

Botany for Master Gardeners

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Resources Educator
Cornell Cooperative Extension
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What is Botany?

The scientific study of plants.

Plant Biology

Molecular Biology
Biochemistry
Genetics
Anatomy
Physiology
Morphology
Ecology
Paleobotany
Systematics
Taxonomy

Organismal Specialties

Algae
Mosses
Ferns
Palms
Pines
etc
etc
etc

Applied Sciences

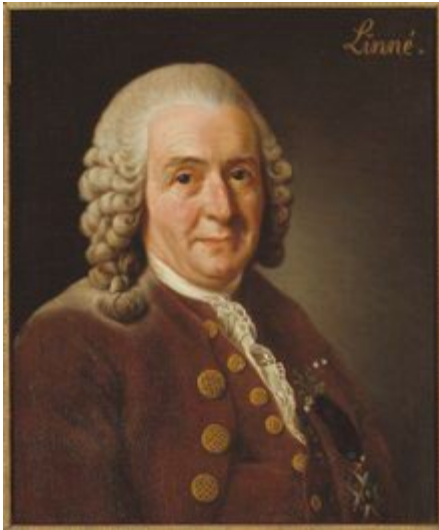
Breeding
Pathology
Weed Science
Agronomy
Forestry
Biotechnology
Natural Resources
Horticulture

Ethnobotany

People & Plants



Noteworthy Plant Scientists



Carl Linnaeus

1707-1778

Taxonomy &
Classification



Gregor Mendel

1882-1884

Genetics

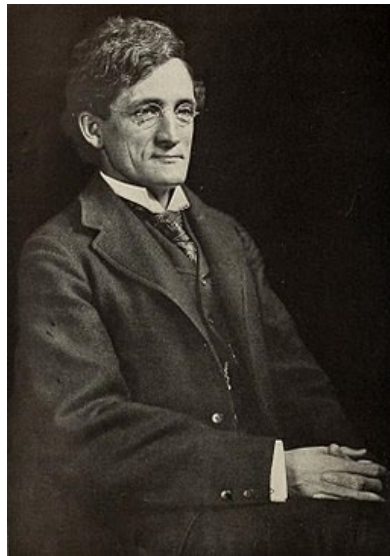


George Washington
Carver

1860-1843

Agriculture

Famous Cornellians



Liberty
Hyde Bailey

1858-1954
Taxonomy &
Classification
Palms
Agriculture



Barbara
McClintock

1902-1992
Genetics
Ethnobotany

Basic Concepts

Taxonomy



Anatomy



Physiology



Reproduction



Practical Applications

Naming, Identification

Planting, Pruning

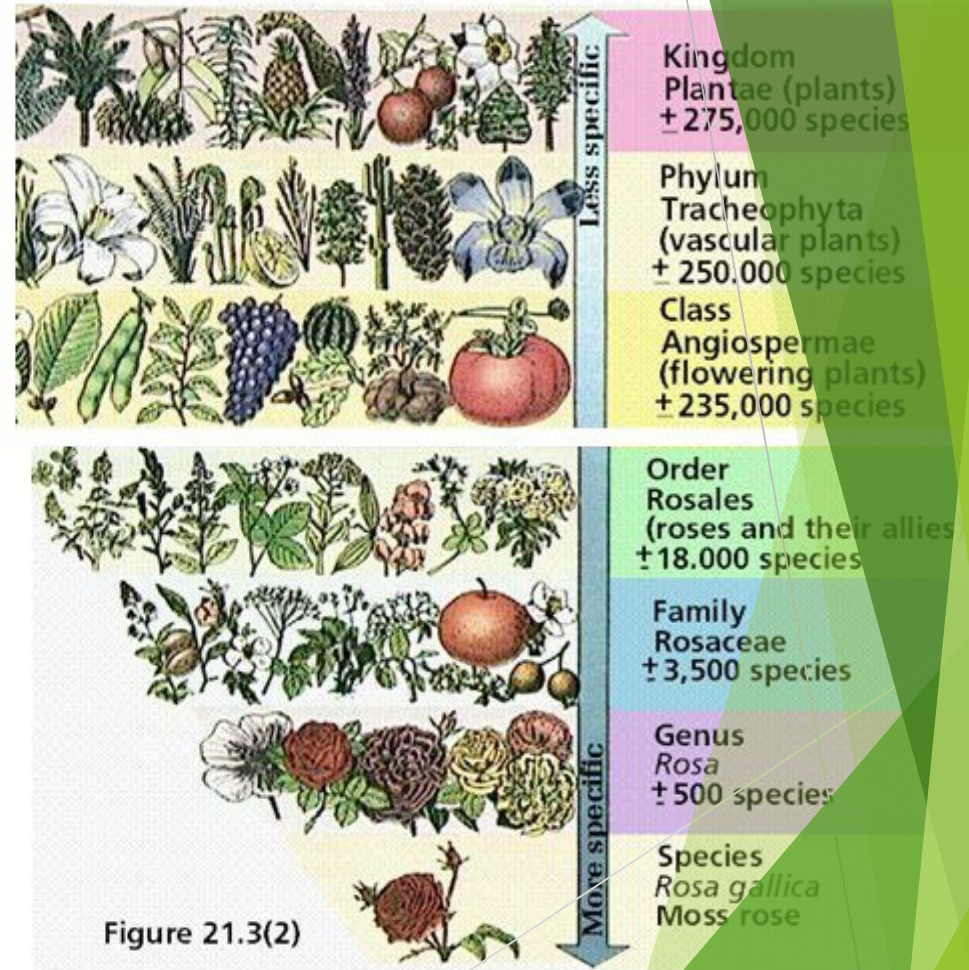
Watering, Fertilizing

Propagation

Taxonomy

Plant Classification

- Kingdom
- Phylum
- Class
- Order
- Family
- Genus
- Species



Binomial Nomenclature

Genus species



*Rhododendron
macrophyllum*



*Hydrangea
macrophyllum*

Binomial Nomenclature

Allium?



Common Name Confusion

Buttercup?



Ranunculus

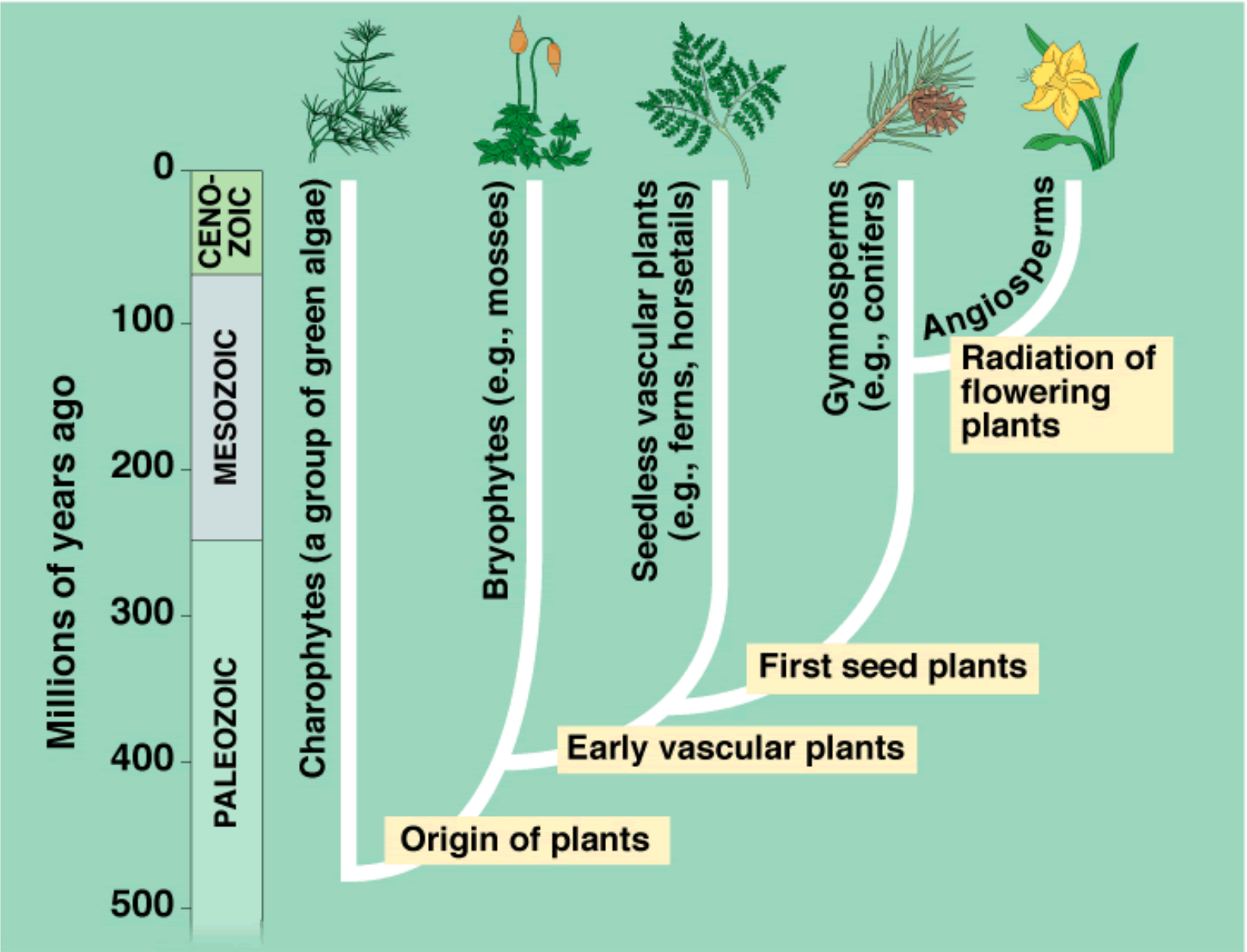


Oenothera

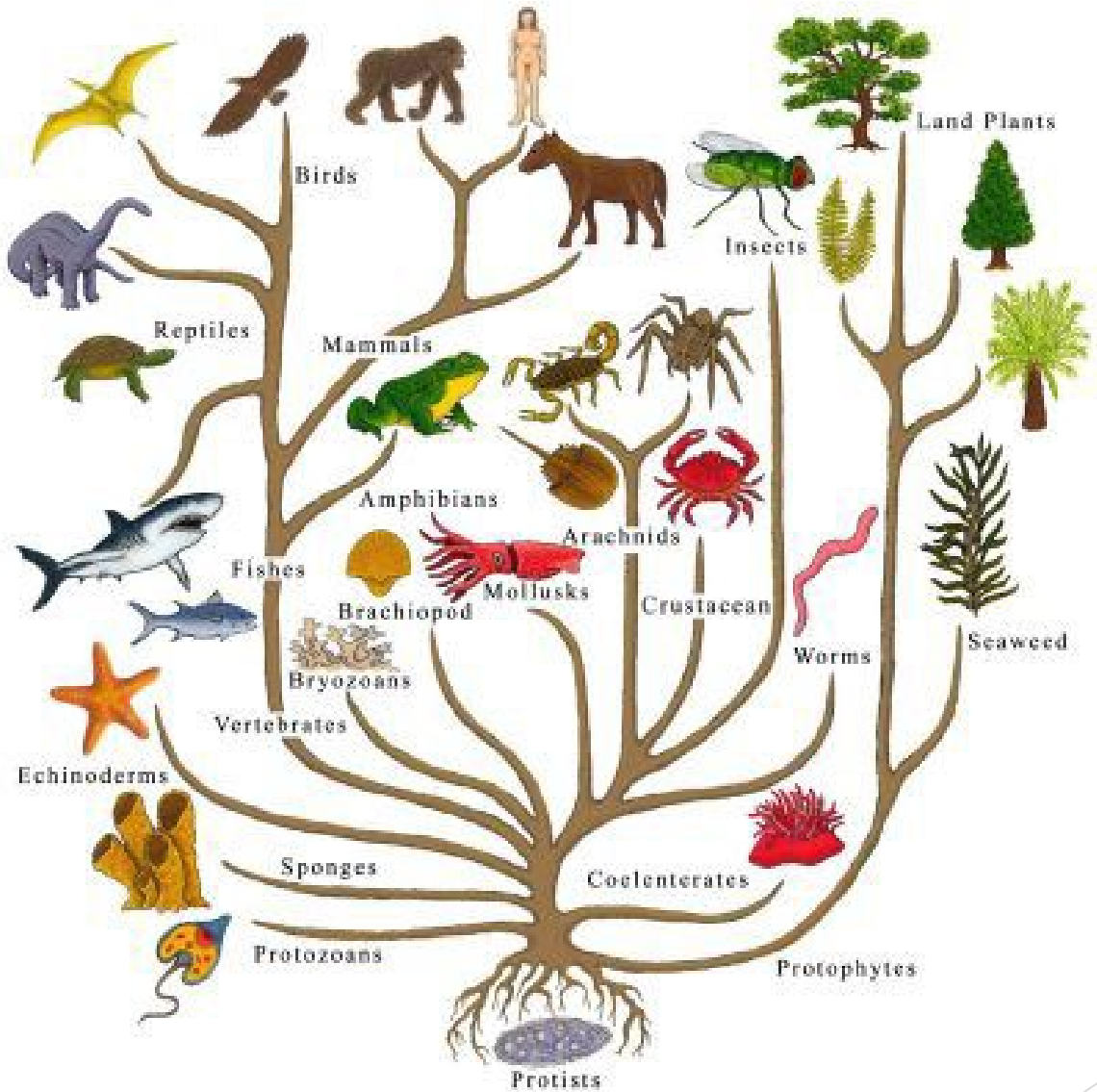


Oenothera

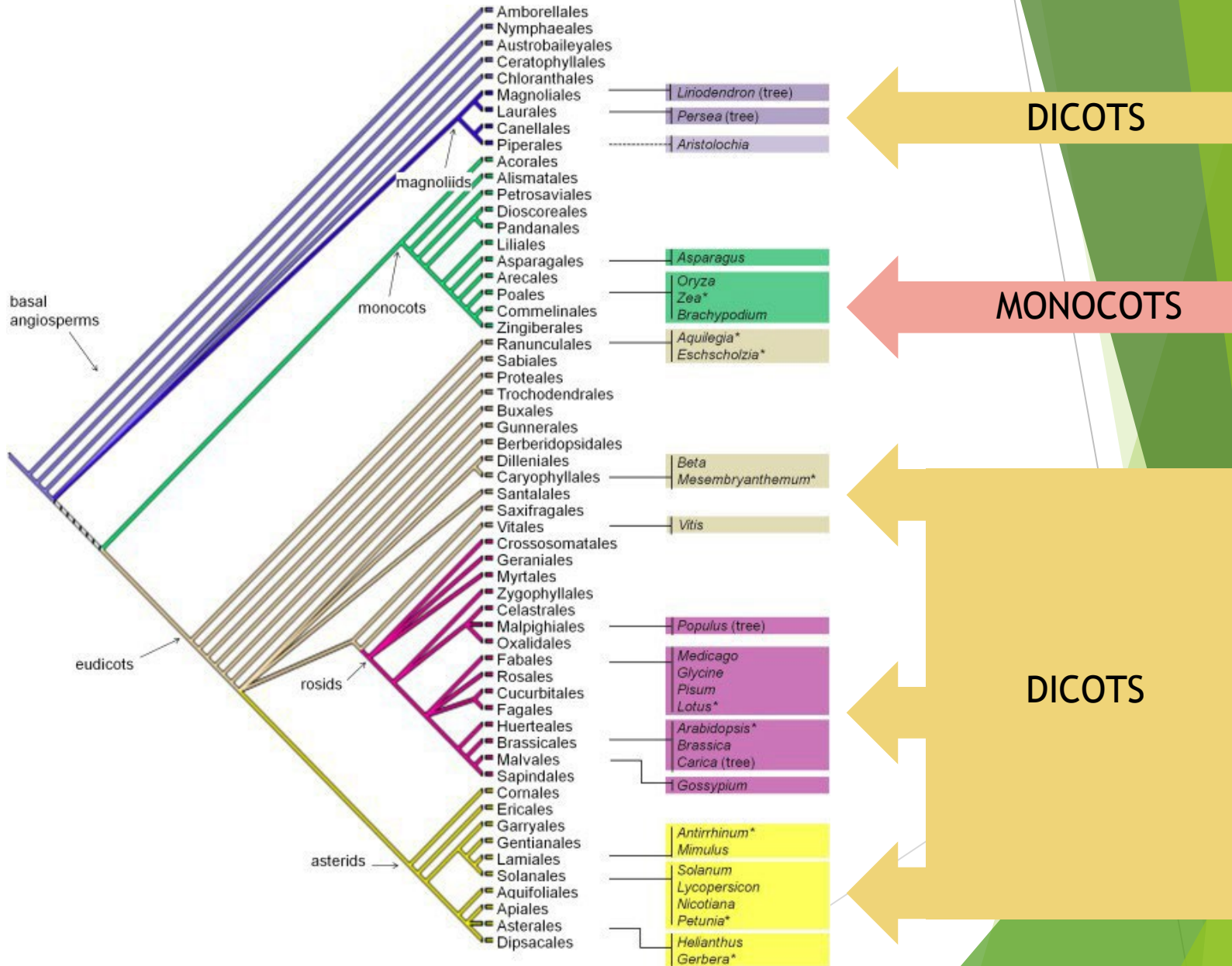
Plant Evolution



Co-evolution with Animals



Plant Classification



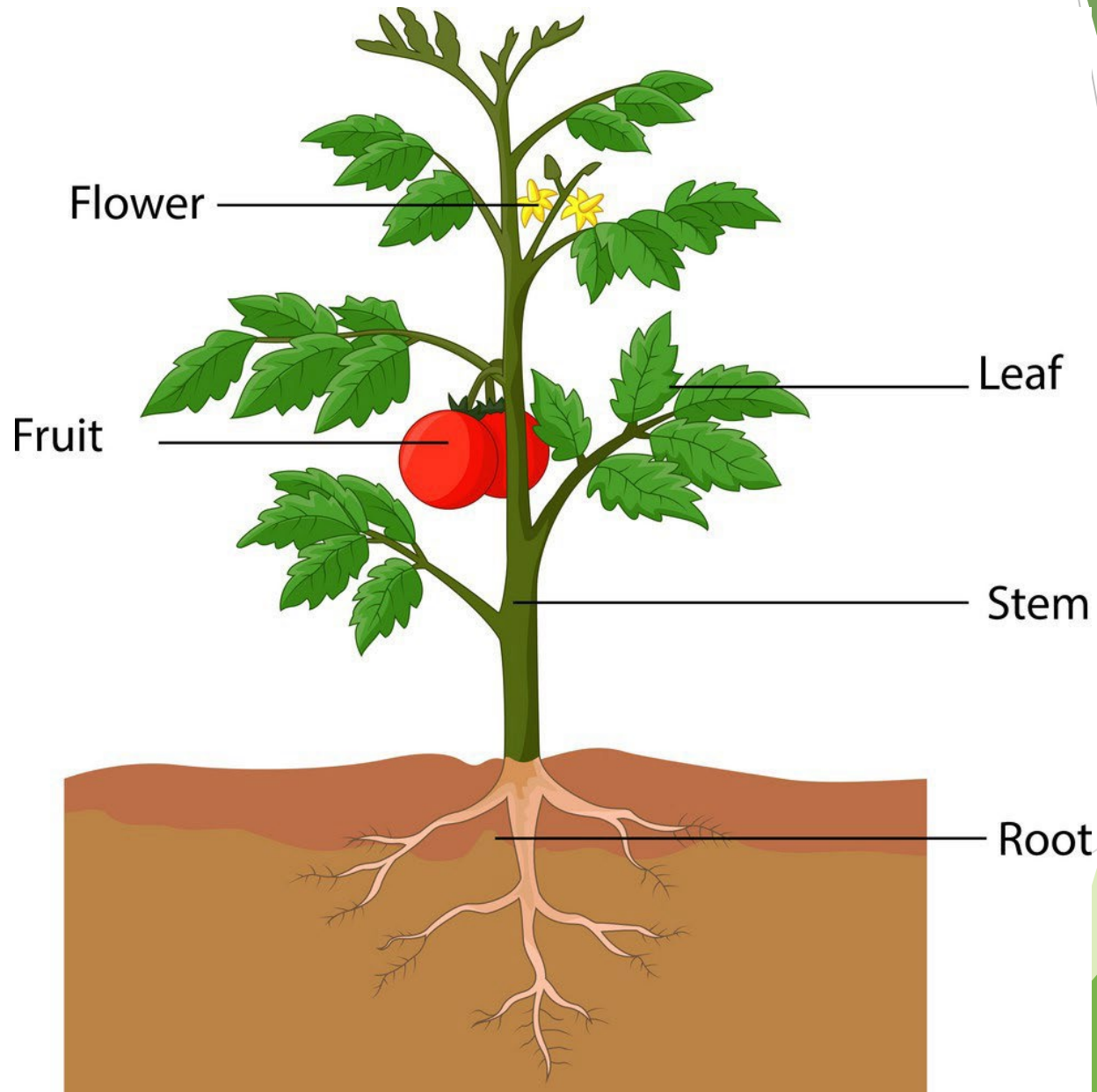
Monocot



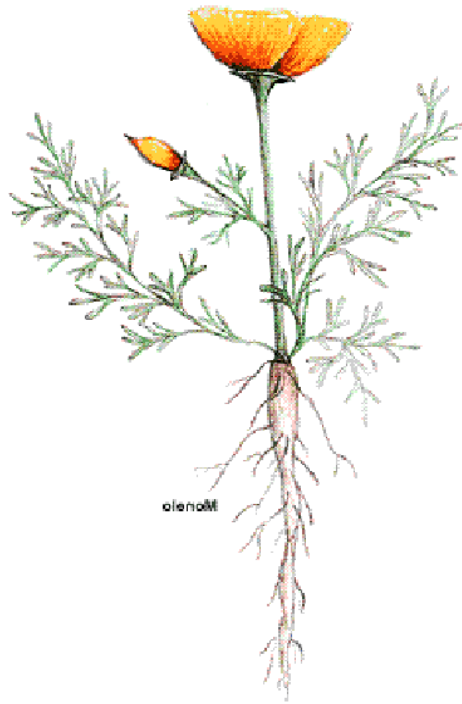
Dicot



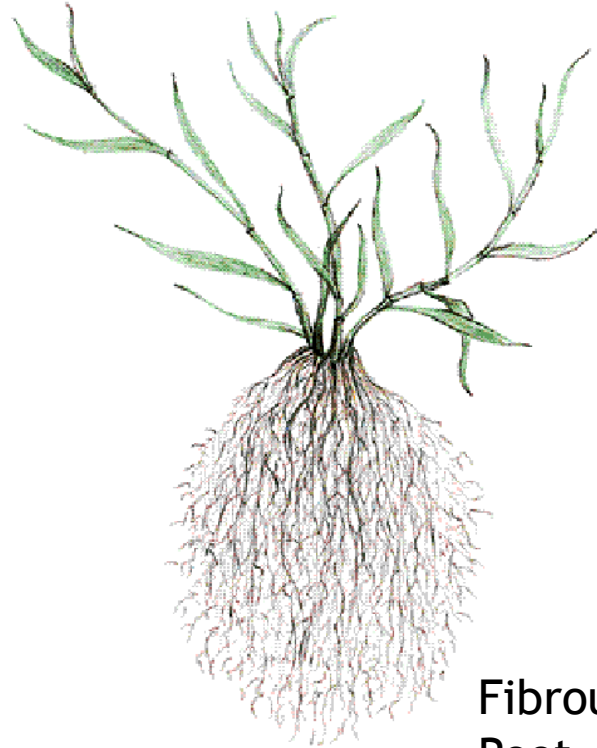
Plant Anatomy



Roots



Taproot



Fibrous
Root

Functions

- All plants: Water/nutrient uptake, anchoring, storage
- Some plants: extra storage, asexual reproduction

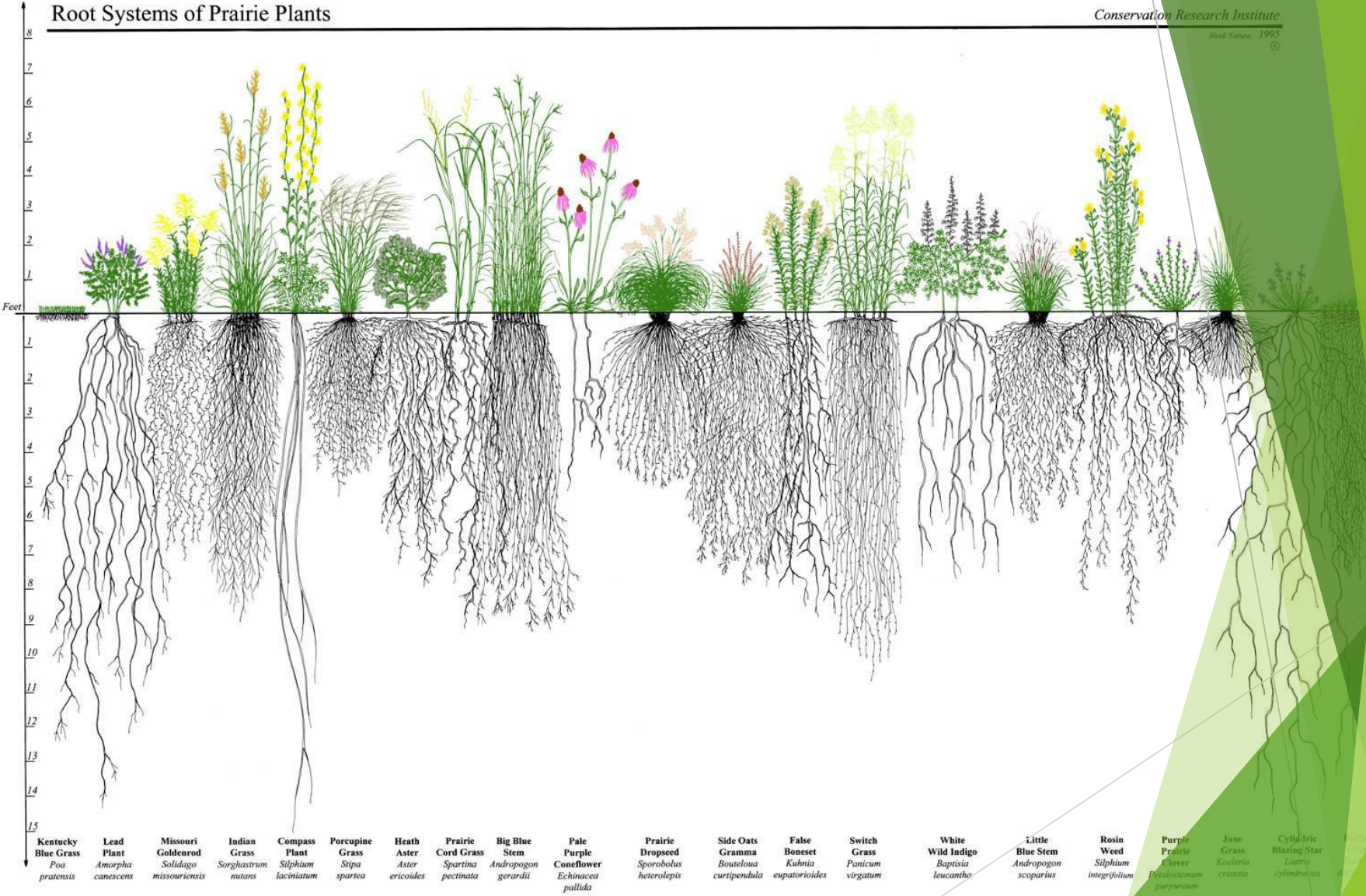
Roots

Root Systems of Prairie Plants

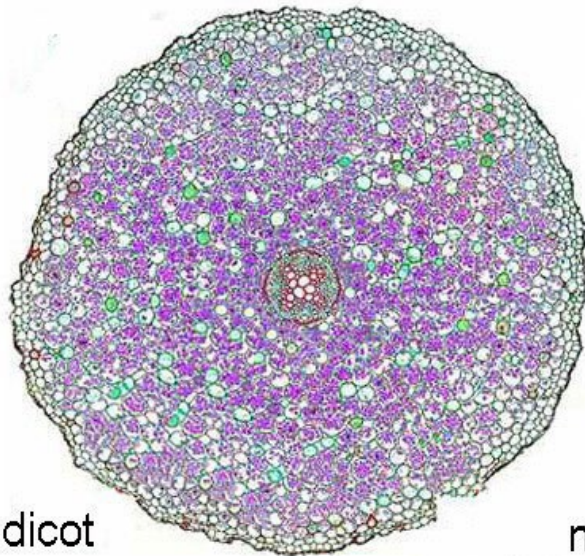
Conservation Research Institute

Heidi Nansen 1995

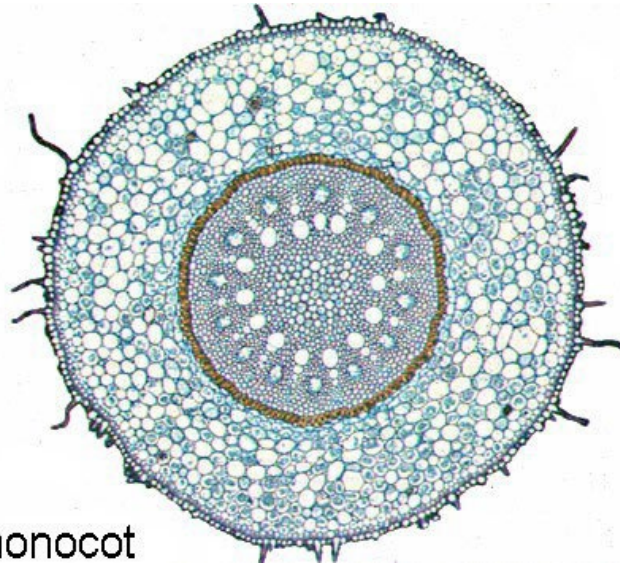
©



Roots

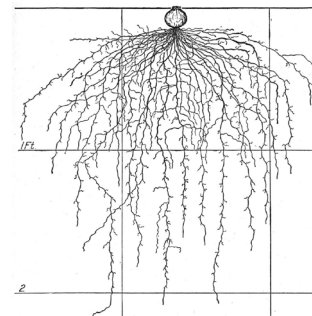
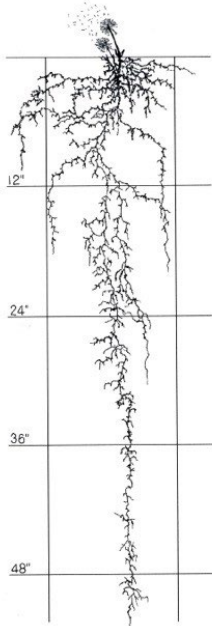


dicot



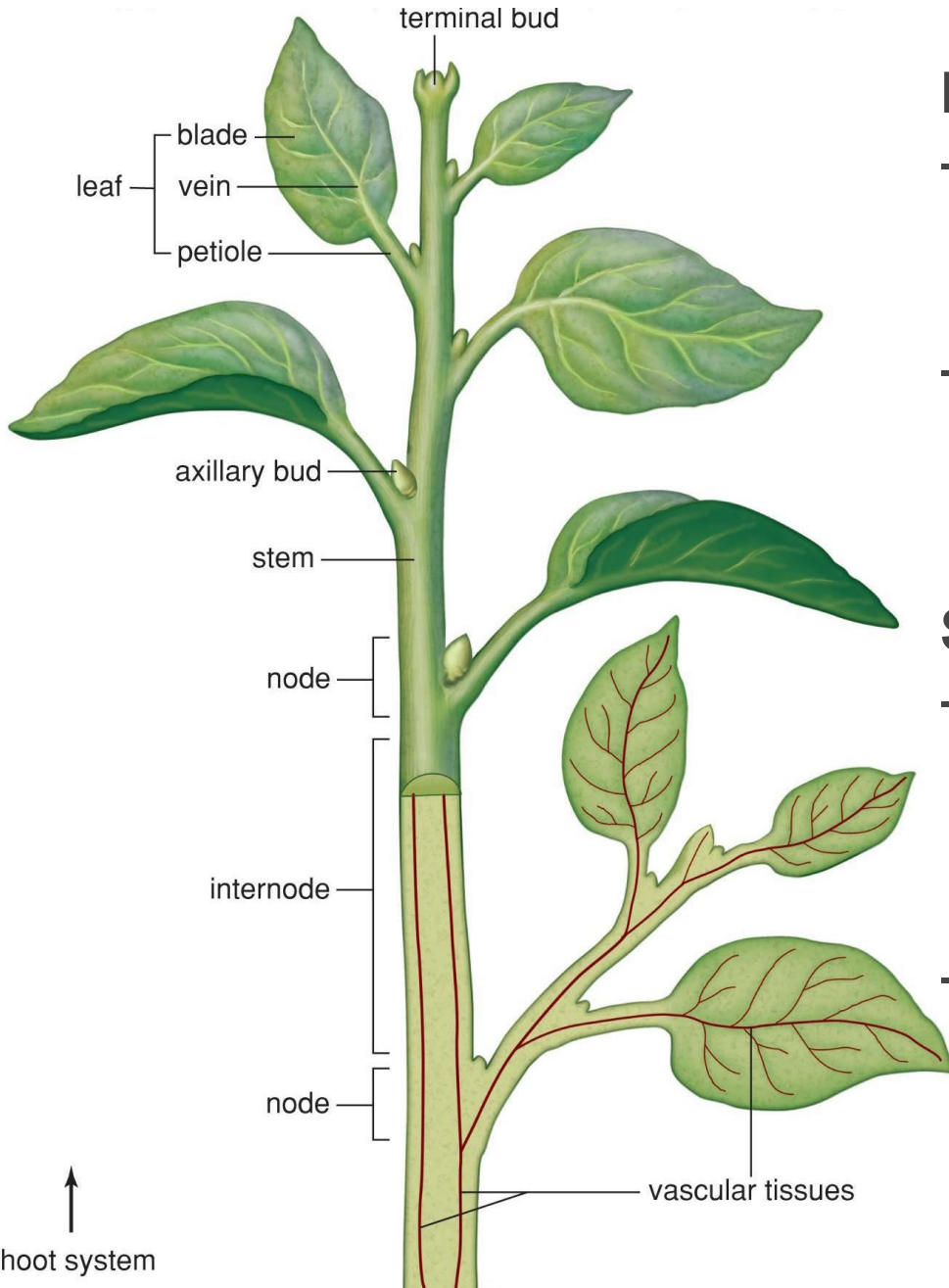
monocot

**Taproots &
Fibrous
Roots**



**Fibrous
Roots only**

Stems & Leaves



Leaf Functions

- All plants: Food production, gas exchange
- Some plants: storage, asexual reproduction

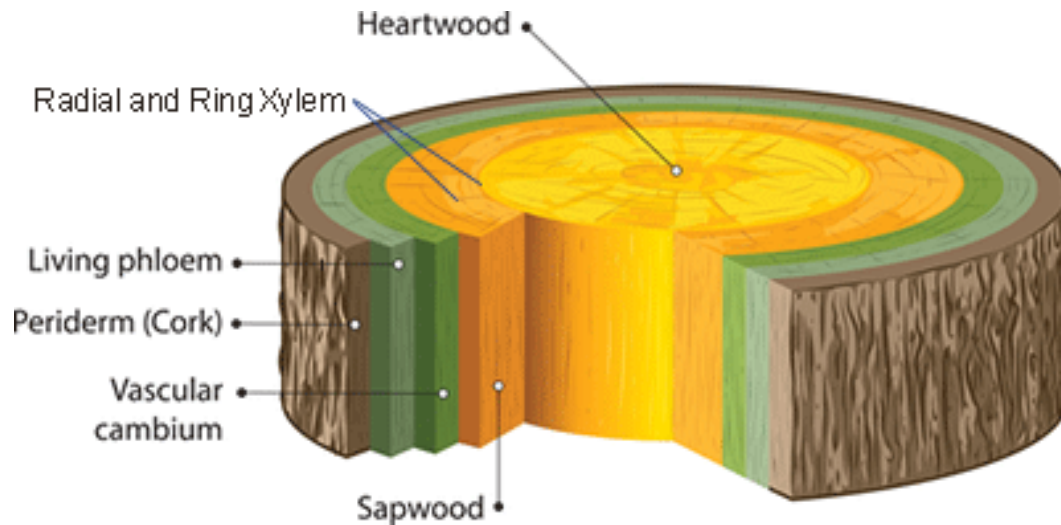
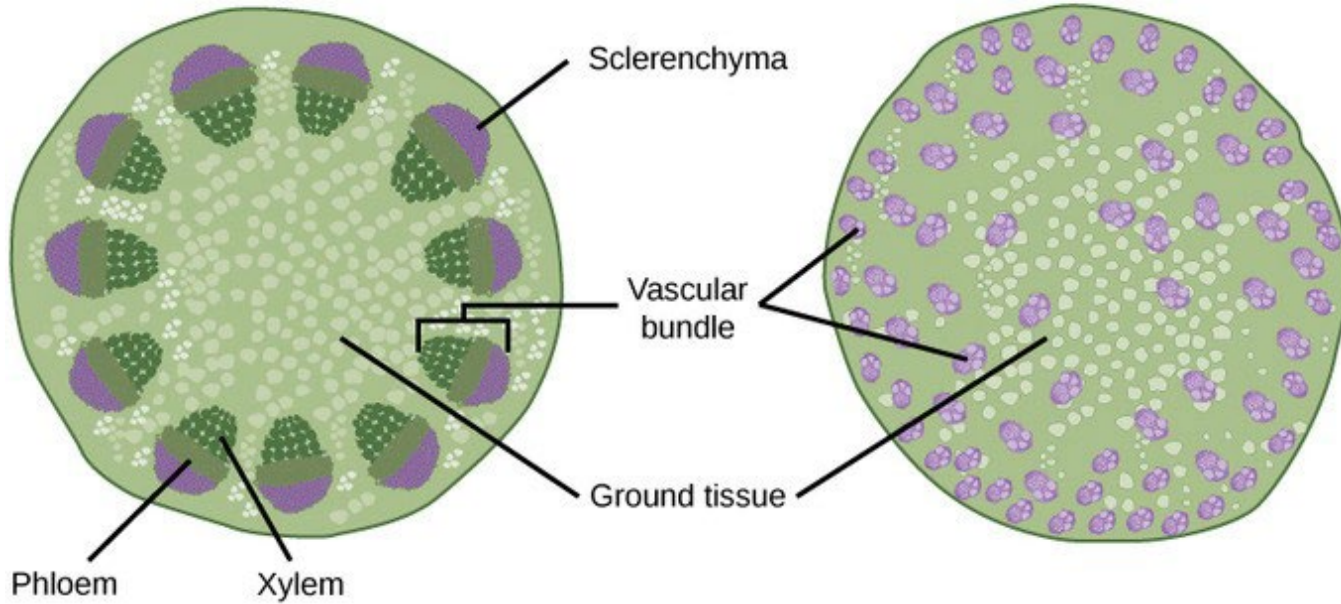
Stem Functions

- All plants: Water/nutrient transport, support, storage
- Some plants: extra storage, asexual reproduction

Stem Anatomy

Dicot stem

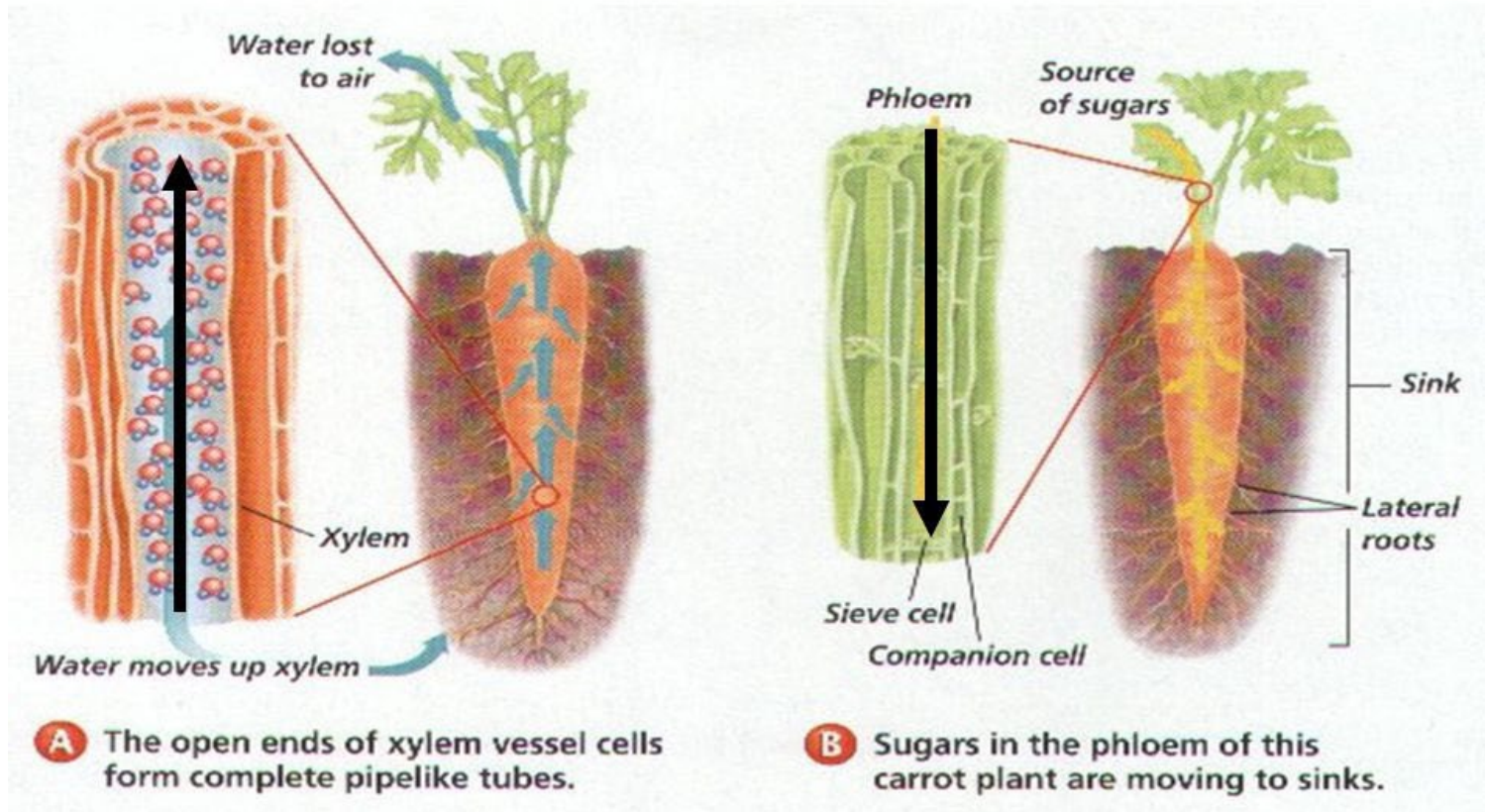
Monocot stem



Stem Anatomy

Xylem

Phloem



Stem Arrangement



Alternate



Spiral



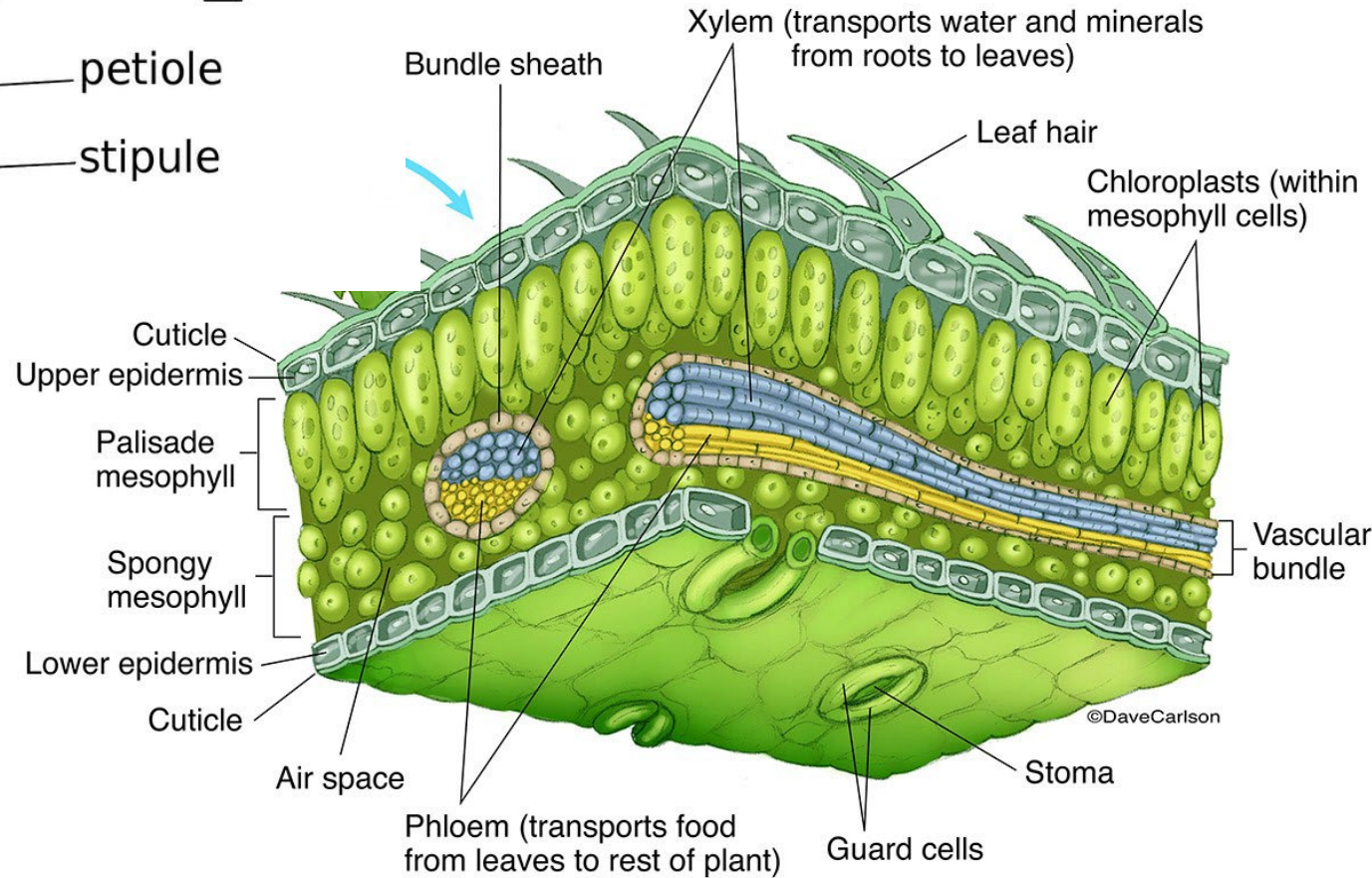
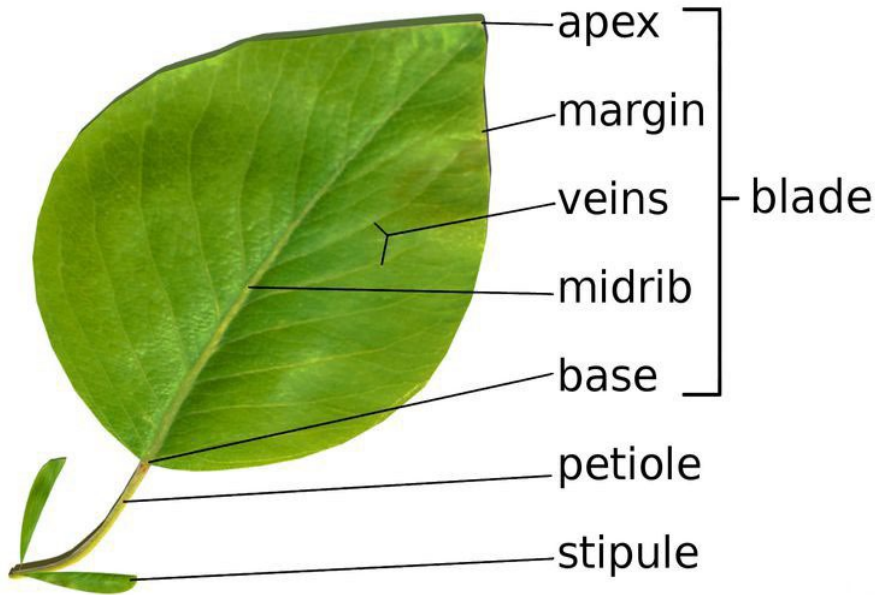
Opposite


























Whorled



Leaf Anatomy



Leaf Morphology

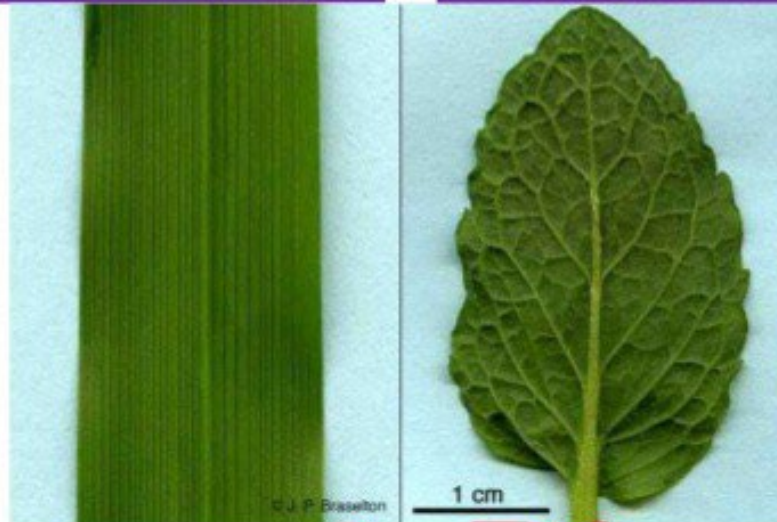
VENATION	SHAPES	ARRANGEMENT	MARGINS	ARRANGEMENT ON THE STEM
 <p>pinnate</p>	 <p>linear</p>  <p>obovate</p>  <p>ovate</p>	 <p>simple</p>  <p>palmately compound</p>	 <p>entire</p>  <p>crenate</p>	 <p>alternate</p>
 <p>parallel</p>	 <p>pinnately lobed</p>  <p>palmately lobed</p>  <p>reniform</p>	 <p>pinnately compound</p>	 <p>dentate</p>	 <p>opposite</p>
 <p>palmate</p>	 <p>lanceolate</p>  <p>sagittate</p>	 <p>bipinnately compound</p>	 <p>serrate</p>  <p>lobed</p>	 <p>opposite</p>

Leaf Morphology

Monocot & Dicot leaves

Long & slender leaf
Parallel veins

Broad leaf
Branching veins



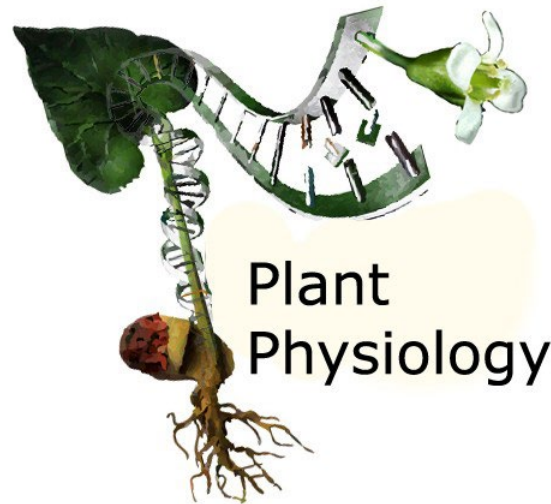
Monocot

Dicot

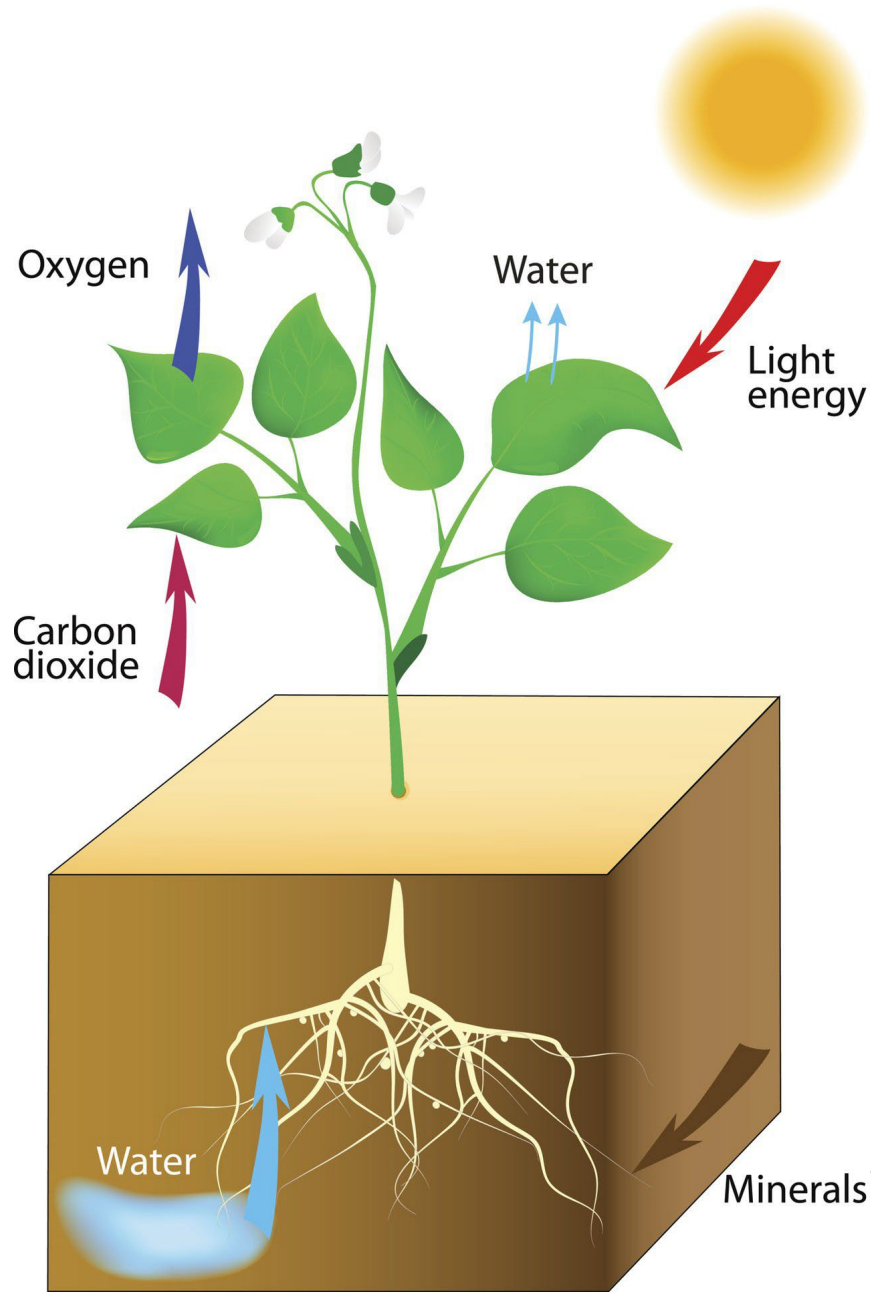
Plant Physiology

**Study of the functions of cells, tissues, and organs
AND the physics/chemistry of these functions**

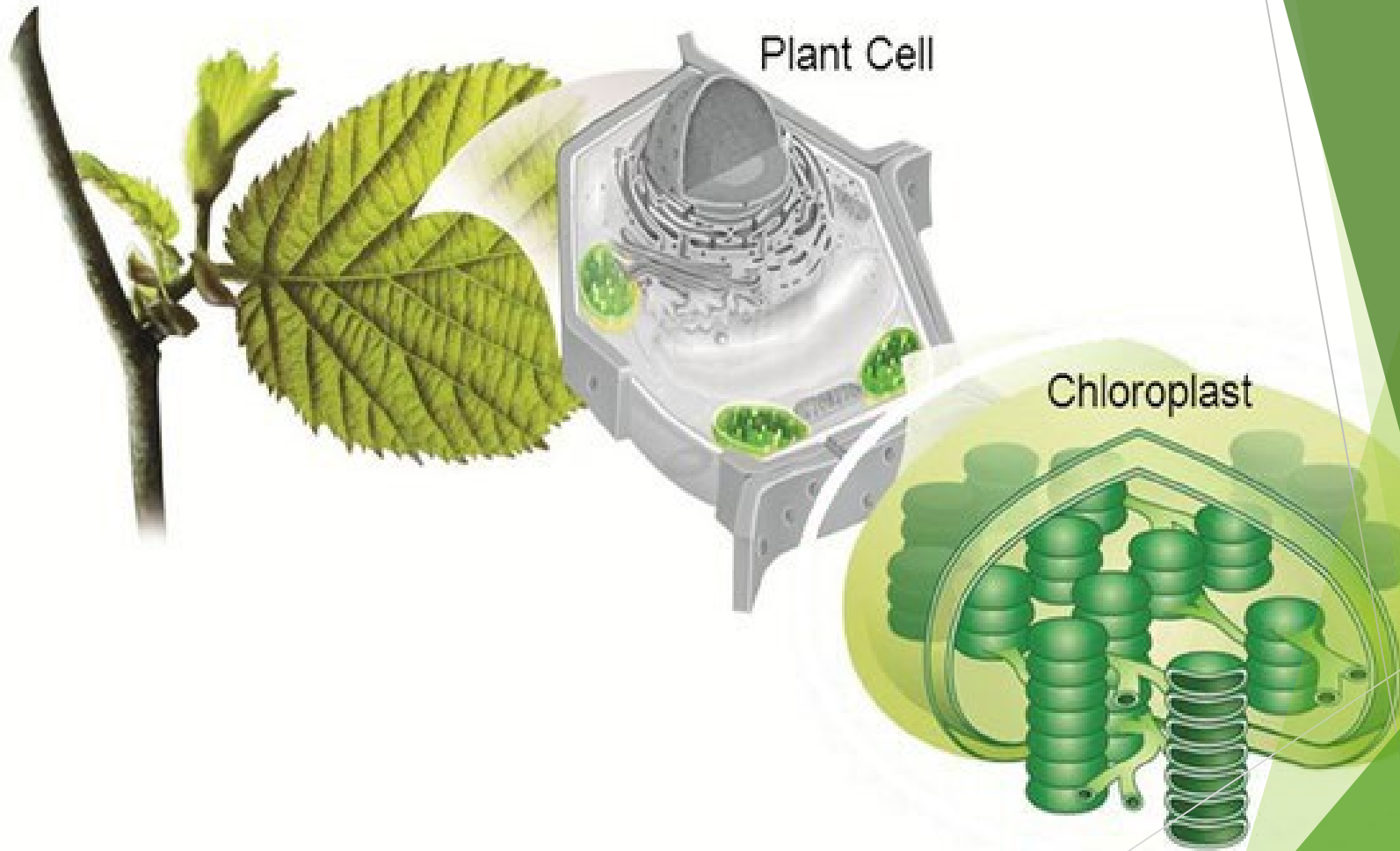
- Photosynthesis
- Hormones
- Senescence
- Nutrient uptake
- Stress responses
- Seed development & germination



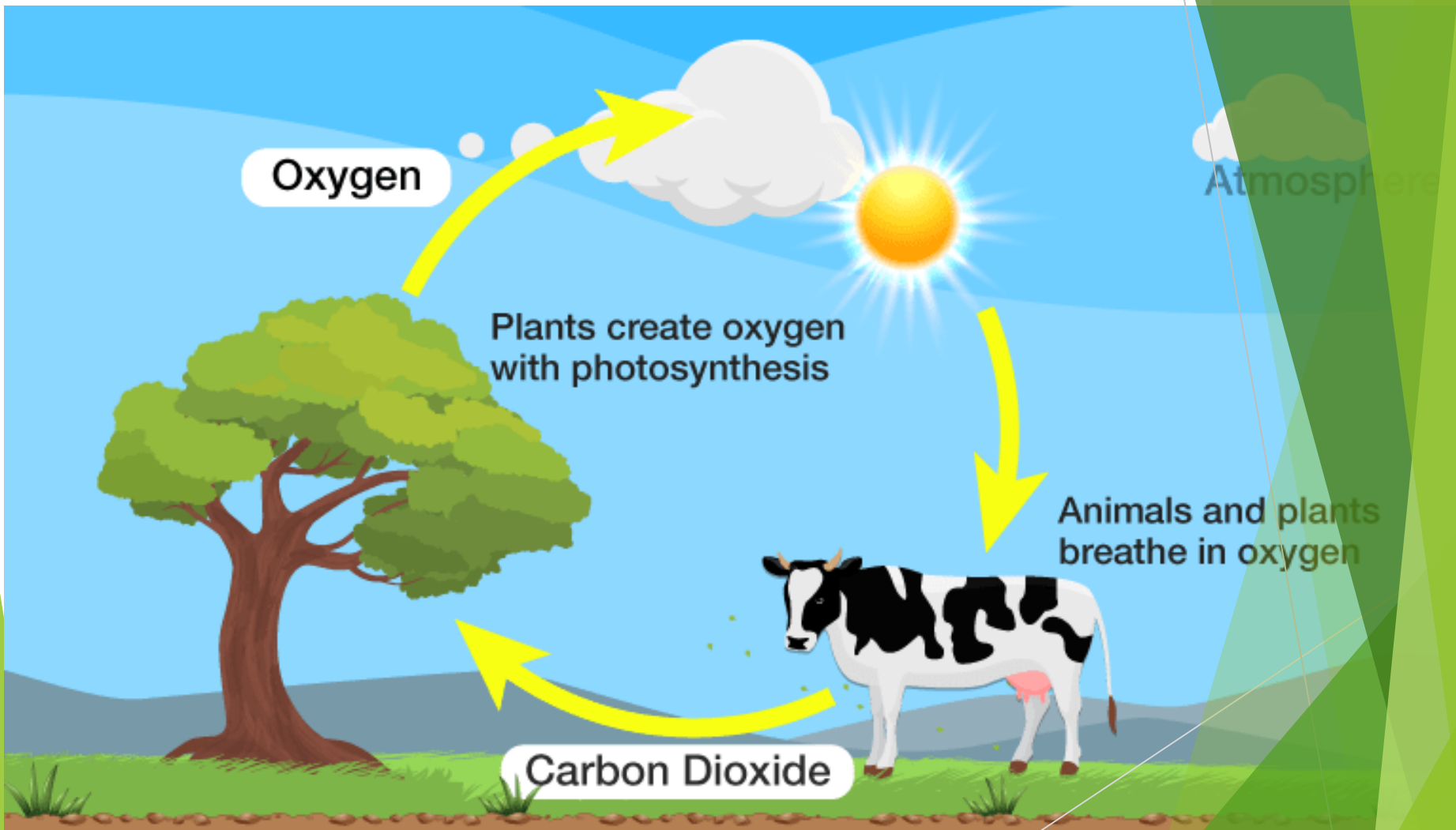
Photosynthesis



Photosynthesis

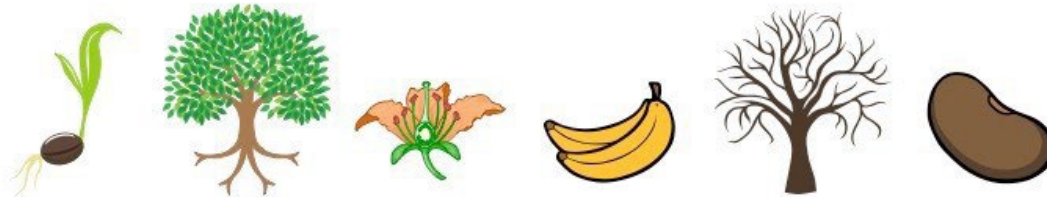


The Oxygen Cycle



Phytohormones

Hormones	Uses
Abscisic acid	Closing of stomata; seed dormancy
Auxins	Cell elongation and differentiation of shoots and roots
Cytokinins	Promote cell division, promotion of sprouting of lateral buds, delaying the ageing in leaves, opening of stomata.
Ethylene	Ripening of fruit
Gibberellins	Germination of seeds and sprouting of buds; elongation of stems; stimulation of flowering; development of fruit, breaking the dormancy in seeds and buds.



	Germination	Growth to Maturity	Flowering	Fruit Development	Abscission	Seed Dormancy
Gibberellin	✓	✓	✓	✓	✗	✗
Auxin	✗	✓	✓	✓	✗	✗
Cytokinins	✗	✓	✓	✓	✗	✗
Ethylene	✗	✗	✓	✓	✓	✗
Abscisic Acid	✗	✗	✗	✗	✓	✓

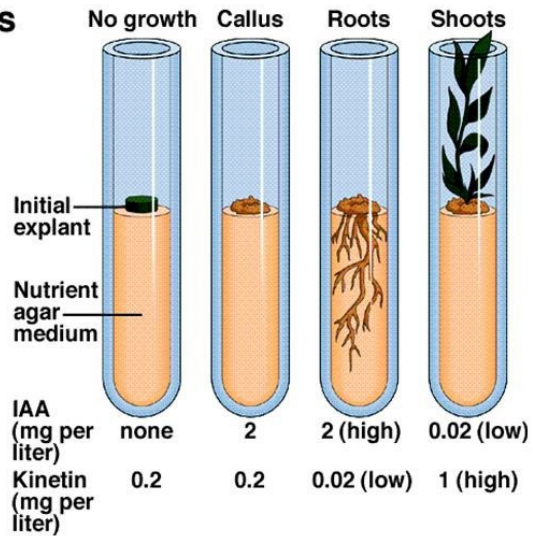
Phytohormones - Auxin



Phytohormones - Kinetin

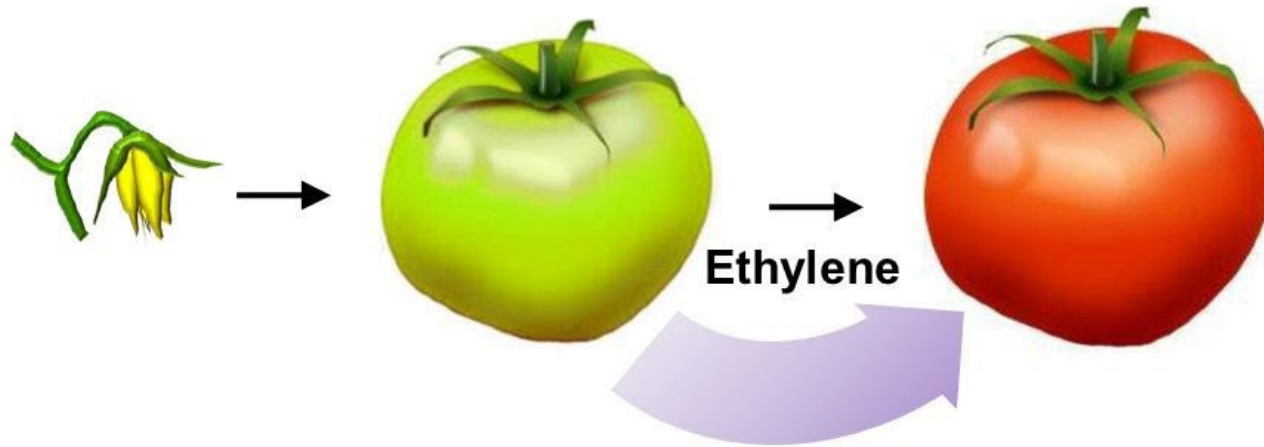
Cytokinin & tissue culture

Responses of Plant Tissue Culture to Kinetin and Auxin



Phytohormones - Ethylene

Fruit ripening is induced by ethylene



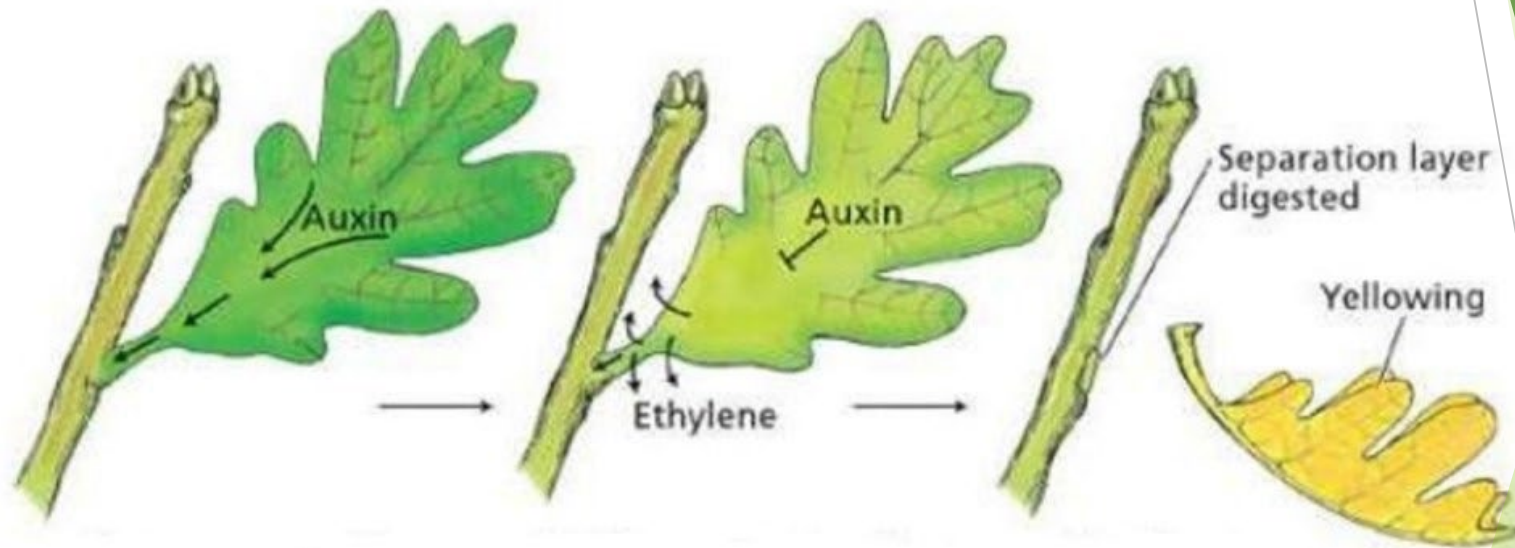
Ripening includes:

- Changes in cell wall structure
- Pigment accumulation
- Flavor and aromatic volatile production
- Conversions of starches to sugars

Phytohormones - Gibberelic Acid

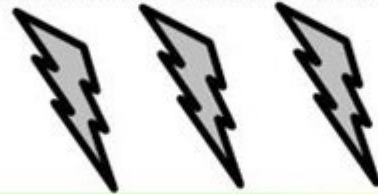
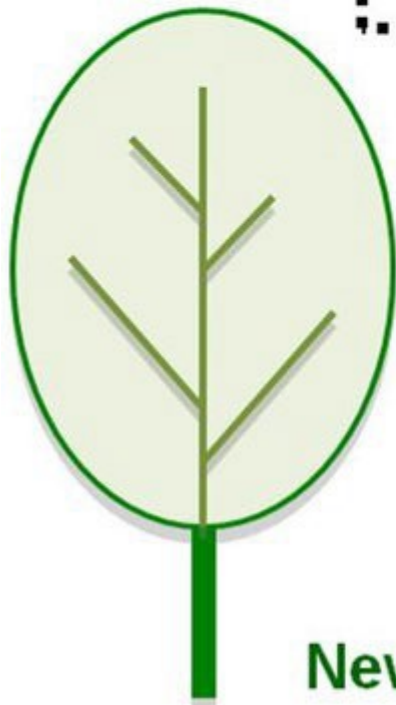


Phytohormones - Abscisic Acid



Leaf Senescence

Age of the plant
Environmental changes
Developmental cues
Ethylene and other hormones



Nutrients



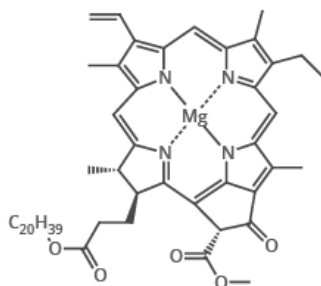
Newly growing and storage tissues

Pigmentation

THE CHEMISTRY OF THE COLOURS OF AUTUMN LEAVES



CHLOROPHYLL

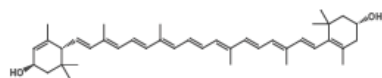


CHLOROPHYLL A
A type of chlorin

Chlorophyll is the chemical that gives plant leaves their green colour. Plants require warm temperatures and sunlight to produce chlorophyll - in autumn, the amount produced begins to decrease, and the existing chlorophyll is slowly broken down, diminishing the green colour of the leaves.

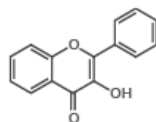


CAROTENOIDS & FLAVONOIDS

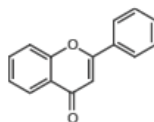


LUTEIN
A type of carotenoid

Carotenoids and flavonoid pigments are always present in leaves, but as chlorophyll is broken down in the autumn their colours come to the fore. Xanthophylls, a subclass of carotenoids, are responsible for the yellows of autumn leaves. One of the major xanthophylls, lutein, is also the compound that contributes towards the yellow colour of egg yolks.



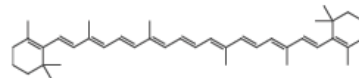
FLAVONOL
(general structure)



FLAVONE
(general structure)



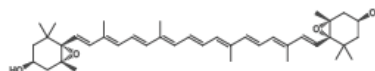
CAROTENOIDS



B-CAROTENE
A type of carotenoid

Carotenoids can also contribute orange colours. Beta-carotene is one of the most common carotenoids in plants, and absorbs green and blue light strongly, reflecting red and yellow light and causing its orange appearance. It is also responsible for the orange colouration of carrots.

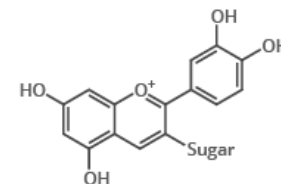
Carotenoids in leaves start degrading at the same time as chlorophyll, but they do so at a much slower rate; beta-carotene is amongst the most stable, and some fallen leaves can still contain measurable amounts.



VIOLAXANTHIN
A type of carotenoid

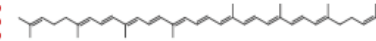


ANTHOCYANINS & CAROTENOIDS



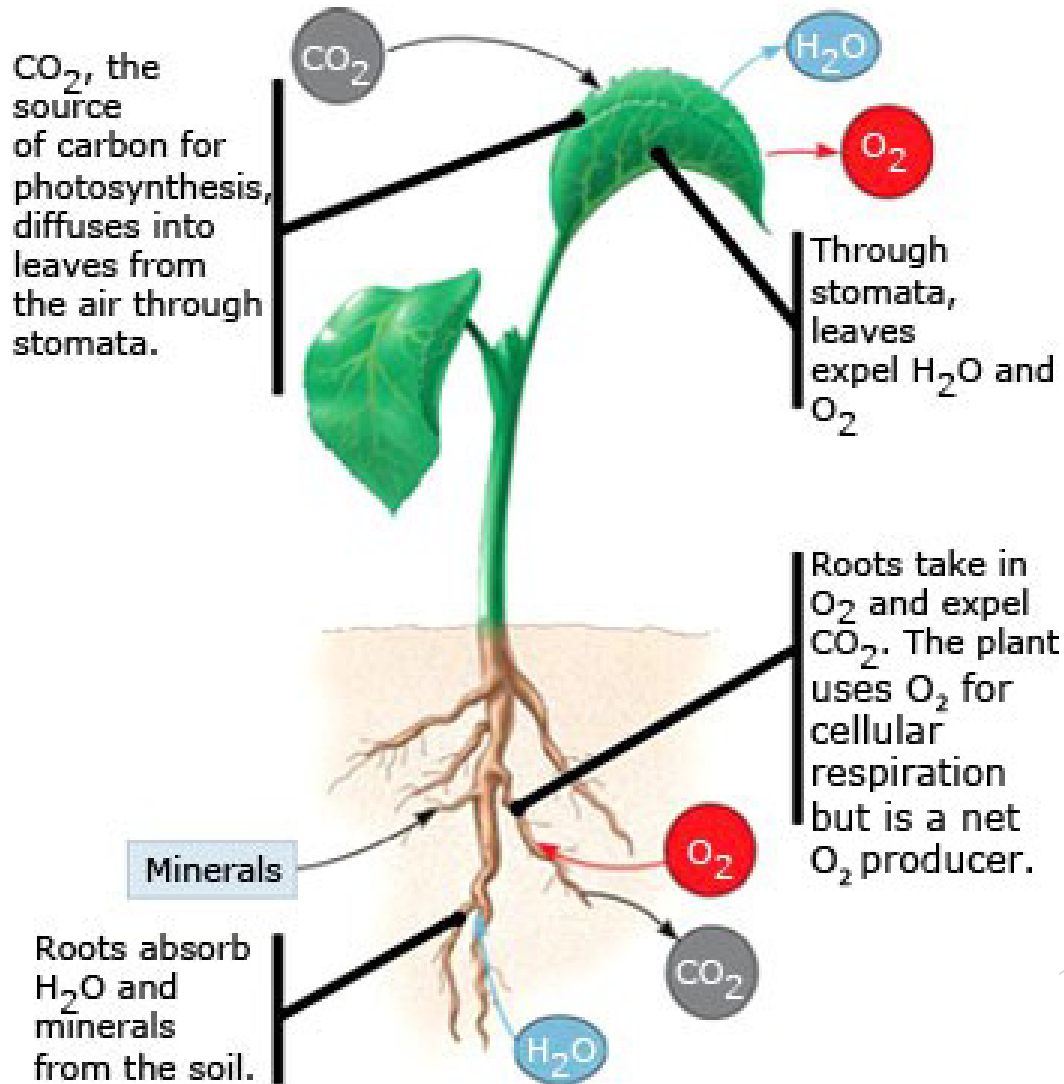
ANTHOCYANINS
(general structure)

Unlike the carotenoids, anthocyanin synthesis is kick-started by the onset of autumn - as sugar concentration in the leaves increases, sunlight initiates anthocyanin production. The purpose they serve isn't clear, but it's been suggested that they help protect the leaves from excess light, prolonging the amount of time before they fall.



LYCOPENE
A type of carotenoid

Nutrient Uptake



Macronutrients

N

Nitrogen

Healthy foliage.
Chlorophyll production.
Vegetative Growth.



P

Phosphorus

Development of flowers
DNA/RNA Synthesis
Strong Roots



K

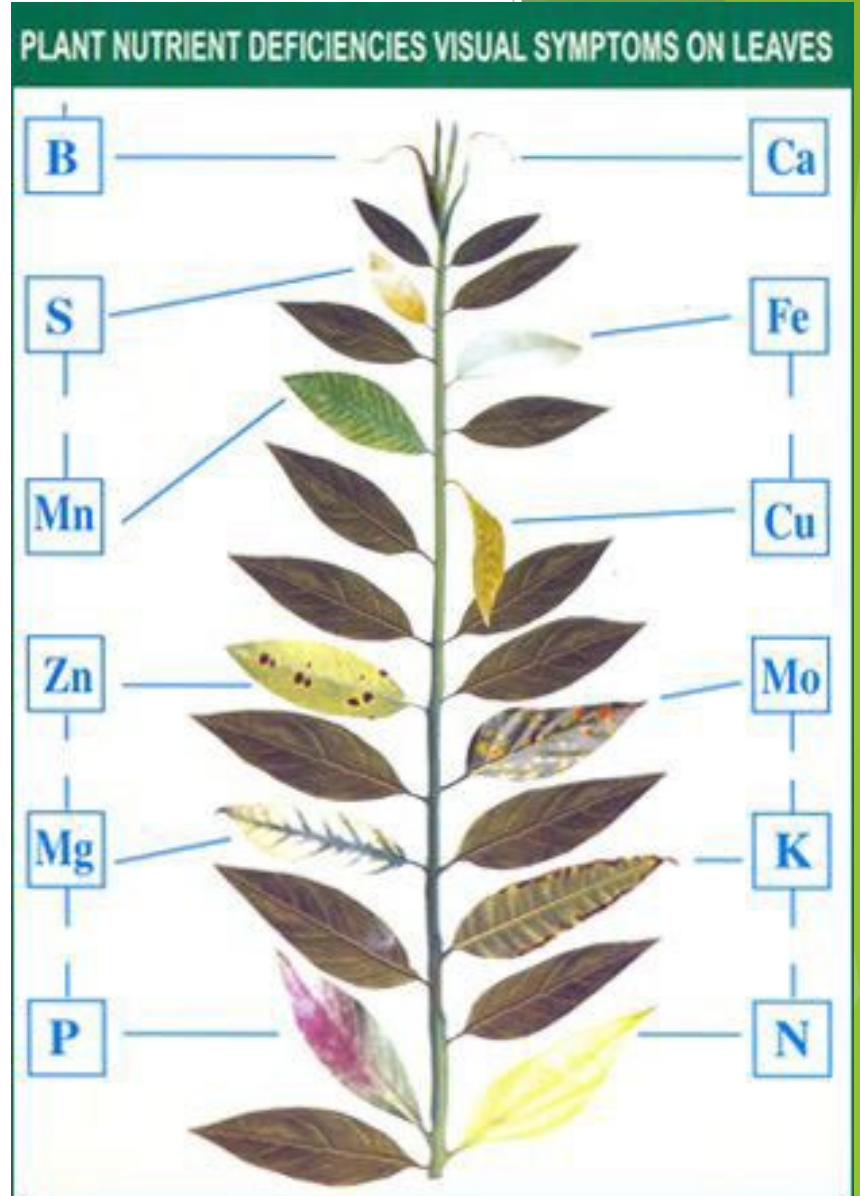
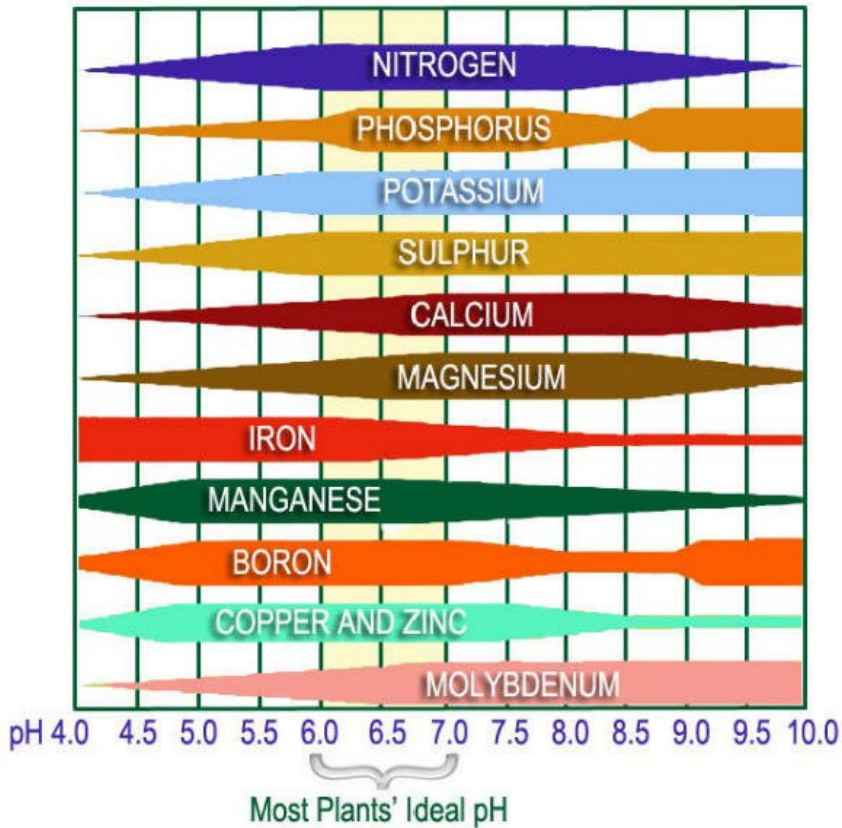
Potassium

Hearty Growth
Synthesize Proteins &
Carbohydrates



Nutrient Uptake

Nutrient Availability Varies by pH Level



Plant Stress Responses

Abiotic stress



heat



cold

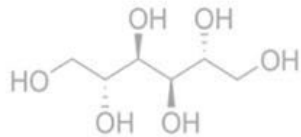
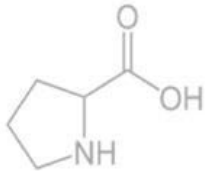


drought

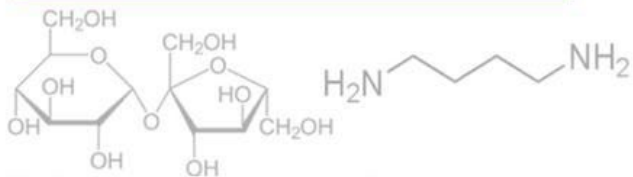
salt

metals

flooding



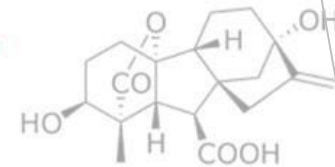
primary metabolites



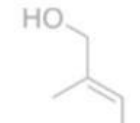
plant development

Biotic stress

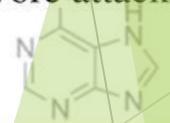
pathogen attack



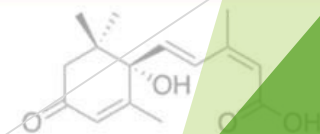
insect attack



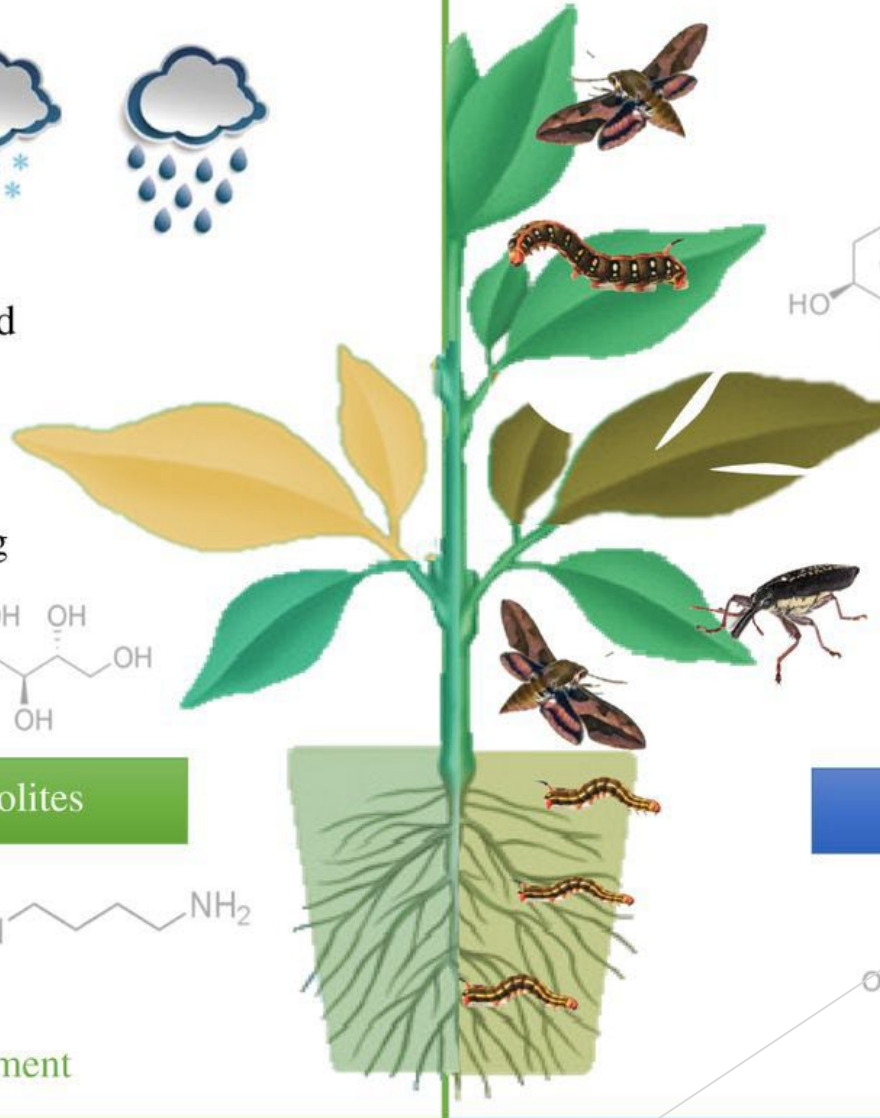
herbivore attack



phytohormones

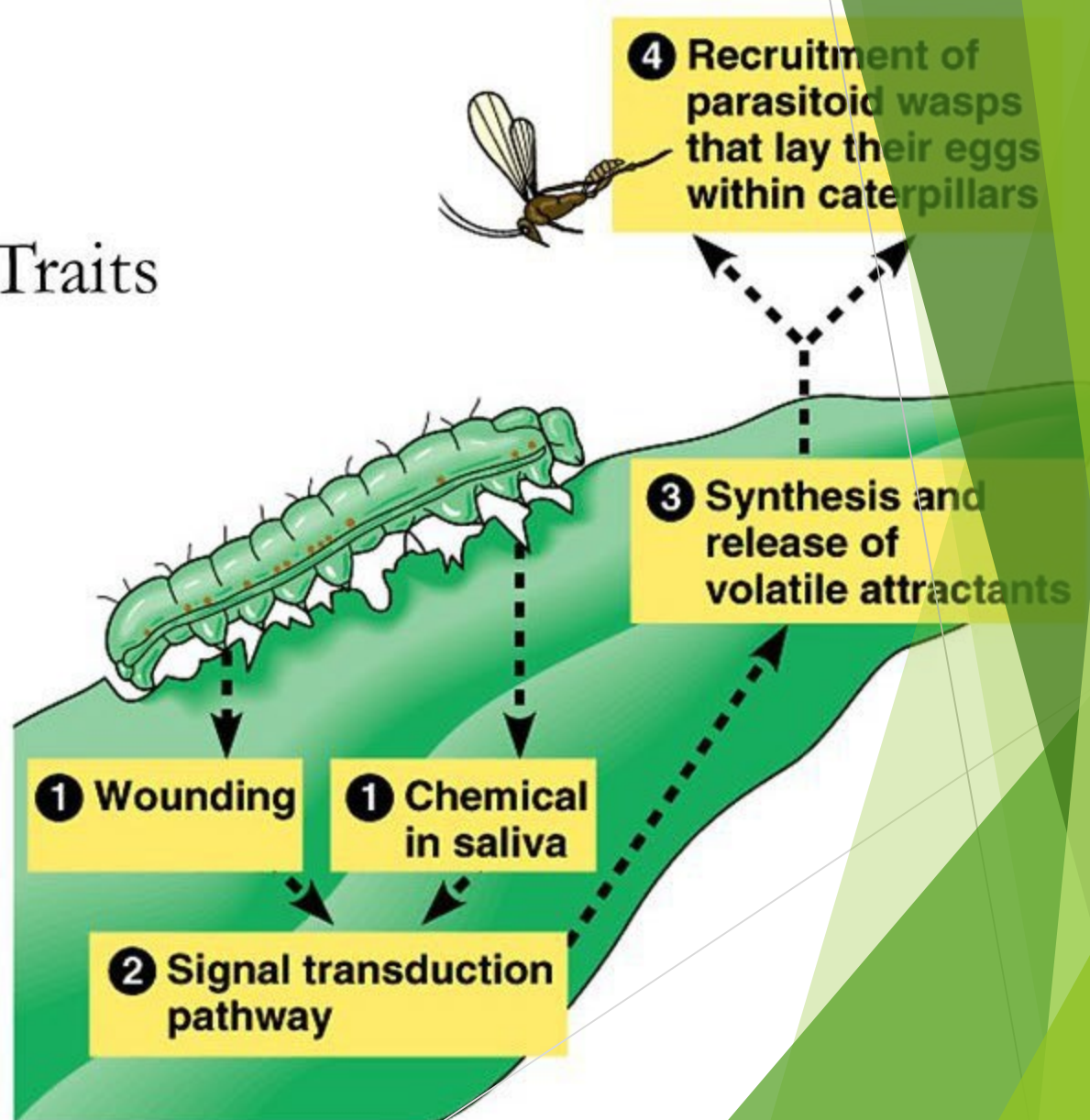


plant defence

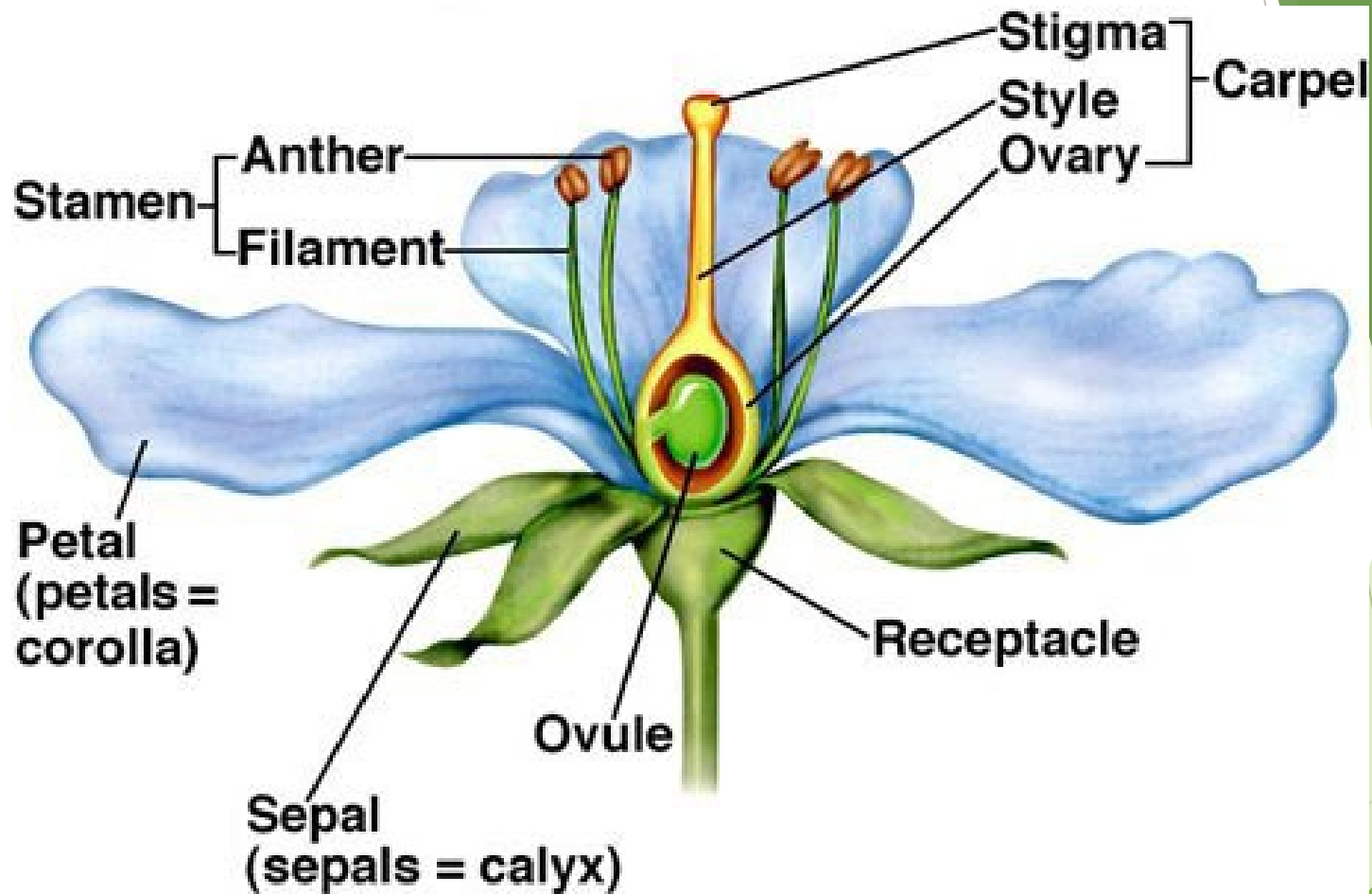


Plant Stress Responses

Plant Defense Traits

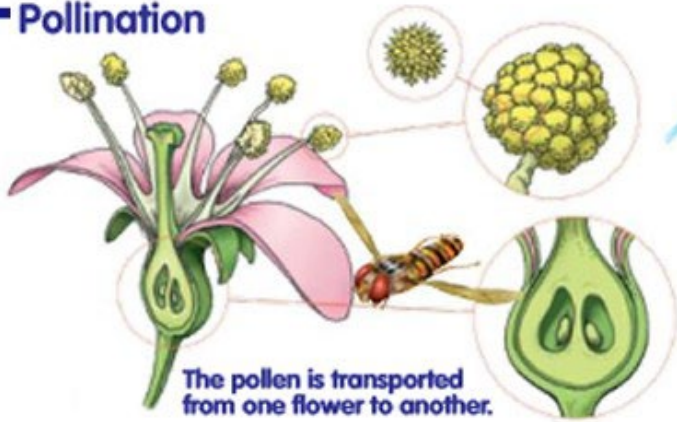


Plant Reproduction



Plant Reproduction

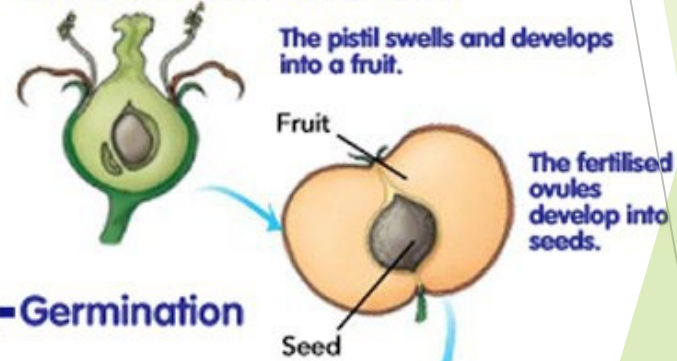
1.- Pollination



2.- Fertilisation



3.- Seed and fruit formation



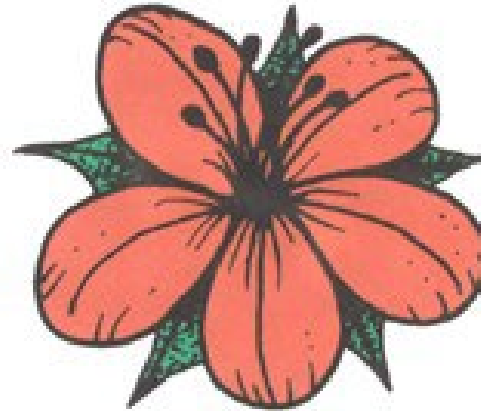
4.- Germination



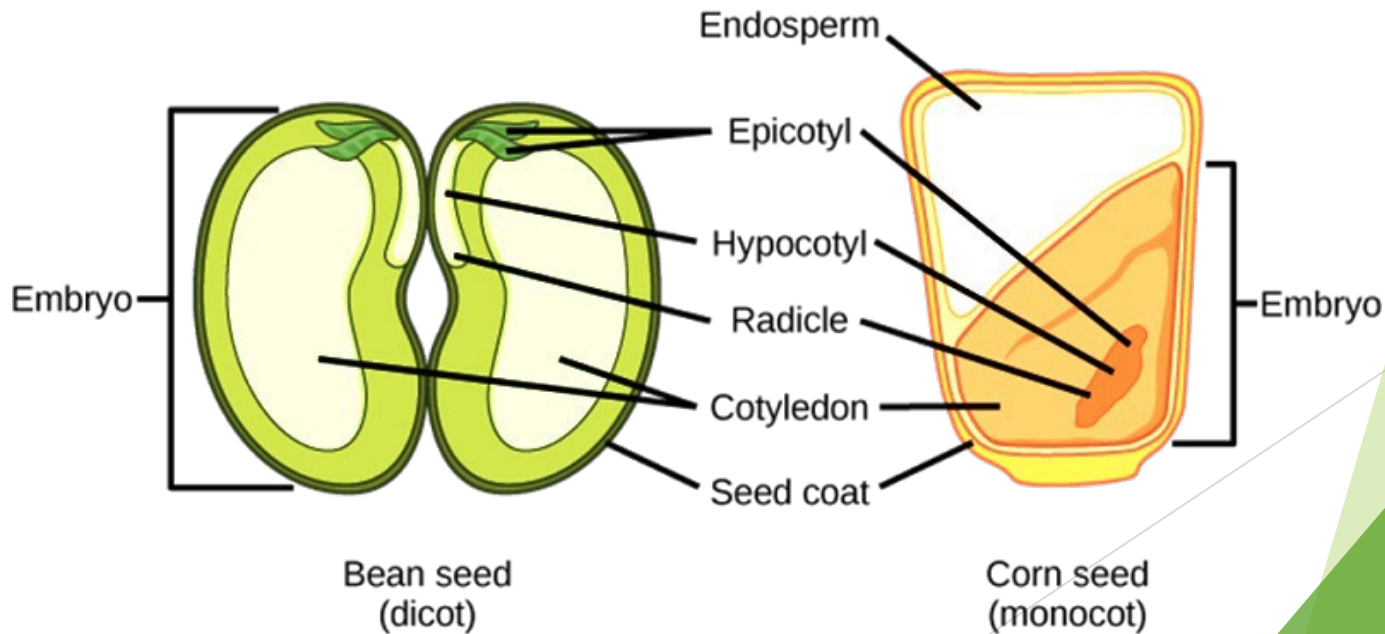
Monocots vs. Dicots



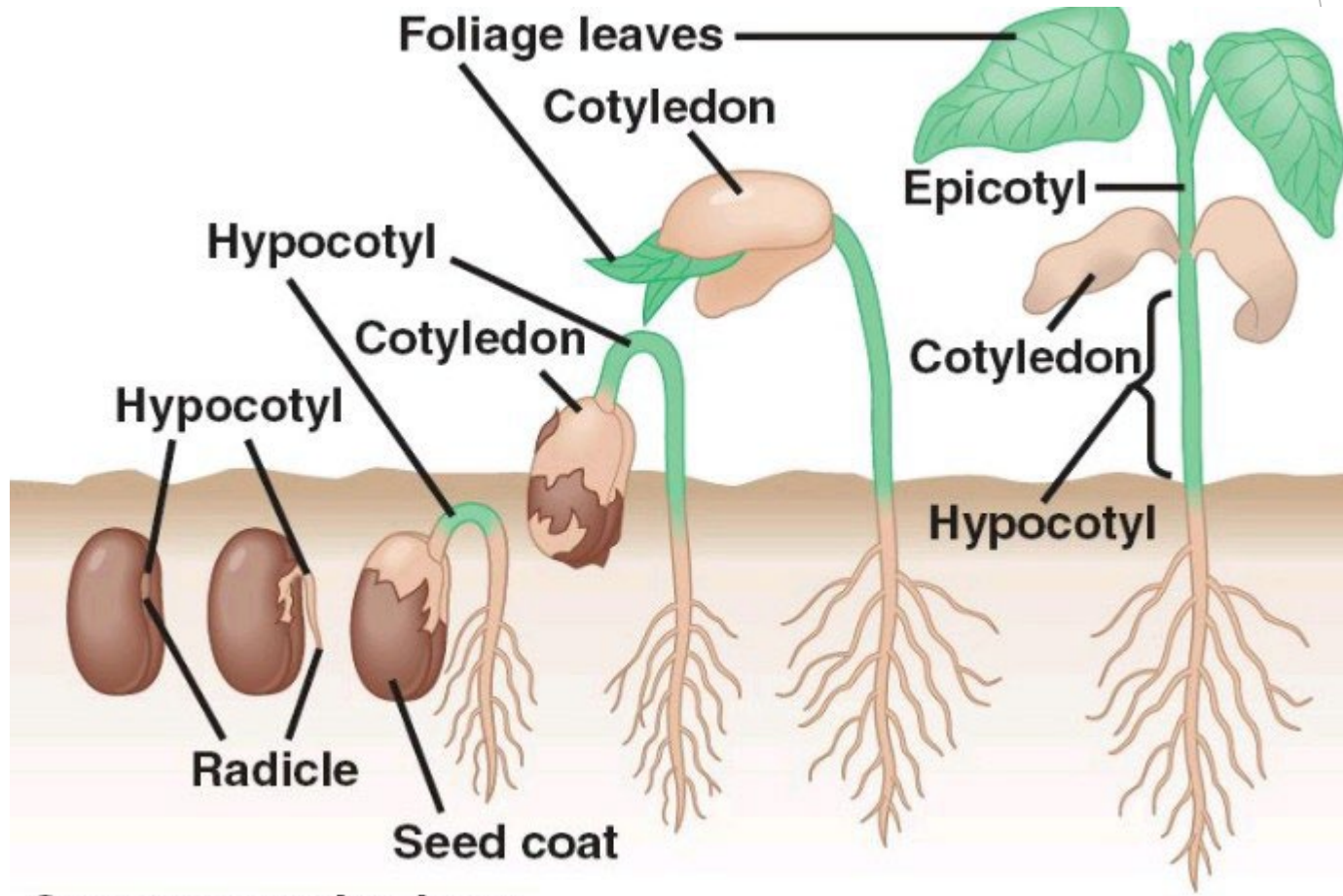
Monocots
Parts in 3s



Dicots
Parts in 4s or 5s



Seed Germination



Common garden bean