BI 111
Plant Body

Overview of the Plant body

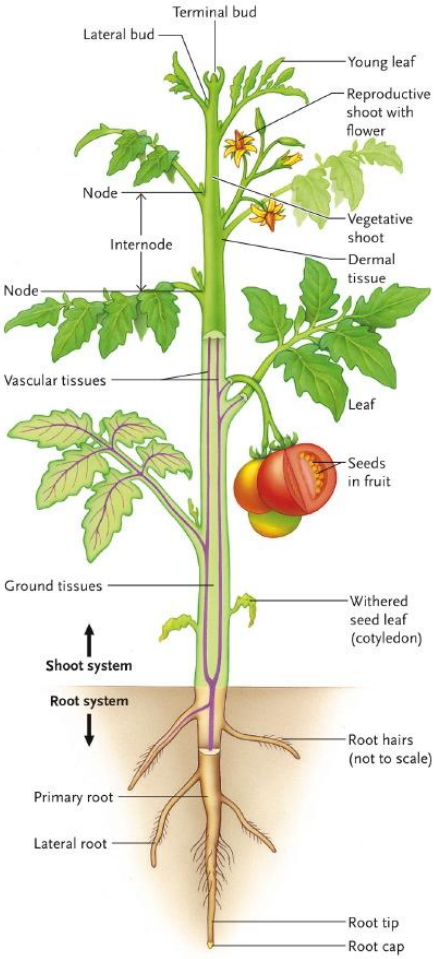
- Almost all plants are photosynthetic autotrophs
- Shoot systems above ground
  - Photosynthetic leaves, stems
- Root system below ground
  - Non-photosynthetic roots
- Plant bodies are dendritic → spreading and branched in form

Shoot System: Functions

- Stems, leaves, buds flowers
- Highly adaptive for photosynthesis & positions flowers for pollination
- Vegetative (non-reproductive) shoot
  - Stem with attached leaves and buds
  - Bud gives rise to extension of shoot or new, branching shoot
- Reproductive shoot
  - Produces flowers which later develop fruits containing seeds

Root System: Functions

- Usually grows below ground
- Anchors plant and supports upright parts
- Absorbs water and dissolved minerals from soil
- Stores carbohydrates



Vascular Plant body

- 3 Tissue Systems:
  - Ground
  - Vascular
  - Dermal
- Organ/Tissue system
  - body structure that contains 2^+ types of tissues and have a definite form & function
- Tissue
  - group of 1^+ types of cells and intercellular substances that function together in one or more specialized tasks

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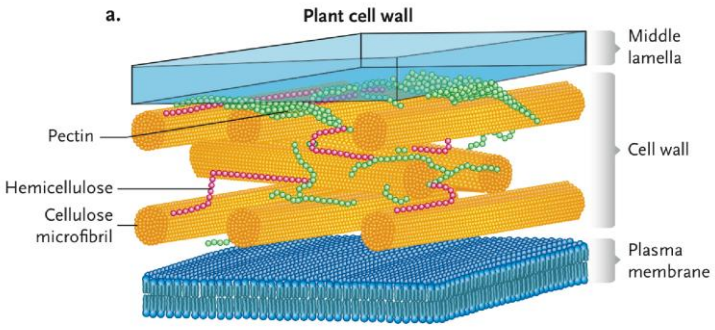
The plant cell: General Properties

- Primary cell wall → surrounds plasma membrane and cell contents
  - Cellulose fibres in matrix of hemicellulose
  - Rigid but flexible
- Large vacuole (30-80% of internal volume) Tonoplast membrane
  - Used for storage and to maintain turgot pressure against the cell wall
- Plasmodesmata
  - Cytoplasmic connections between adjacent cells

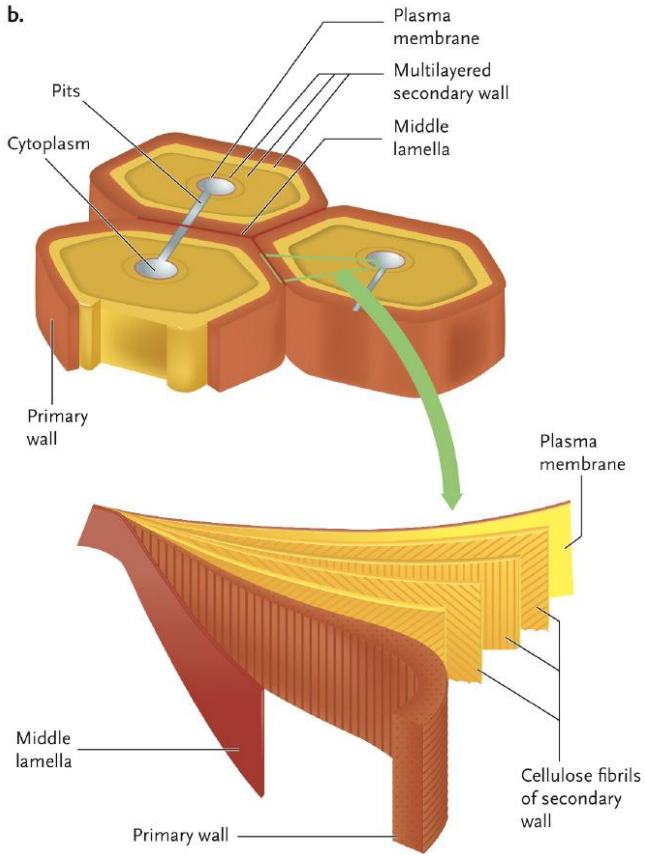
Plant Cell Wall structure

- Cellulose is a branched polymer made of 7,000 – 15,000 glucose molecules per polymer (most abundant organic substance on Earth
- Hemicellulose is a branchig polymer consists of chains of 500 – 3,000 sugar units
- Pectins particularly abundant in the non-woody parts of terrestrial plants



Lignin

- Some plant cells have "lignified" secondary cell wall
  - Cellulose fibres anchored with lignin → stronger, more rigid
  - Creates waterproof barrier (hydrophobic)
  - Resistant to decay and attack by microbes



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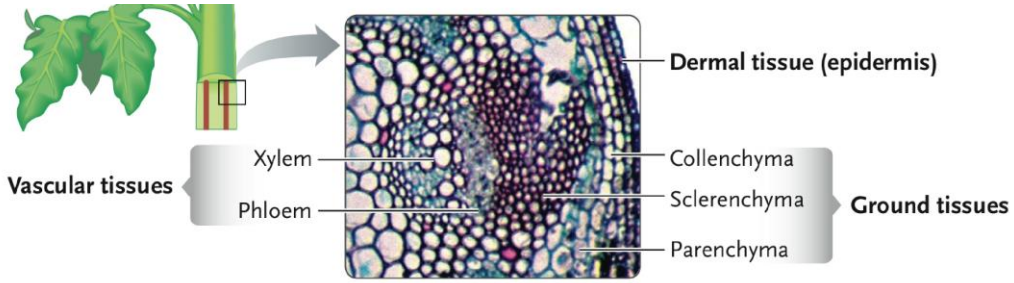
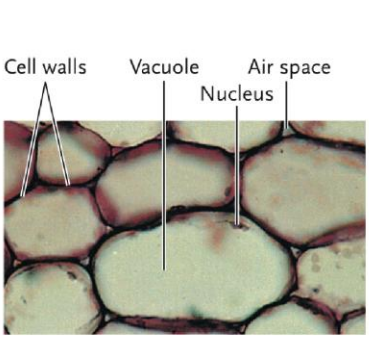
Plant Tissue System: Form & Function

- 3 Tissue Systems:
  - Ground [Collenchyma, Sclerenchyma, Parenchyma]
    - All structurally simple but exhibit important differences
  - Vascular [xylem, phloem]
    - Specialized for conducting fluids
  - Dermal [epidermis]
    - Protects plant surfaces

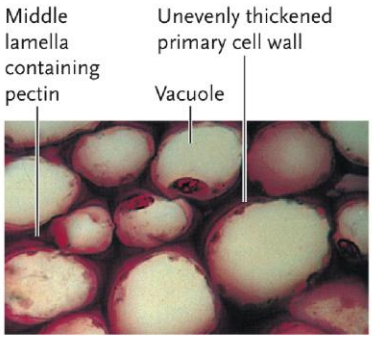


Summary of Flowering Plant Tissues and Their Components

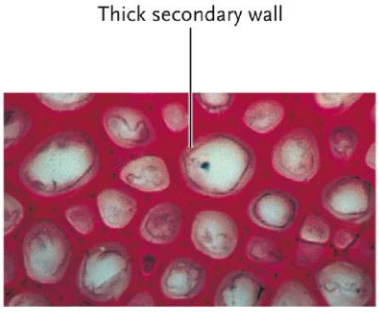
Tissue System	Name of Tissue	Cell Types in Tissue	Tissue Function
Ground tissue	Parenchyma	Parenchyma cells	Photosynthesis, respiration, storage, secretion
	Collenchyma	Collenchyma cells	Flexible strength for growing plant parts
	Sclerenchyma	Fibres or sclereids	Rigid support, deterring herbivores
Vascular tissue	Xylem	Conducting cells (tracheids, vessel members), parenchyma cells, sclerenchyma cells	Transport of water and dissolved minerals
	Phloem	Conducting cells (sieve tube members), parenchyma cells, sclerenchyma cells	Sugar transport
Dermal tissue	Epidermis	Undifferentiated cells, guard cells, other specialized cells	Control of gas exchange, water loss, protection
	Periderm	Cork, cork cambium, secondary cortex	Protection



a. Parenchyma tissues consist of soft, living cells specialized for storage, other functions.



b. Collenchyma tissues provide flexible support.



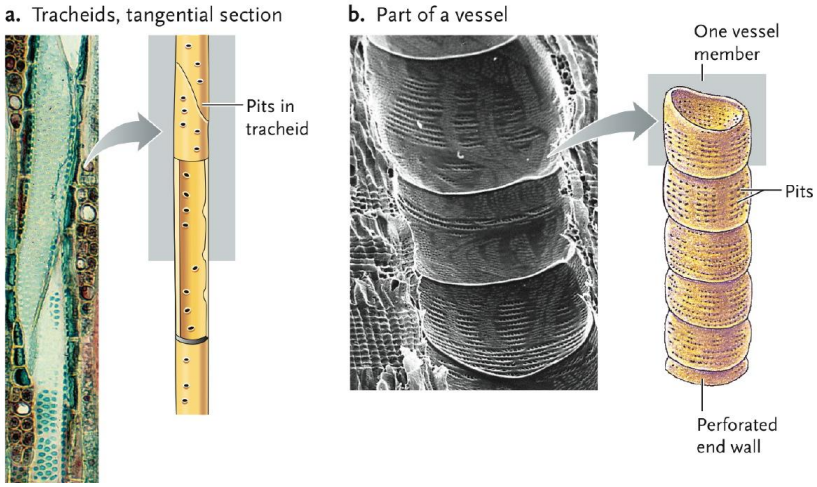
c. Sclerenchyma tissues provide rigid support and protection.

Ground tissues:

- parenchyma
    - thin parimary cell walls, pliable and permeable to water, often round
    - Air spaces (gas exchange, buoyancy)
    - Specialized for storage, secretion, photosynthesis
        - They are found in the cortex and pith of stems, the cortex of roots, the mesophyll of leaves, the pulp of fruits, and the endosperm of seeds
    - Metabolically active when mature
    - Capable of additional cellular division (meristematic) if stimulated
    - mesophyll cells → heavy lifting of photosynthesis
        - made in parenchyma cells
        - usually not densely packed → buoyancy
    - directly exposed to air
        - vast of vegetable & fruit we eat are parenchyma cells
- collenchyma
    - Pectin → provides flexible support
    - Thicker (uneven) primary cell walls (pectin) → especially at the corners
    - Elongated cells in strans or sheath like cylinder
    - Strenthen plant parts still elongating
        - Found adjacent to outer growing tissues and the vascular cambium
    - Metabolically active & meristematic
        - Additional growth stimulated by mechanical stress
    - meristematic →still living, acting, responsive cells adapts to mechanical cells and pressure composed on them.
        - Adapts to what they need by changing pectin amounts
- Sclerenchyma
    - Rigid support and protection
    - Found in stems, leaf veins and make up the hard outer covering of seeds & nuts
    - Thick, uniform, secondary cell walls (hemicellulose & lignin)
    - Secondary cell wall → composed of lignin
        - Super rigid → provides support, strength and stability
    - Cons
        - Secondary cell wall cuts off plasmodesmata
        - each cell will eventually die because no exchange between cells
    - Two major types
        - Sclereids (protective casings)
            - Cells are irregular in shape. Commonly found in fruit and seeds
        - Fibres (support)
            - Cells are often needle-shaped with pointed tips – some elasticity

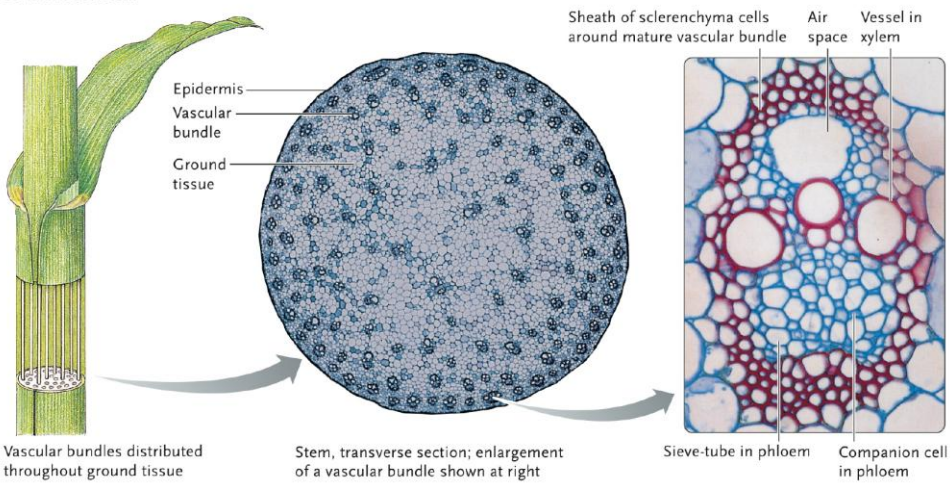
Vascular Tissues:

- Xylem tissues:
  - Conducts water and dissolved minerals
    - plant's transport of water and minerals
  - Use thick, lignified secondary cell walls
    - Thick tubes (gives them a hydrophobic characteristic)
  - Dead when functional
- Tracheids and Vessel members →transportation of water
  - Trachieds
    - Elongated, tapered, overlapping ends.
    - Lateral connection through pits
    - Long and skinny tubes, a lot of lateral connection
    - Pros: they have laterial pits, which allows water to move around
      - More efficient for air bubbles
    - Cons: slow movers of water (thin strays)
  - Vessel members
    - Shorter, tubelike columns
    - Lateral connections through pits and perforations
    - Vessel members are better at quickly moving water, more easily blocked by air bubbles in water
    - Smaller barrel cells (stack on top of one another) large tube like channels
    - Pros: thick and lots of space for water to move
    - Cons: easily blocked [AIR BUBBLES] → increasing air to the xylem system, air clogs the channel (blocking the water)
  - Water freezing during the winter blocks the xylem and contracts → kills the plants

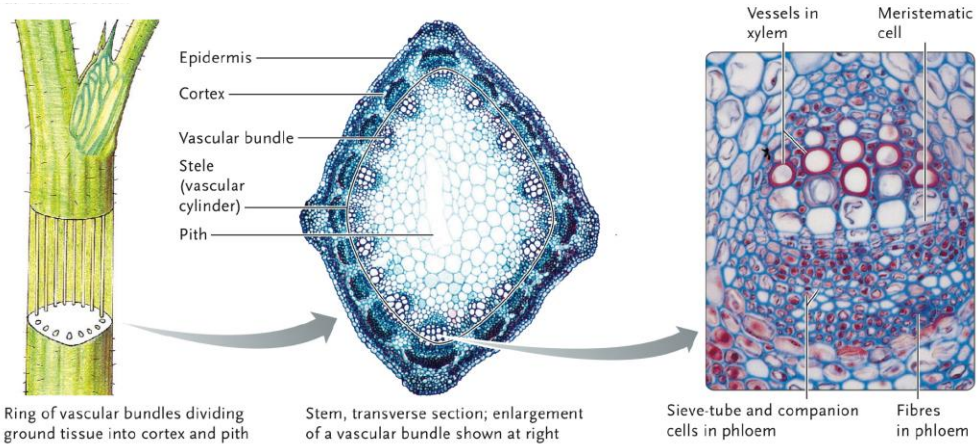


-
- Phloem Tissue:
  - Conducts sugars and other solutes
  - Living when functional
  - Works on sources (leaves) and sinks (roots) → sugars and other solutes

- Sieve Tube Members
  - Joined end to end in sieve tubes
  - Sieve tube cells assisted by "companion cells"
    - Parenchyma cells that load and unload organic compounds into sieve tube
  - End walls (sieve plates) studded with pores
- Vascular Tissues
  - Organized into vascular bundles → primary, secondary
    - Primary phloem and xylem in each bundle
    - Wrapped in sclerenchyma for support
    - Lengthwise through parenchyma
- Two Major Classes of Flowering(angeosperm) Plants
  - **Monocots**: → One cotyledon (seed leaves in plant embyos)
  - Vascular bundles are spread throughout ground tissue of stem (all over)
  - Grasses, lillies, cattails, corn, rice

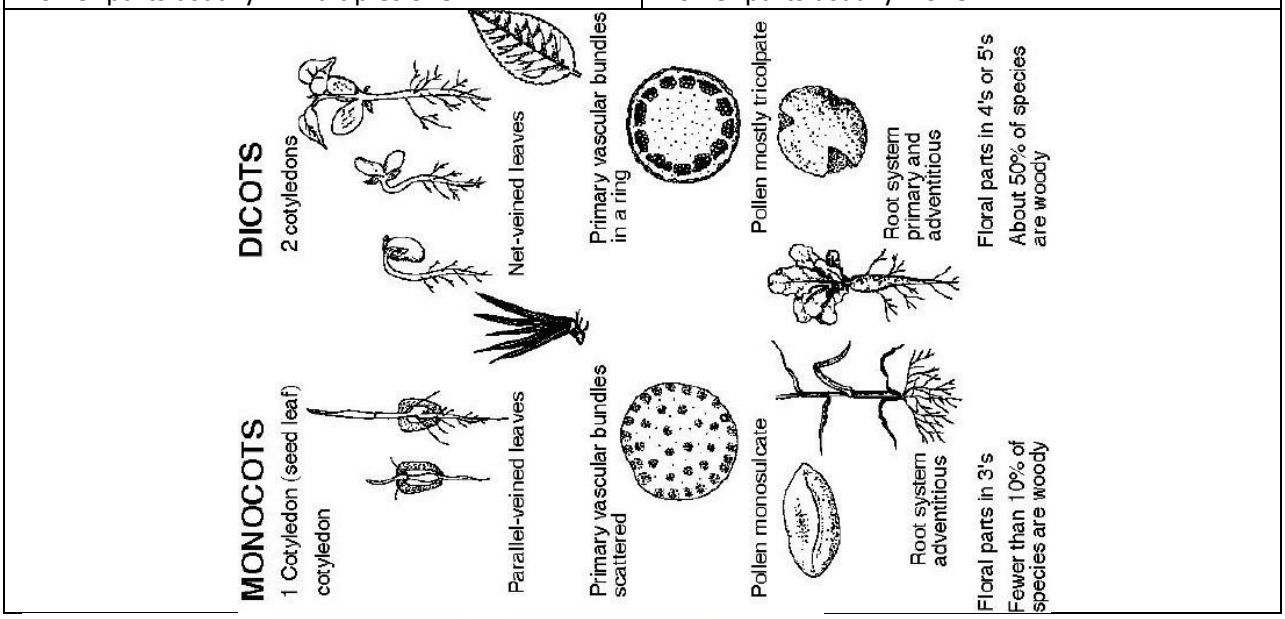


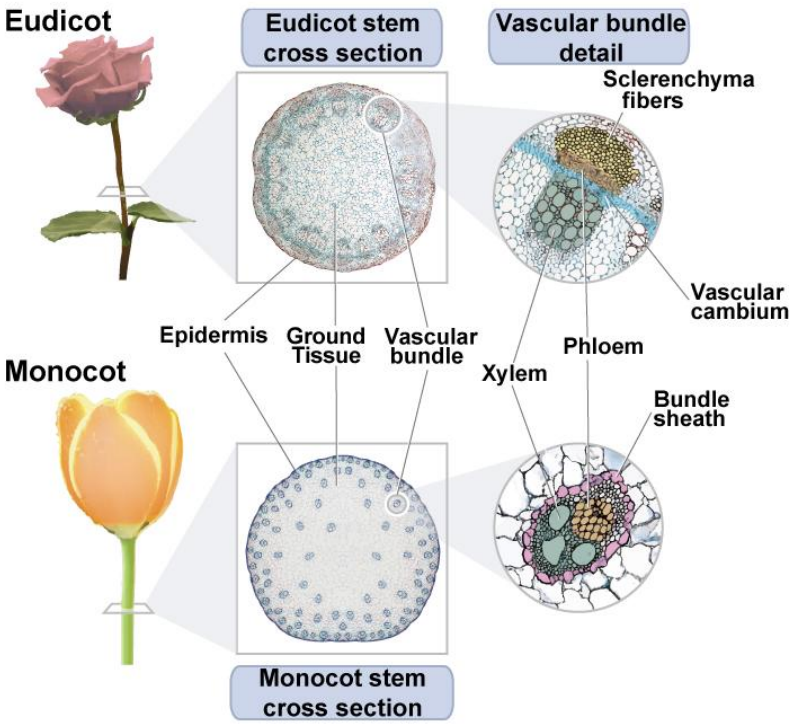
  - **Eudicots:** →Two cotyledons
  - Vascular bundles (grouping of xylem and phloem into rings)
    - Ring like structure (vascular bundles are on the outskirts)
    - Outer →cortex; inner →pith
  - Poplars, willows, oaks, cacti, roses, poppies, sunflowers, garden beans, peas

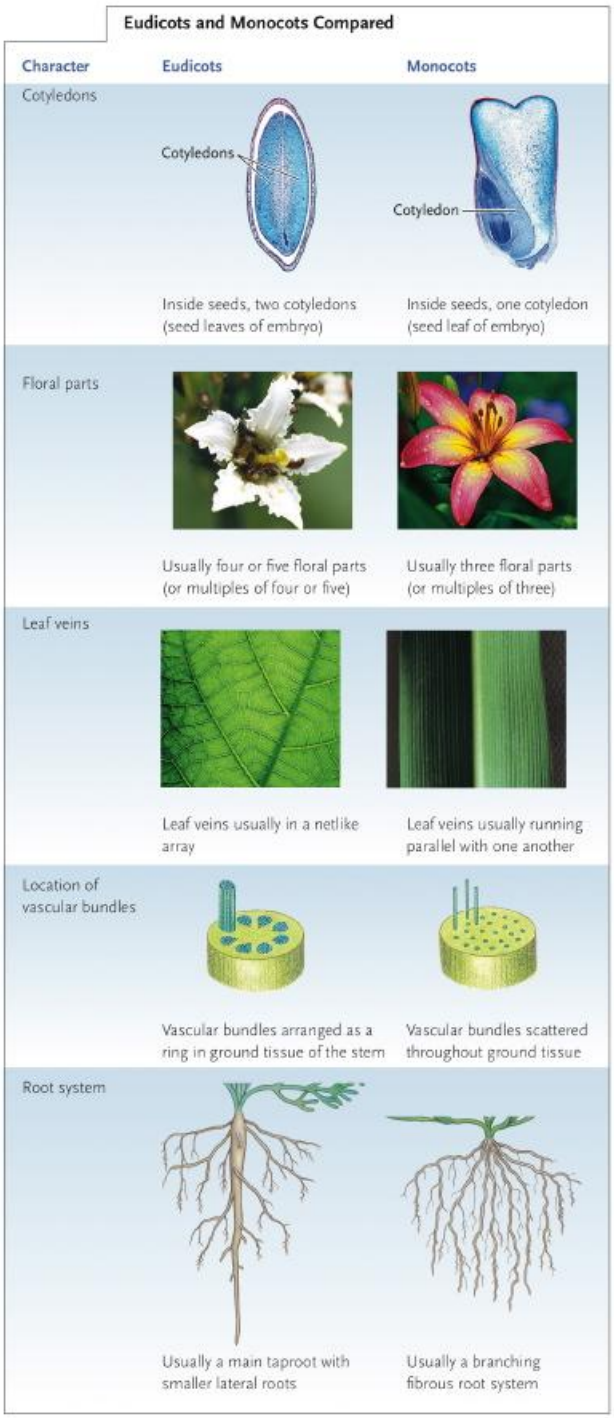


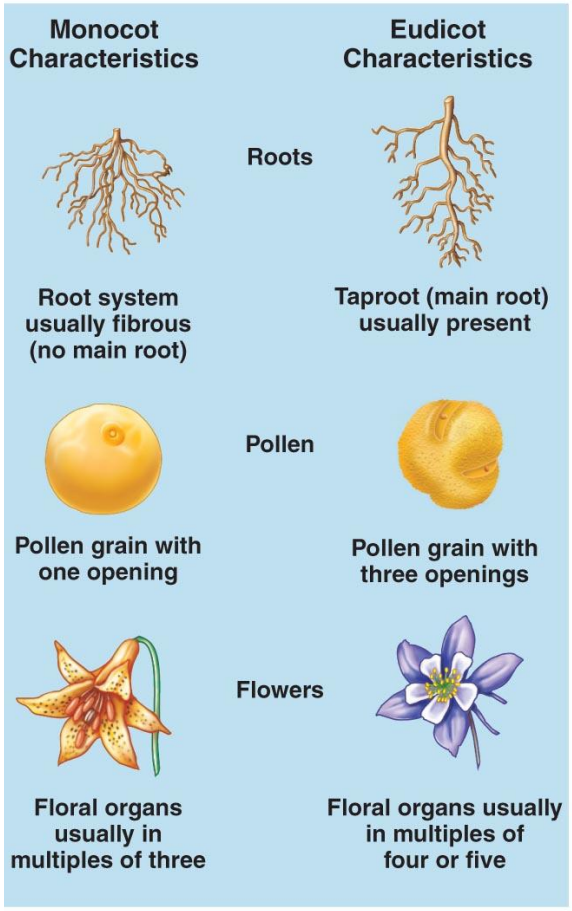
- Difference between monocots and eudicots

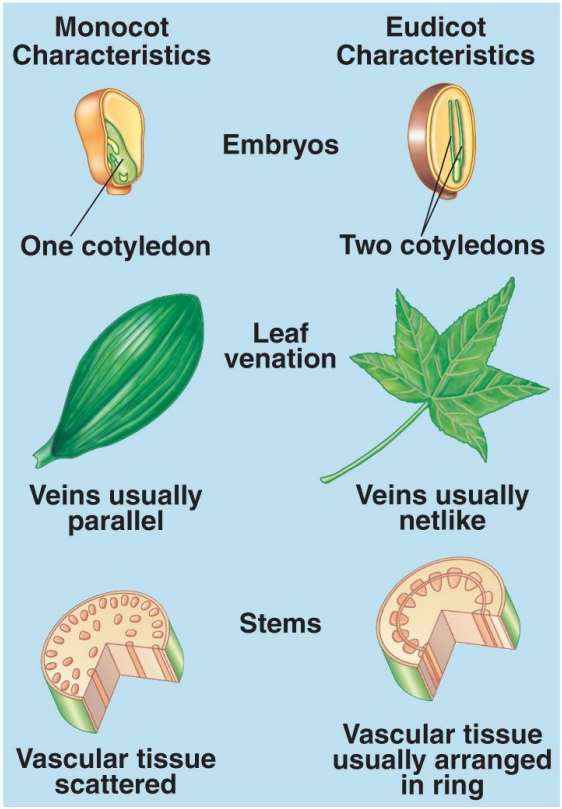
Monocots	**Dicots**
Embryo with 1 cotyledon, usually developing under ground	Embryo with 2 cotyledons, usually developing above ground
Roots usually fibrous	A primary root usually present
Growth is mostly herbaceous	Growth either herbaceous or woody
Vascular bundles scattered	Vascular bundles usually forming a ring
Leaves usually parallel-veined	Leaves usually net-veined
Flower parts usually in multiples of 3	Flower parts usually 4 or 5



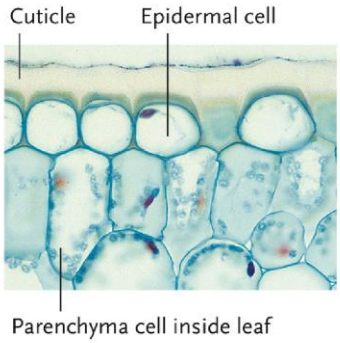



Eudicots and Monocots Compared
Character
Eudicots
Monocots
Cotyledons
Cotyledons
Cotyledon
Inside seeds, two cotyledons (seed leaves of embryo)
Inside seeds, one cotyledon (seed leaf of embryo)
Floral parts
Usually four or five floral parts (or multiples of four or five)
Usually three floral parts (or multiples of three)
Leaf veins
Leaf veins usually in a netlike array
Leaf veins usually running parallel with one another
Location of vascular bundles
Vascular bundles arranged as a ring in ground tissue of the stem
Vascular bundles scattered throughout ground tissue
Root system
Usually a main taproot with smaller lateral roots
Usually a branching fibrous root system


Monocot Characteristics
Eudicot Characteristics
Roots
Root system usually fibrous (no main root)
Taproot (main root) usually present
Pollen
Pollen grain with one opening
Pollen grain with three openings
Flowers
Floral organs usually in multiples of three
Floral organs usually in multiples of four or five

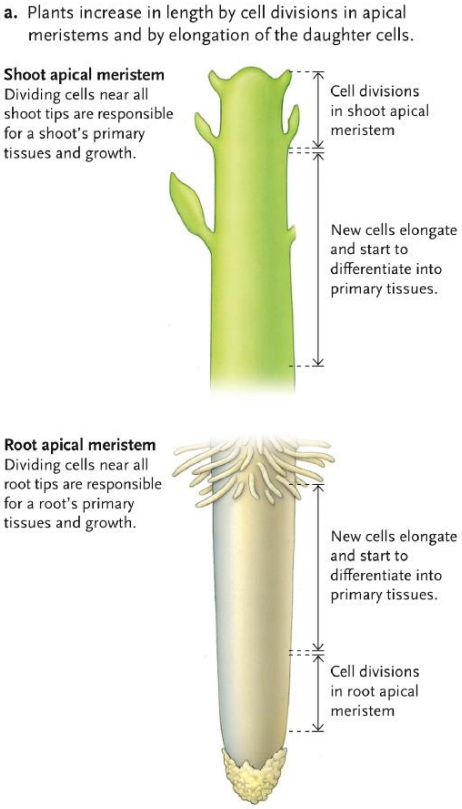

Monocot Characteristics
Eudicot Characteristics
Embryos
One cotyledon
Two cotyledons
Leaf venation
Veins usually parallel
Veins usually netlike
Stems
Vascular tissue scattered
Vascular tissue usually arranged in ring

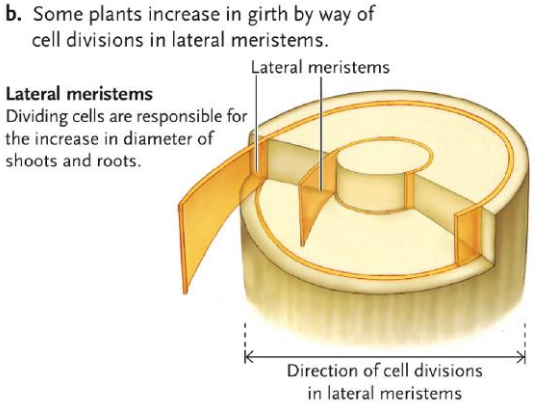
- Dermal Tissue
    - Epidermis covers primary plant body
        - Cuticle layer restricts water loss
        - Pairs of guard cells in leaf epidermis create stomata for gas exchange
            - Gives rise to the ground cells
        - Epidermal specialization
        - Trichomes (hairs)
        - absorbent root hairs
    - Periderm
        - Cork, cork cambium, and secondary cortex



Growth in Plants

- Determinate growth common in animals
- Indeterminate growth in plants
    - Plants grow throughout its life
    - Meristems give rise to plant body
- Animal cells It stops growing after maturation
- Plant cells it never stops growing!
    - Plasticity of growth → provides some flexibility, since plants cannot move around
    - Great capacity to change in their environment
    - Physically larger/great capacity to change the size of the cells and number of cells, which helps plants to respond to their environment
    - Plants grow by increasing the number of cells Or increasing the size of cells
- Types of growth
    - **Primary growth**
    - Apical meristems at root and shoot tips
        - Self-perpetuating cluster of cells
        - Increases height of shoot, length of roots [Upwards/downwards]
    - **Secondary growth**
    - Lateral meristems at root and shoot tips →Self-perpetuating cylinder of tissue
    - Widening and thickening of plant cells
        - Horizontal Growth
    - Mostly eudicots





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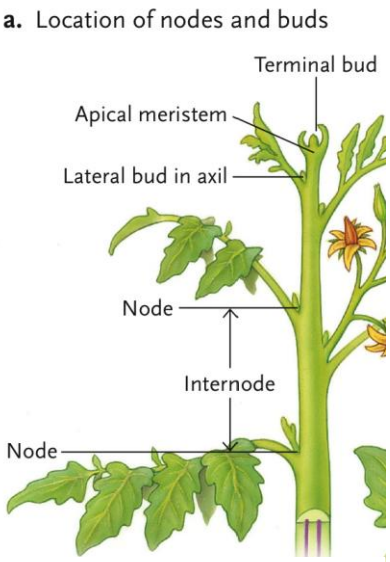
Plant Body

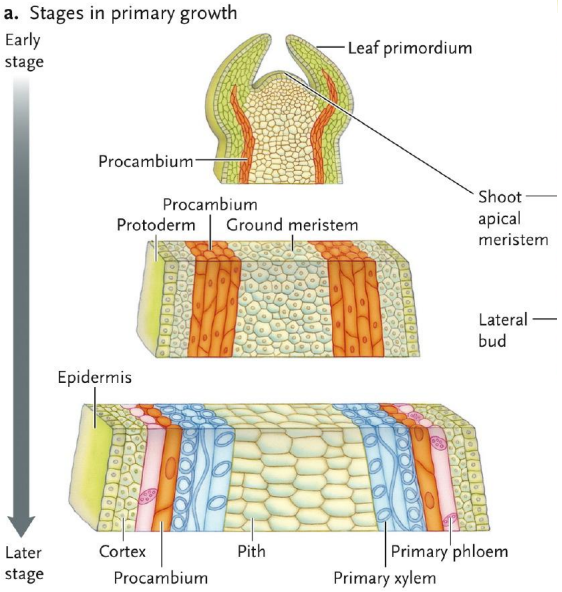
Primary Shoot System

- Consists of main stem, leaves and buds
  - Plus any attached flowers and fruits
- Stems are adapted to provide
  - Mechanical support
  - House vasular tissues
  - Food and water storage
  - Buds and meristems for growth
- Leaves carry out photosynthesis and gas exchange
- Nutrient is stored



Stems

- Organized into modular segments
  - Nodes → where leaves are attached
  - Internodes → between notes
  - Terminal bud → at apex of main shoot
  - Lateral buds → in leaf axils, produce branches



Primary Growth and Stems

- Primary growth produces primary plant body
  - Epidermis →skin, covers the plant

Derivatives of the Apical Meristem

- Three primary meristems
- Protoderm → produces stem's epidermis
- Procambium → produces primary xylem and phloem
- Ground meristem → produces ground tissue

Modified Stems

- Propagate outwards
- Modified to store sugar
- Root → root hair on it

Potato is a stem not a root
Stem → have buds (eyes)

Spatial & Temporal variation in temperature

- Ocean environments are less variable than those on land
  - Angiosperms and gymnosperms → spread on areas that are old and/or seasonal
  - Evolutionary response to environment

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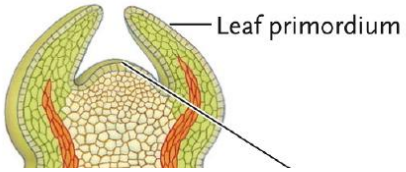
Plant Body

Primary Growth and Leaves



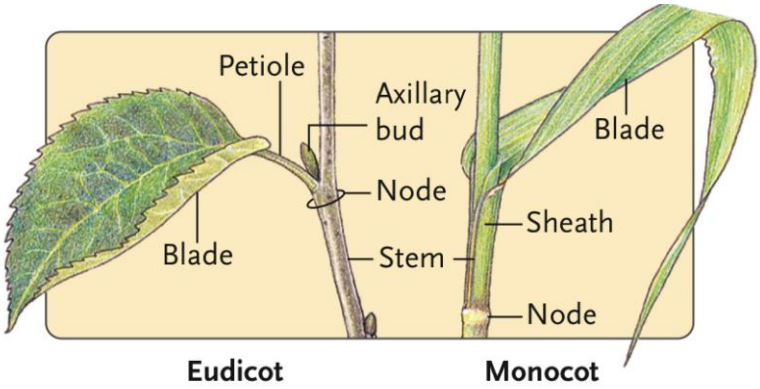
- Leaf Primordia gives rise to leaves

Eudicot and Monocot Leaf forms

- Blade → large surface area for absorbing sunlight and CO_2

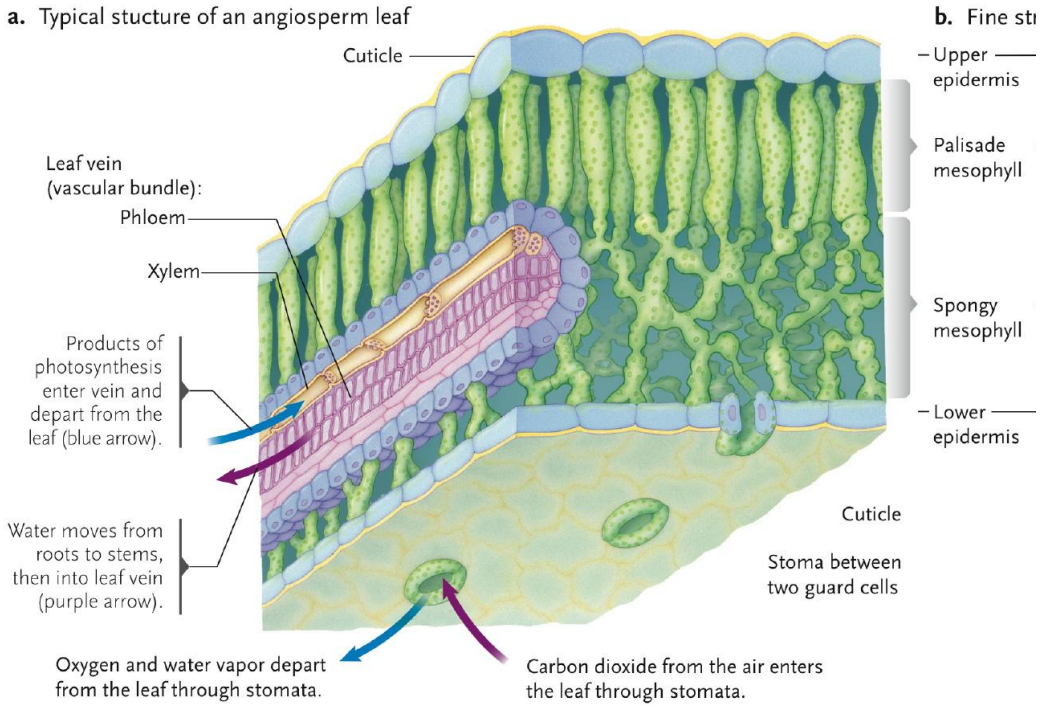
Leaf Adaptation

- Response to environmental and herbivore pressures
- Plants being able to sense around them without vision



Leaf internal structure

- Mesophyll spongy area
- Guard cells
- Vascular bundles
- Phloem takes sugar
- Xylem nutrients



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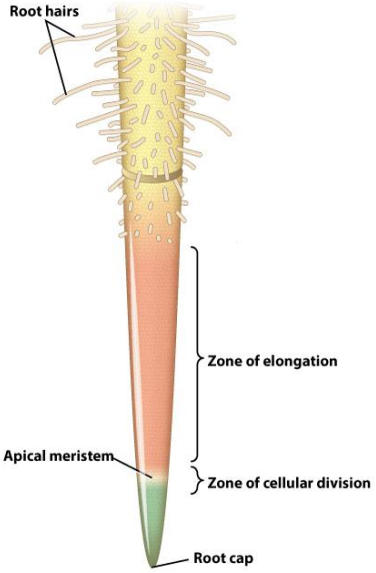
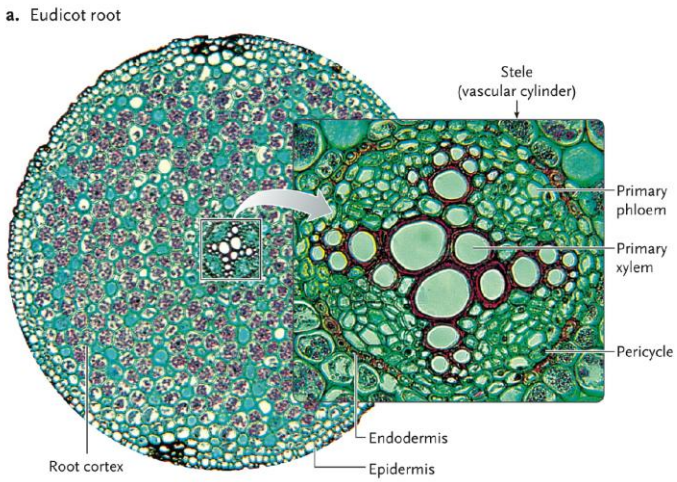
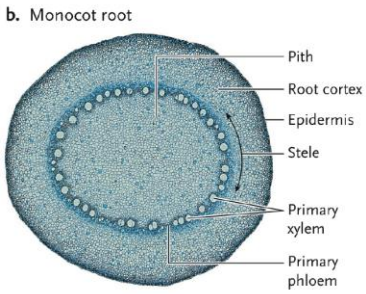
Plant Body

Root Systems

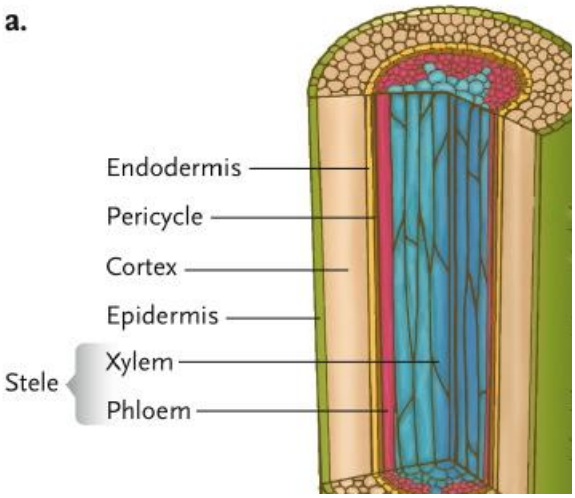
- Structure is specialized for underground growth
  - Absorb water and dissolved minerals
  - Conduct water and minerals to aerial plant parts (xylem sstem)
  - Anchor and support aboveground parts
  - Store nutrients produced by photosynthesis
- Types of roots:
  - taproots → usually in eudicots, access water deep down in the soil
    - Carrots
  - Fibrous root systems → located near the surface
    - Bamboo
  - Adventitious roots system
    secondary growth → could be roots, stem or bud
    - Rice, ivy
  - Gives structural support
  - Helps plants grow and survive
- Zones of Primary Root Growth
  - Zone of cell division
    - Root cap
    - Quiescent centre
  - Zone of elongation
    - Results in growing bigger, pushing the root caps deep into the soil
  - Zone of maturation
  - Tip → apical meristem
    - Acts as a helmet
- Eudicot vs. Monocot Root tissues
  - Eudicot → stele runs through centre of root
  - Stele forms ring and divides ground tissue into cortex and pith, in corn &other monocots







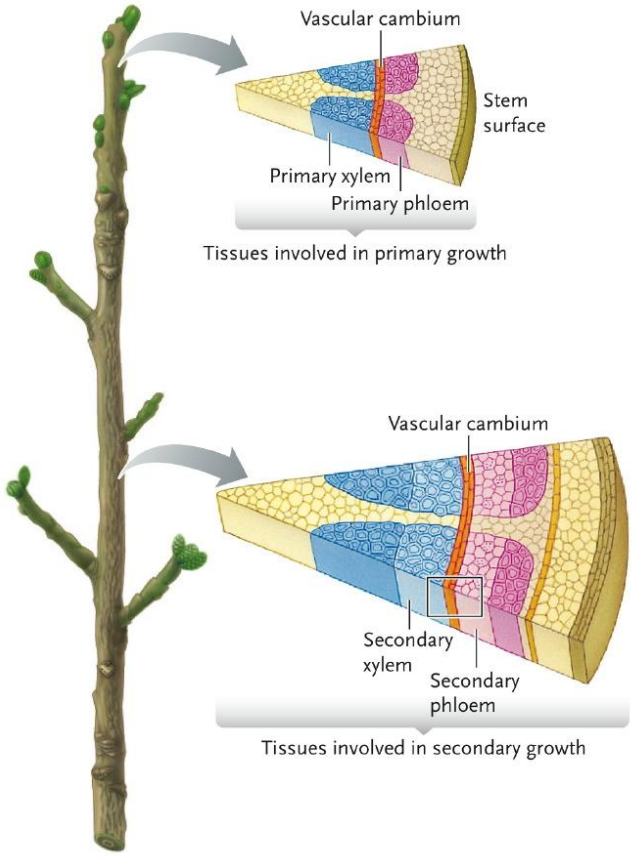
- Root Vascular Tissues
    - Give rise to lateral roots and increases surface area
    - Exodermis
        - Outer layer of root cortex
    - Endodermis
        - Inner layer of root cortex
    - Pericycle
        - Between stele and endodermis
        - Can function as meristem



- Lateral Root Formation
    - Root primordia in pericycle form lateral roots
- Secondary Growth → an adaptive resistance response to lateral growth
    - Plants with taller stems or wider canopies can intercept more light energy from sun
    - With great energy supply for photosynthesis, have metabolic means to increase root and shoot systems
        - Better able to acquire resources and to ultimately reproduce successfully

Primary and Secondary Growth

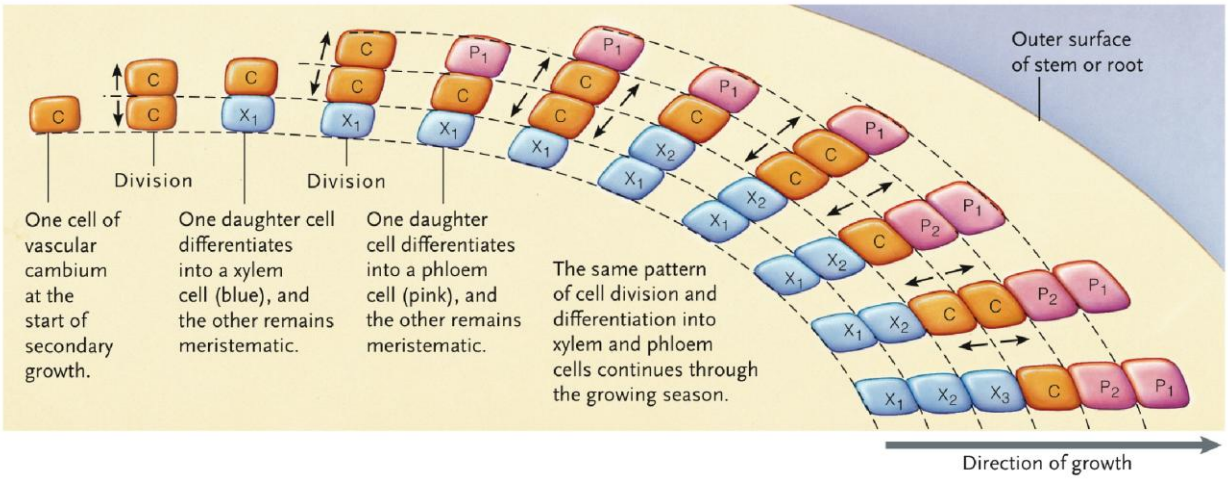
- Secondary growth increases girth of roots and stems
- Vascular cambium
  →Produces secondary xylem (wood) and secondary phloem
- Cork cambium
  →Produces cork, part of protective bark waterproof, well structured



Vascular Cambium

- Fusiform initials generate secondary xylem and phloem
- Ray initials produce horizontal water transport channels called xylem rays

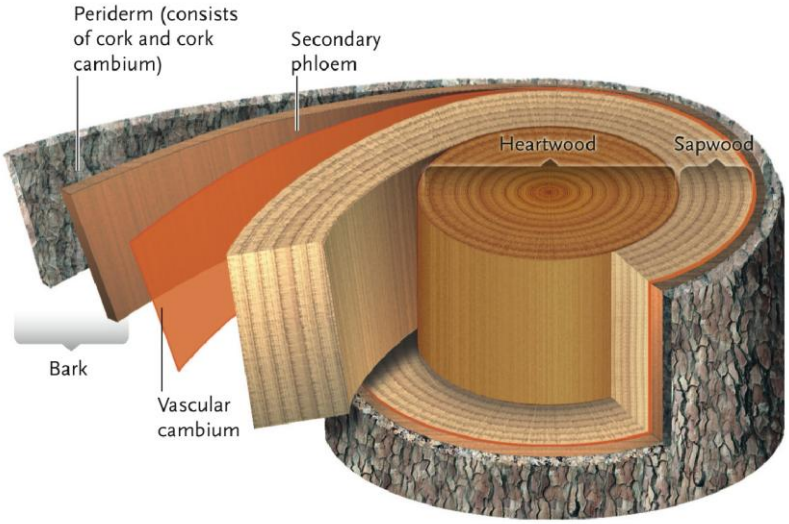
Vascular Cambium and Derivative Cells

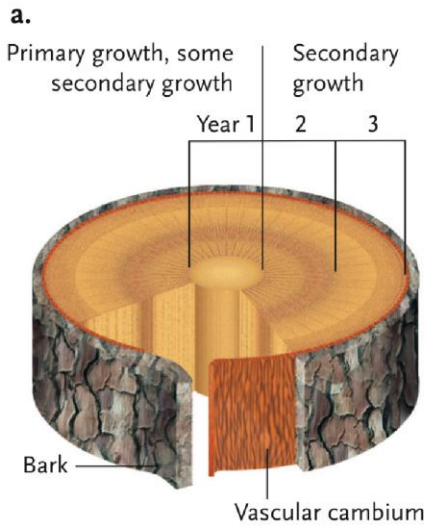


Woody Stem Structure

- Heartwood, sapwood

Secondary Growth and Tree Rings





Support of Growth

- Exogenous trees (all conifers, and almost all broadleaf trees), grow by the addition of new wood outwards, immediately under the bark
- As an exogenous tree grows, it creates growth rings as new wood is laid down concentrically over the old wood
  → newest in the centre of the trunk and older on the outside
- Endogenous trees, mainly monocotyledons (e.g. palm and dragon trees), but also cacti grow by addition of new material inwards

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Root Secondary Growth