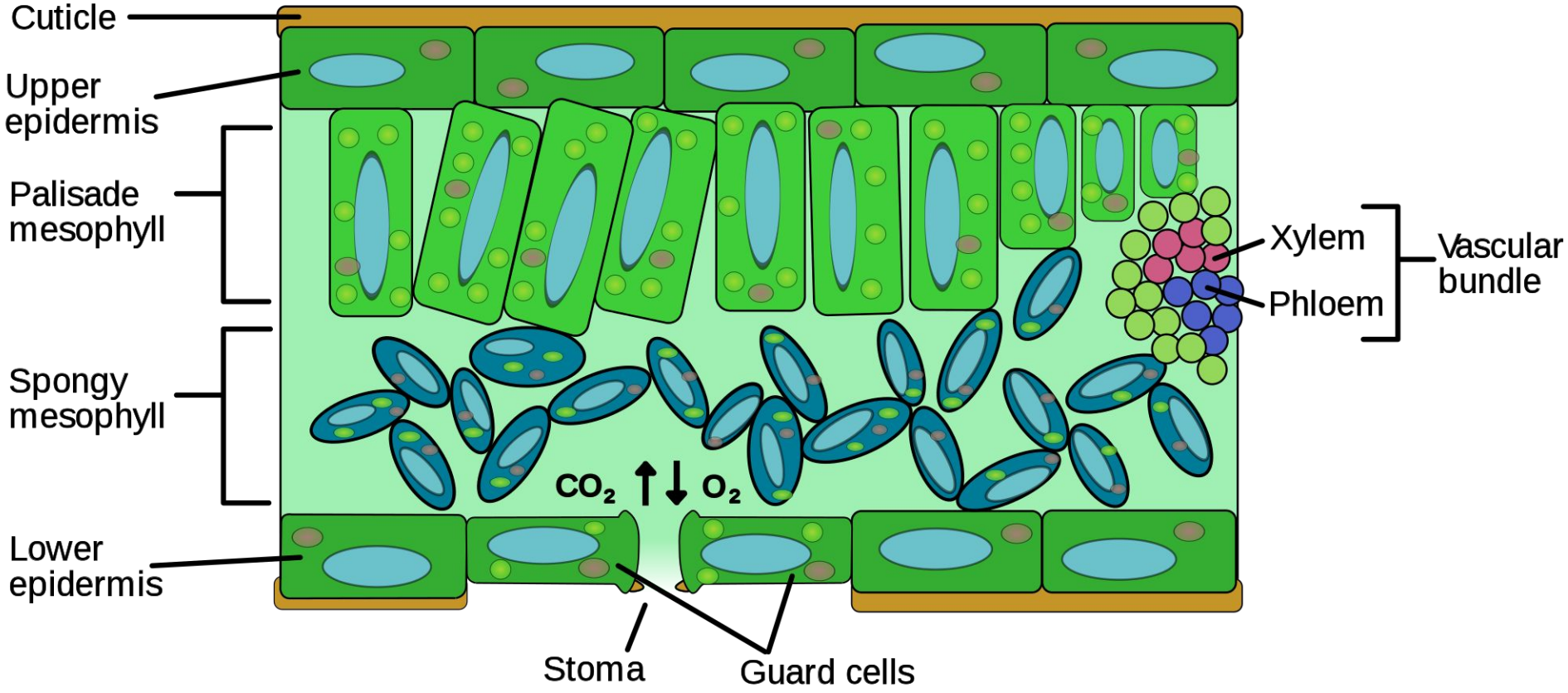
Dermal Tissue	Tissue that covers the plant, protects from desiccation


Trichome
Invaders out
Gases in and out
Sunlight in
Cuticle
Dermal tissue cells
Guard cells


Cuticle
Upper epidermis
Palisade mesophyll
Spongy mesophyll
Lower epidermis
CO_2 ↑↓ O_2
Stoma
Guard cells
Xylem
Phloem
Vascular bundle

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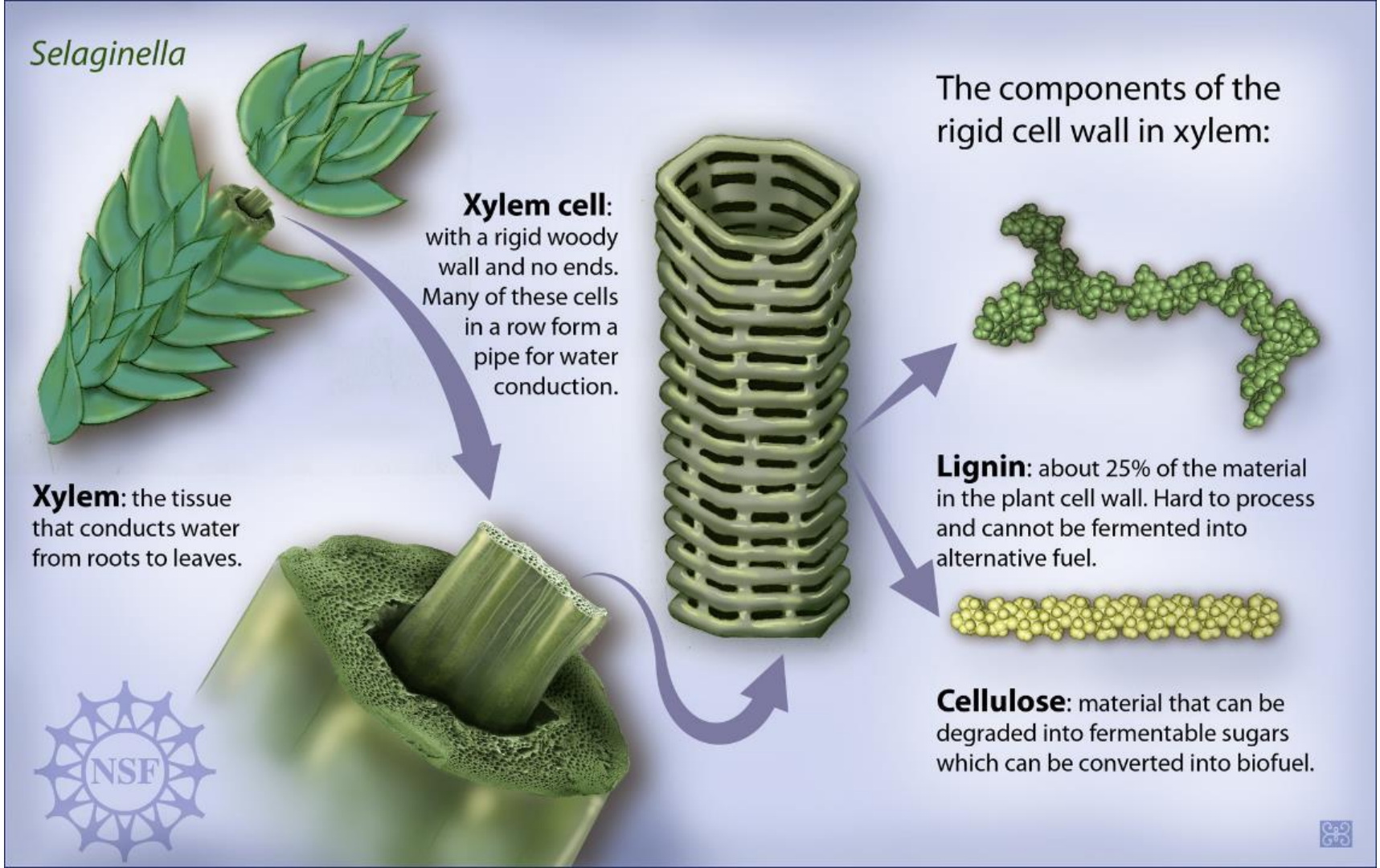
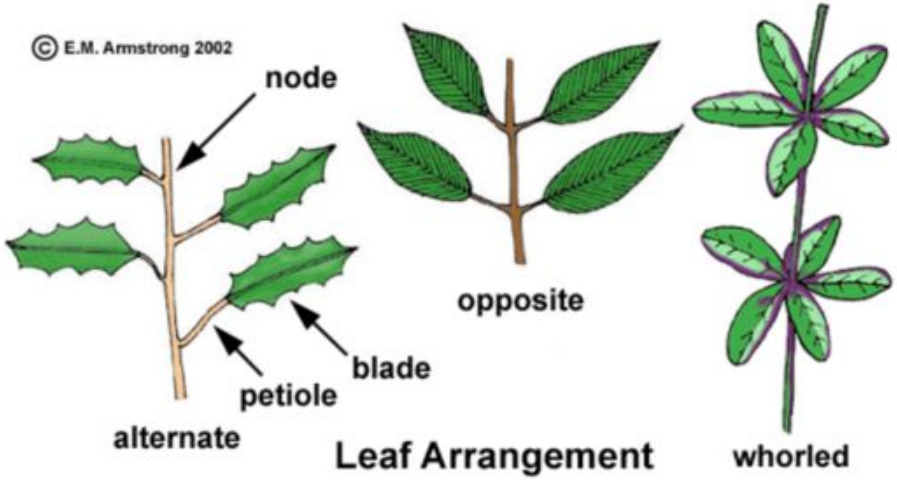
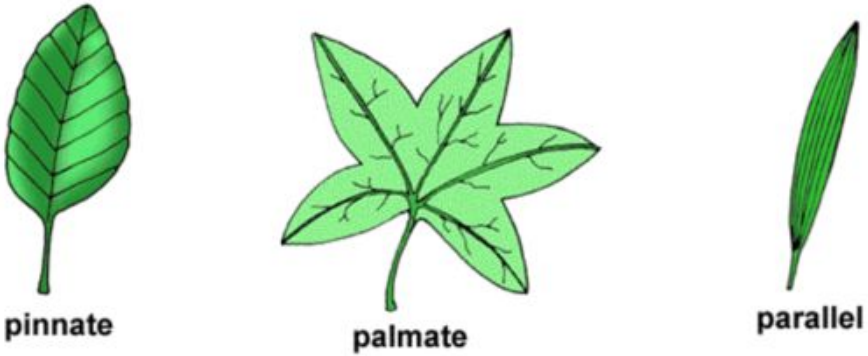
Vascular Tissue	Embedded in ground tissue In stem and leaves, xylem and phloem form vascular bundles


Selaginella
The components of the rigid cell wall in xylem:
Xylem cell: with a rigid woody wall and no ends. Many of these cells in a row form a pipe for water conduction.
Xylem: the tissue that conducts water from roots to leaves.
Lignin: about 25% of the material in the plant cell wall. Hard to process and cannot be fermented into alternative fuel.
Cellulose: material that can be degraded into fermentable sugars which can be converted into biofuel.
NSF

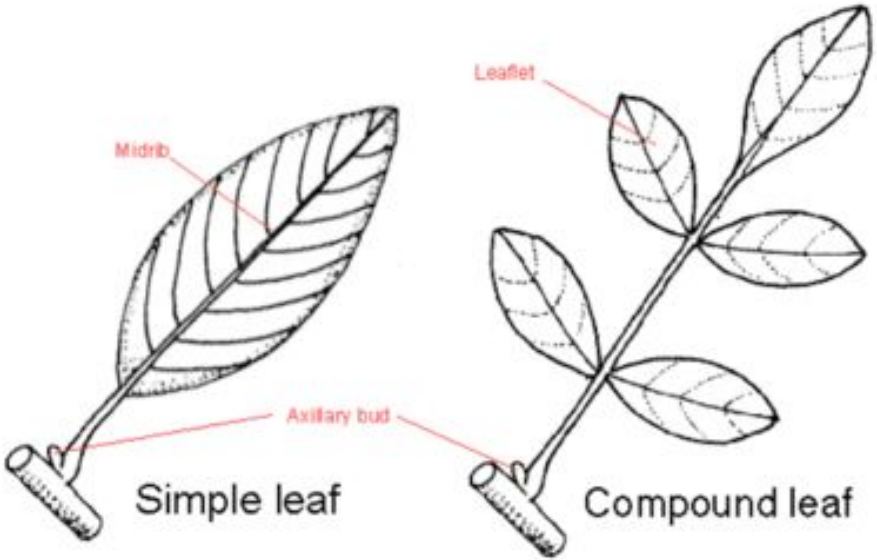
Angiosperms



Leaf Arrangement



Leaf Venation



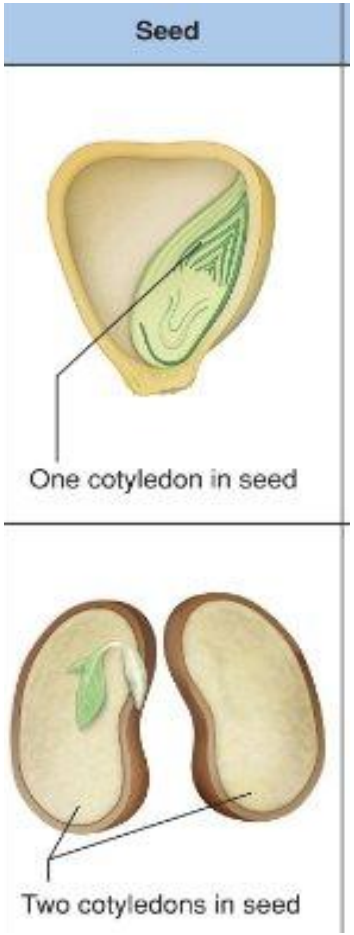
Simple vs Compound Leaves

Monocots

Dicots

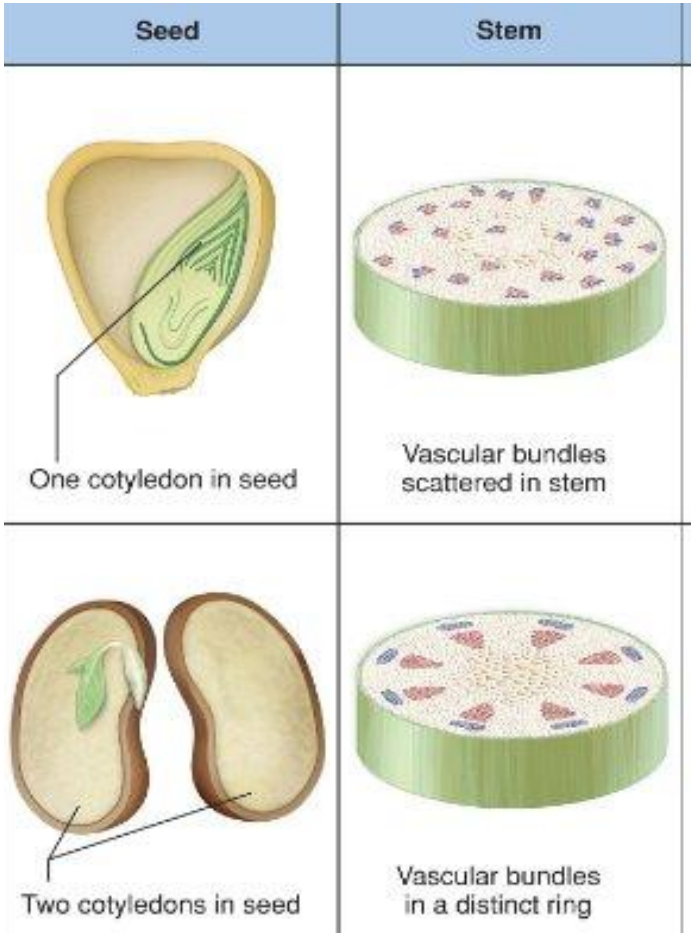
Monocots

Dicots



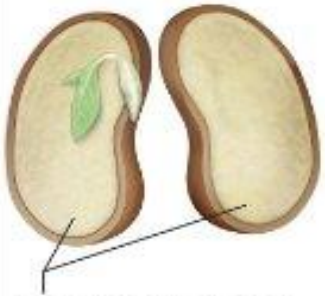
Monocots

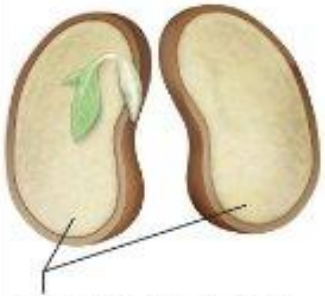
Dicots



Monocots

Dicots

Seed	Stem	Leaf
 One cotyledon in seed	 Vascular bundles scattered in stem	 Leaf veins form a parallel pattern
 Two cotyledons in seed	 Vascular bundles in a distinct ring	 Leaf veins form a net pattern

	Seed	Stem	Leaf	Flower
Monocots	 One cotyledon in seed	 Vascular bundles scattered in stem	 Leaf veins form a parallel pattern	 Flower parts in threes and multiples of three
Dicots	 Two cotyledons in seed	 Vascular bundles in a distinct ring	 Leaf veins form a net pattern	 Flower parts in fours or fives and their multiples

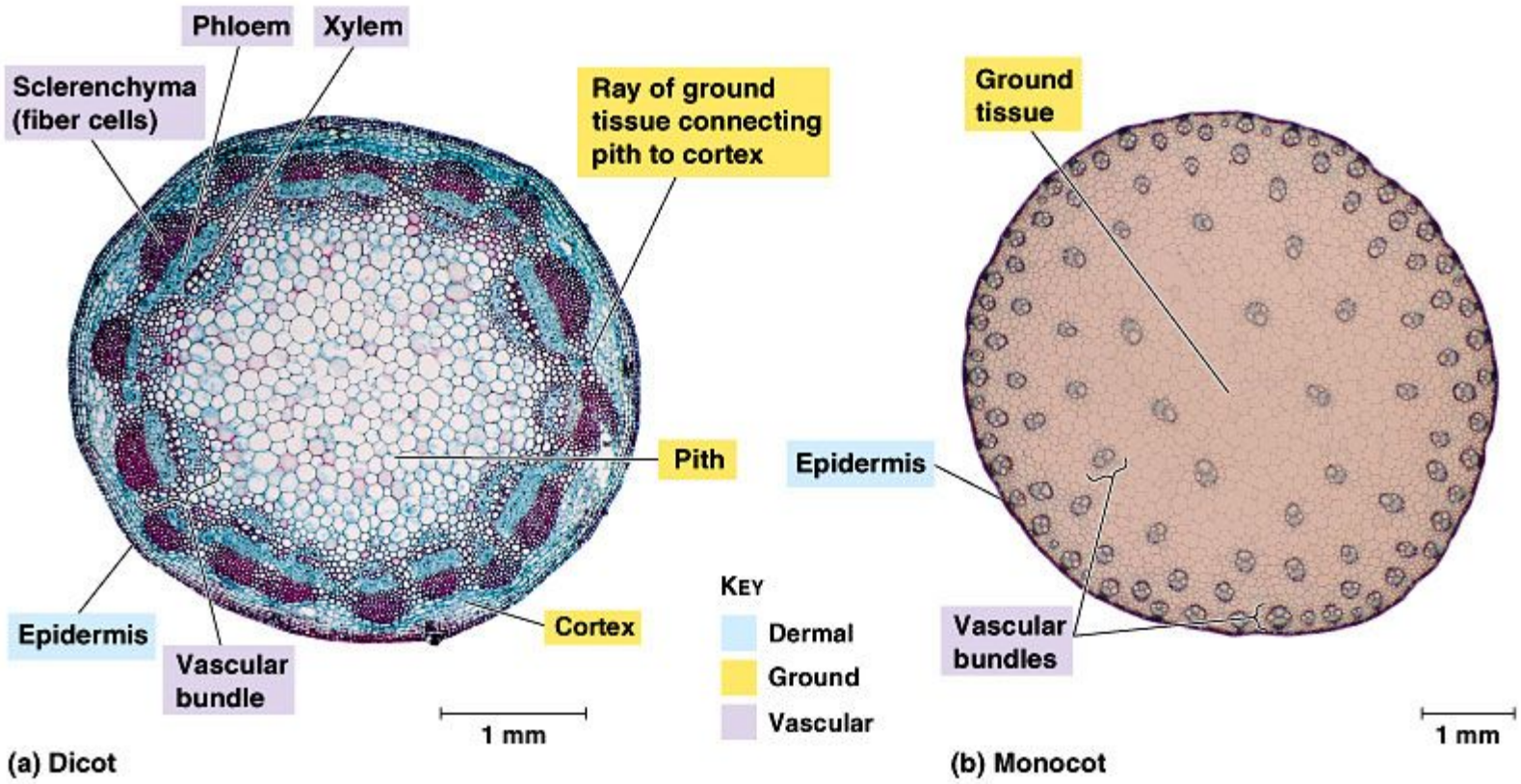
Monocots

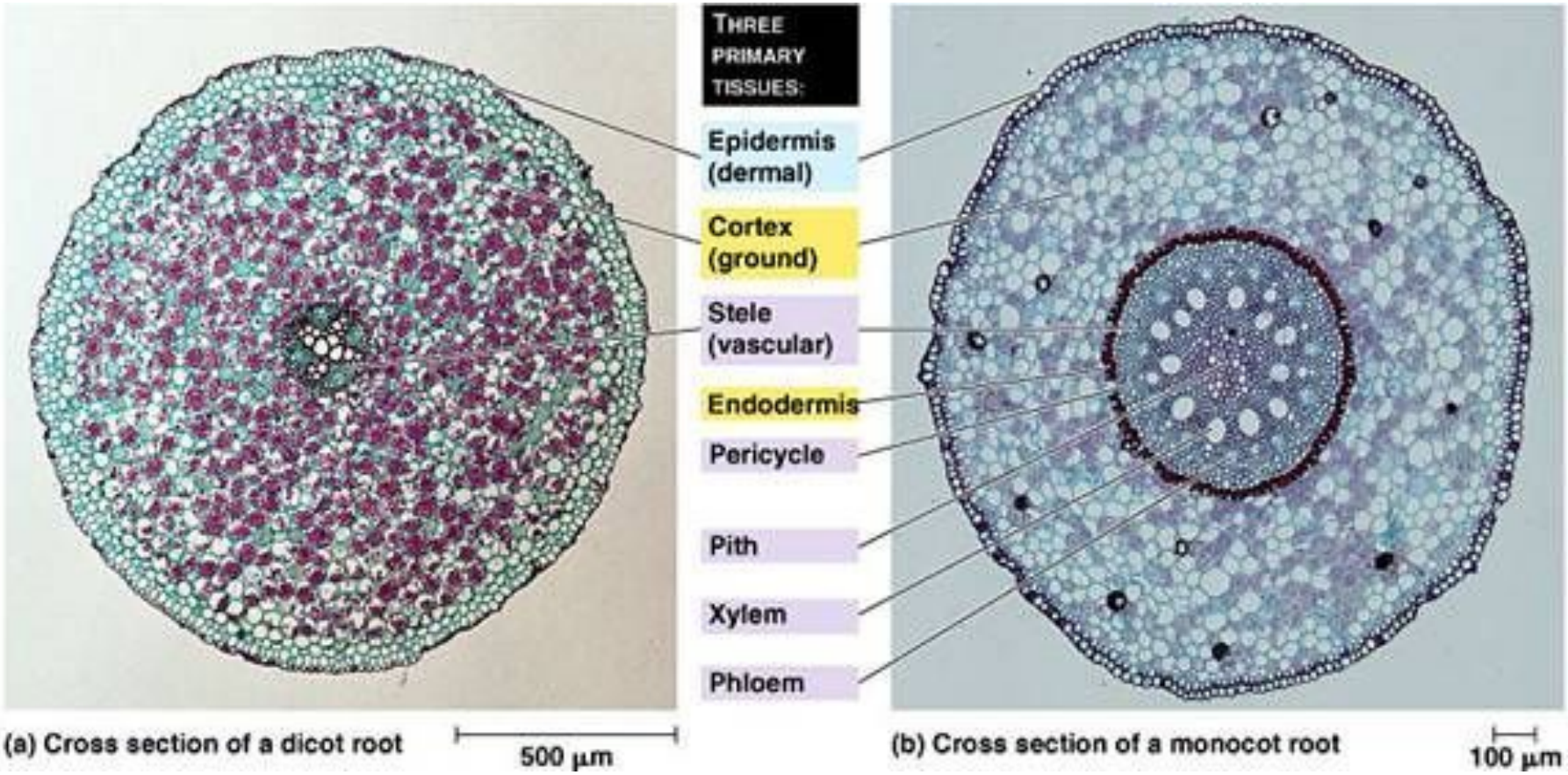


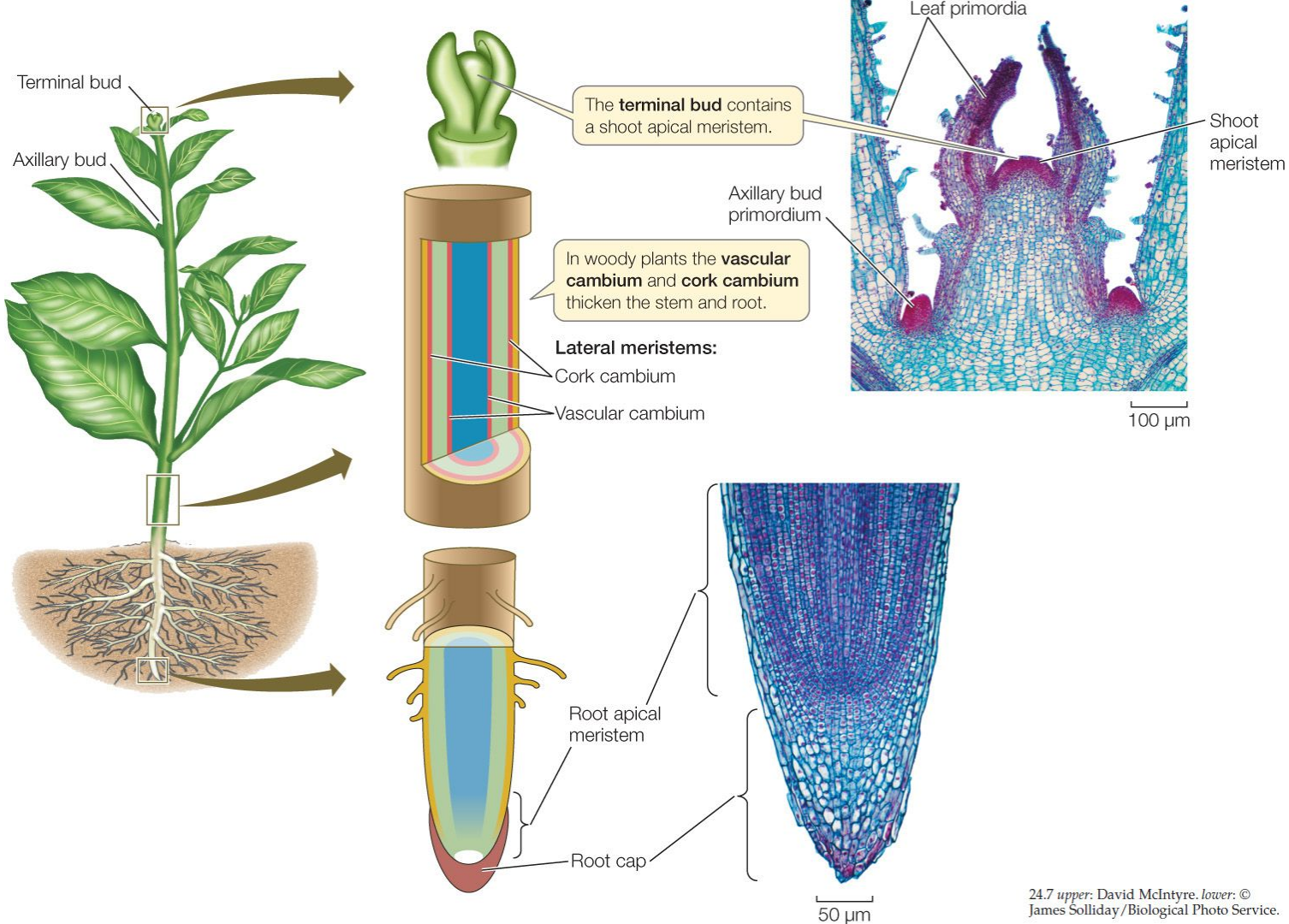


Dicots

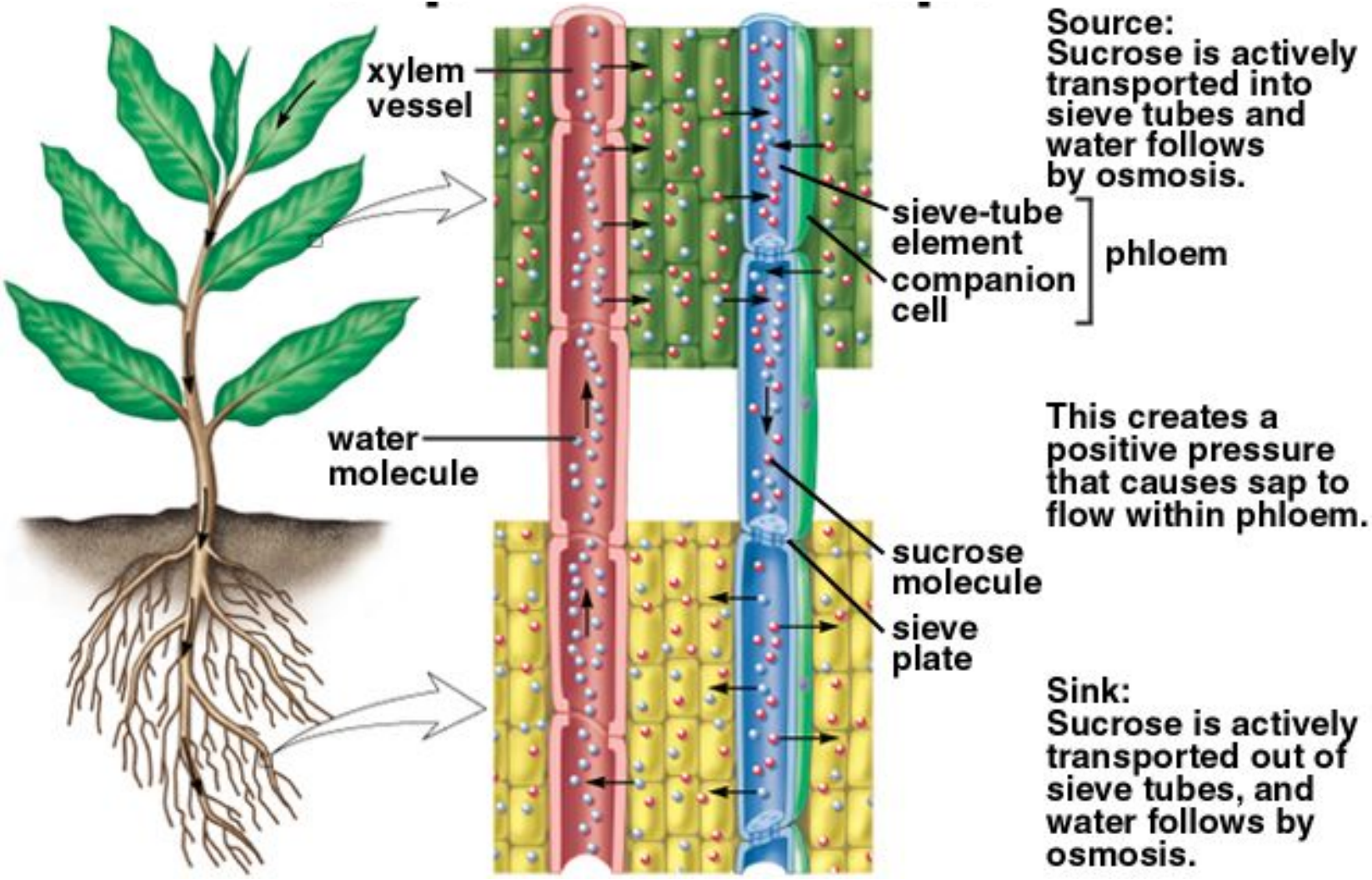


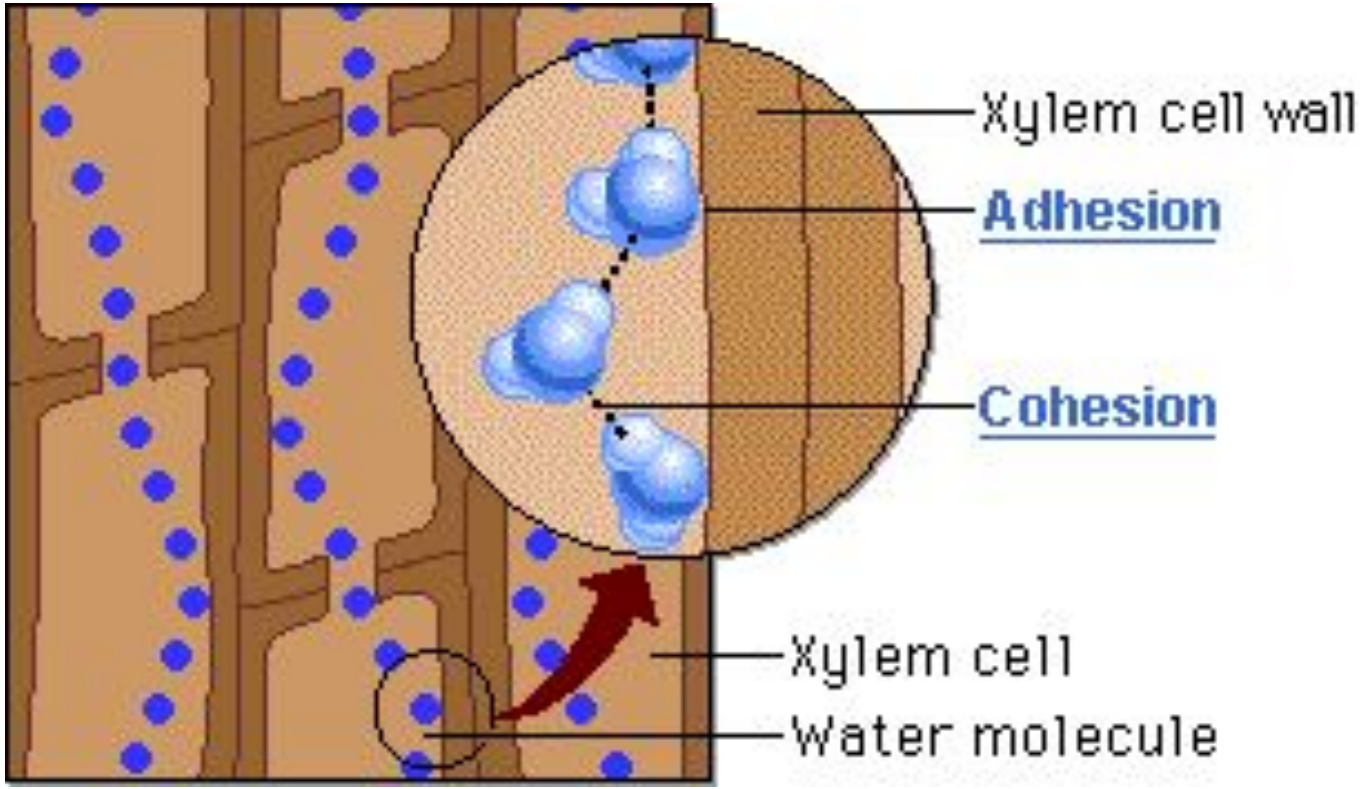

Phloem
Xylem
Sclerenchyma (fiber cells)
Ray of ground tissue connecting pith to cortex
Pith
Epidermis
Vascular bundle
Cortex
1 mm
(a) Dicot
Key
Dermal
Ground
Vascular
Ground tissue
Epidermis
Vascular bundles
1 mm
(b) Monocot


THREE PRIMARY TISSUES:
Epidermis (dermal)
Cortex (ground)
Stele (vascular)
Endodermis
Pericycle
Pith
Xylem
Phloem
(a) Cross section of a dicot root
500 µm
(b) Cross section of a monocot root
100 µm



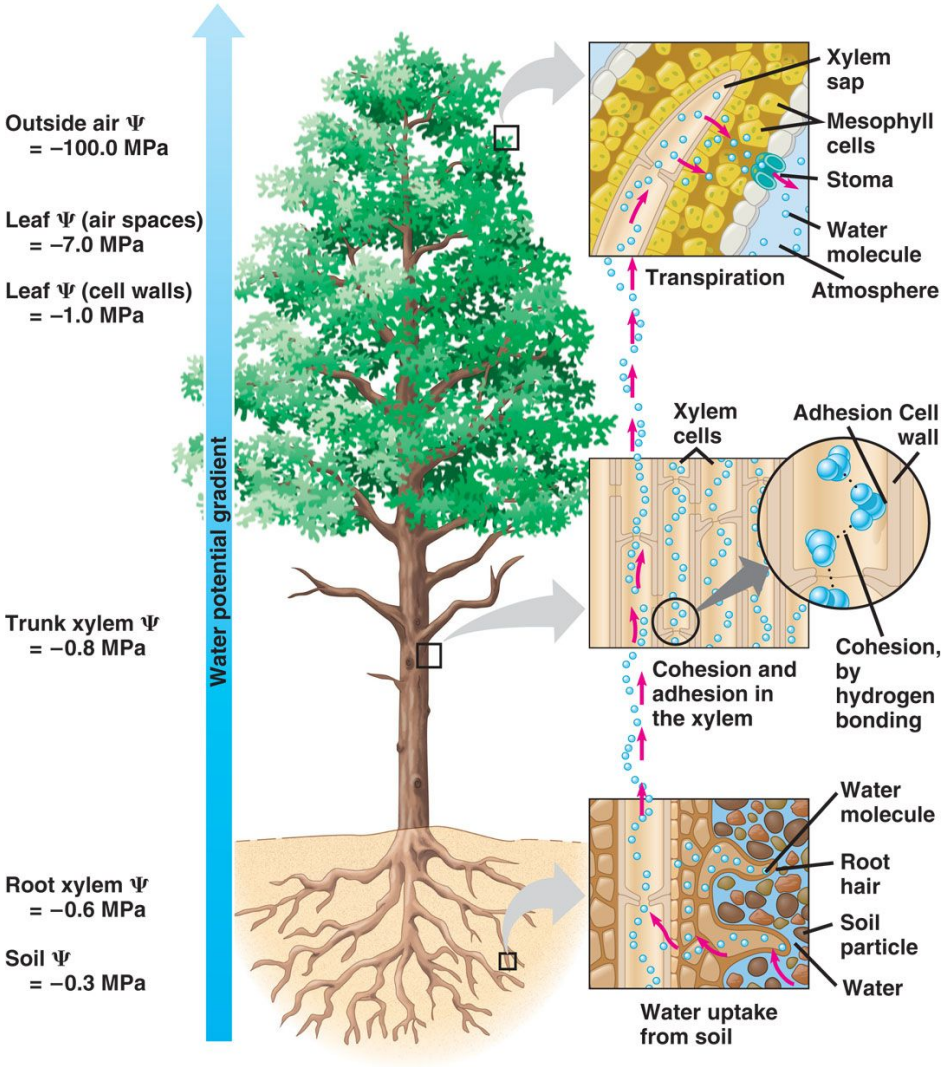
24.7 *upper*: David McIntyre. *lower*: © James Solliday/Biological Photo Service.


xylem vessel
Source:
Sucrose is actively transported into sieve tubes and water follows by osmosis.
sieve-tube element
companion cell
phloem
water molecule
This creates a positive pressure that causes sap to flow within phloem.
sucrose molecule
sieve plate
Sink:
Sucrose is actively transported out of sieve tubes, and water follows by osmosis.


Xylem cell wall
Adhesion
Cohesion
Xylem cell
Water molecule


P
Pa
WORLD'S
LONGEST
STRAW

How can a tree be taller than “the worlds longest straw”?


Outside air Ψ
= –100.0 MPa
Leaf Ψ (air spaces)
= –7.0 MPa
Leaf Ψ (cell walls)
= –1.0 MPa
Trunk xylem Ψ
= –0.8 MPa
Root xylem Ψ
= –0.6 MPa
Soil Ψ
= –0.3 MPa
Water potential gradient
Xylem sap
Mesophyll cells
Stoma
Water molecule
Atmosphere
Transpiration
Xylem cells
Adhesion
Cell wall
Cohesion, by hydrogen bonding
Cohesion and adhesion in the xylem
Water molecule
Root hair
Soil particle
Water
Water uptake from soil

Parasitic plants

Carnivorous Plants

What evolutionary forces would lead a plant to eat animals?