Botany for Master Gardeners

Carla Hegeman Crim, Ph.D.

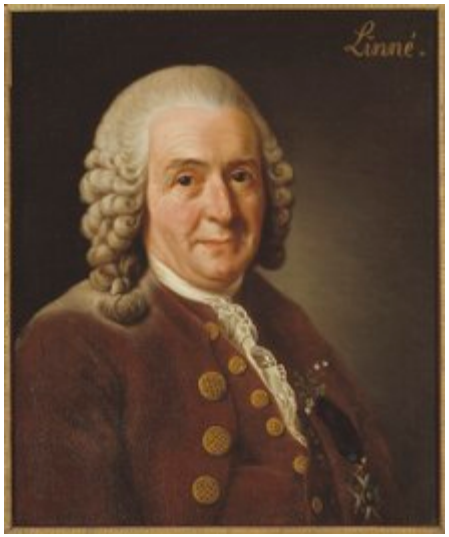
Horticulture and Natural Resources Educator
Cornell Cooperative Extension of Delaware County

What is Botany?

The scientific study of plants.

Plant Biology	Organismal Specialties	Applied Sciences	Ethno-botany
Molecular Biology	Algae	Breeding	*People*
Biochemistry	Mosses	Pathology	*&*
Genetics	Ferns	Weed Science	*Plants*
Anatomy	Palms	Agronomy	
Physiology	Pines	Forestry	
Morphology	*etc*	Biotechnology	
Ecology	*etc*	Natural Resources	
Paleobotany	*etc*	Horticulture	
Systematics			
Taxonomy			

Noteworthy Plant Scientists



Carl Linnaeus

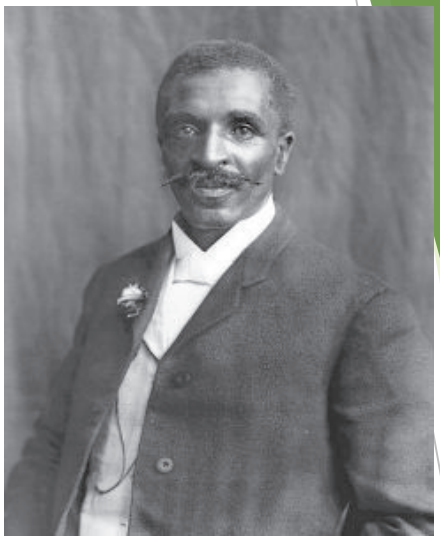
1707-1778

Taxonomy & Classification

Gregor Mendel

1882-1884

Genetics

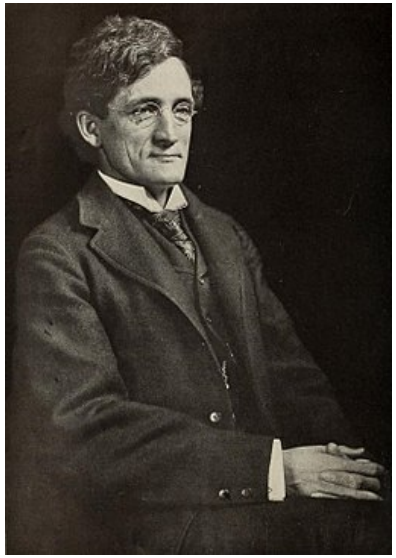


George Washington Carver

1860-1843

Agriculture

Famous Cornellians



Liberty
Hyde Bailey

1858-1954

Taxonomy &
Classification
Palms
Agriculture

Barbara
McClintock

1902-1992

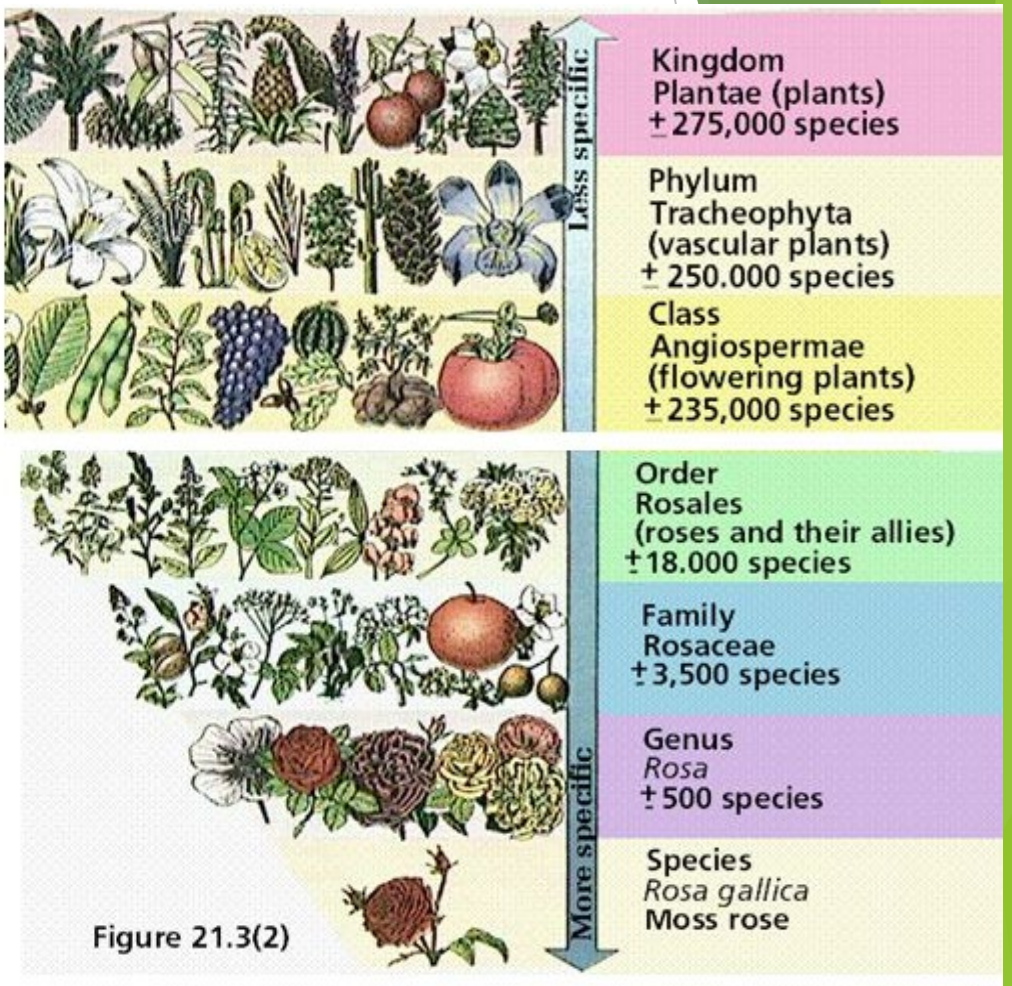
Genetics
Ethnobotany

Basic Concepts		Practical Applications
Taxonomy	→	Naming, Identification
Anatomy	→	Planting, Pruning
Physiology	→	Watering, Fertilizing
Reproduction	→	Propagation

Taxonomy

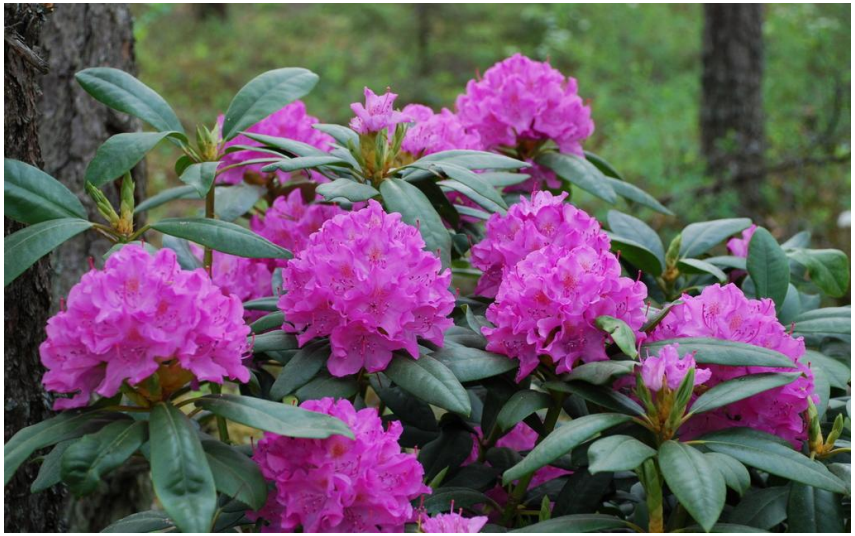
Plant Classification

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



Binomial Nomenclature

Genus species



Rhododendron macrophyllum

Hydrangea macrophyllum

Binomial Nomenclature

Allium?

Common Name Confusion

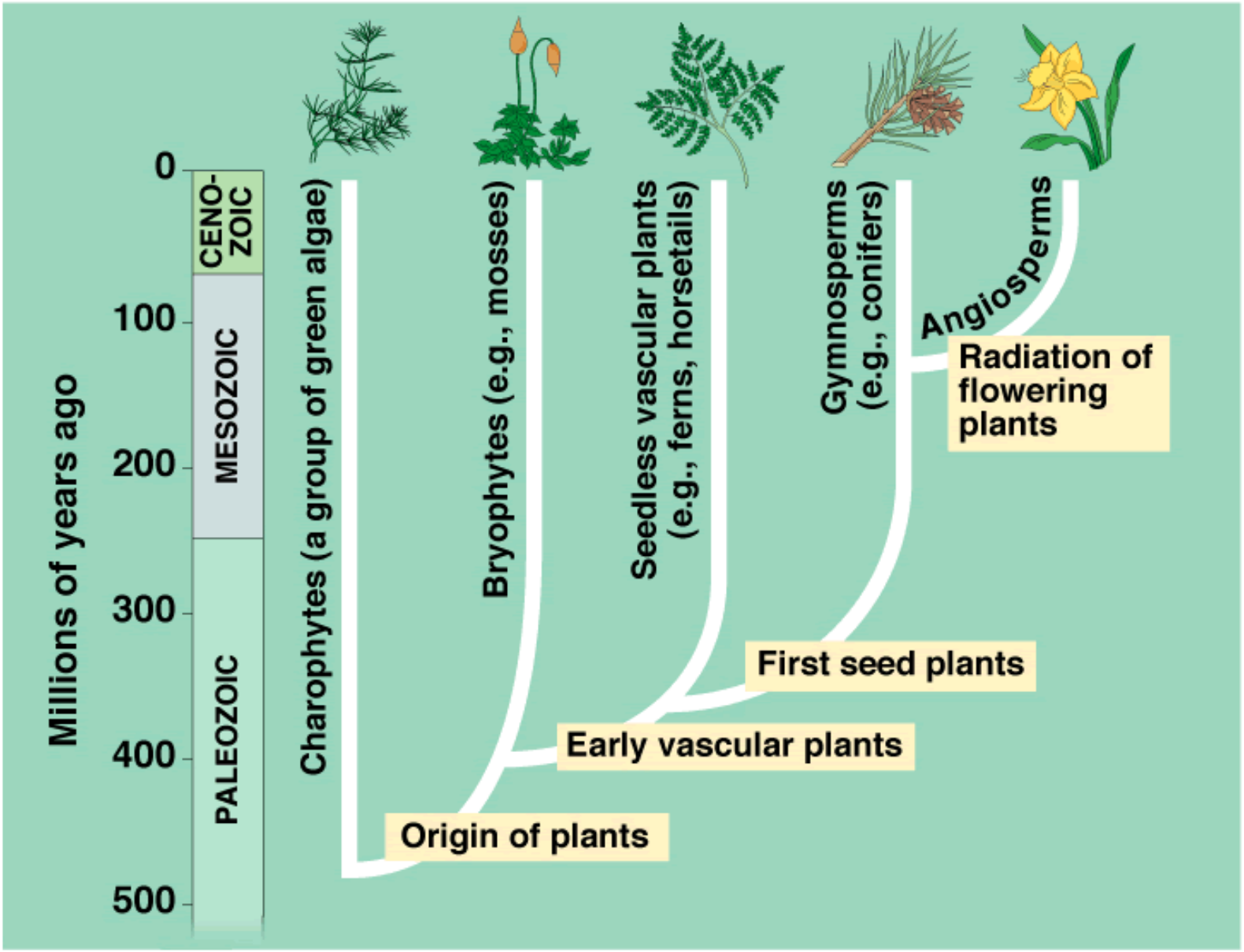
Buttercup?

Ranunculus

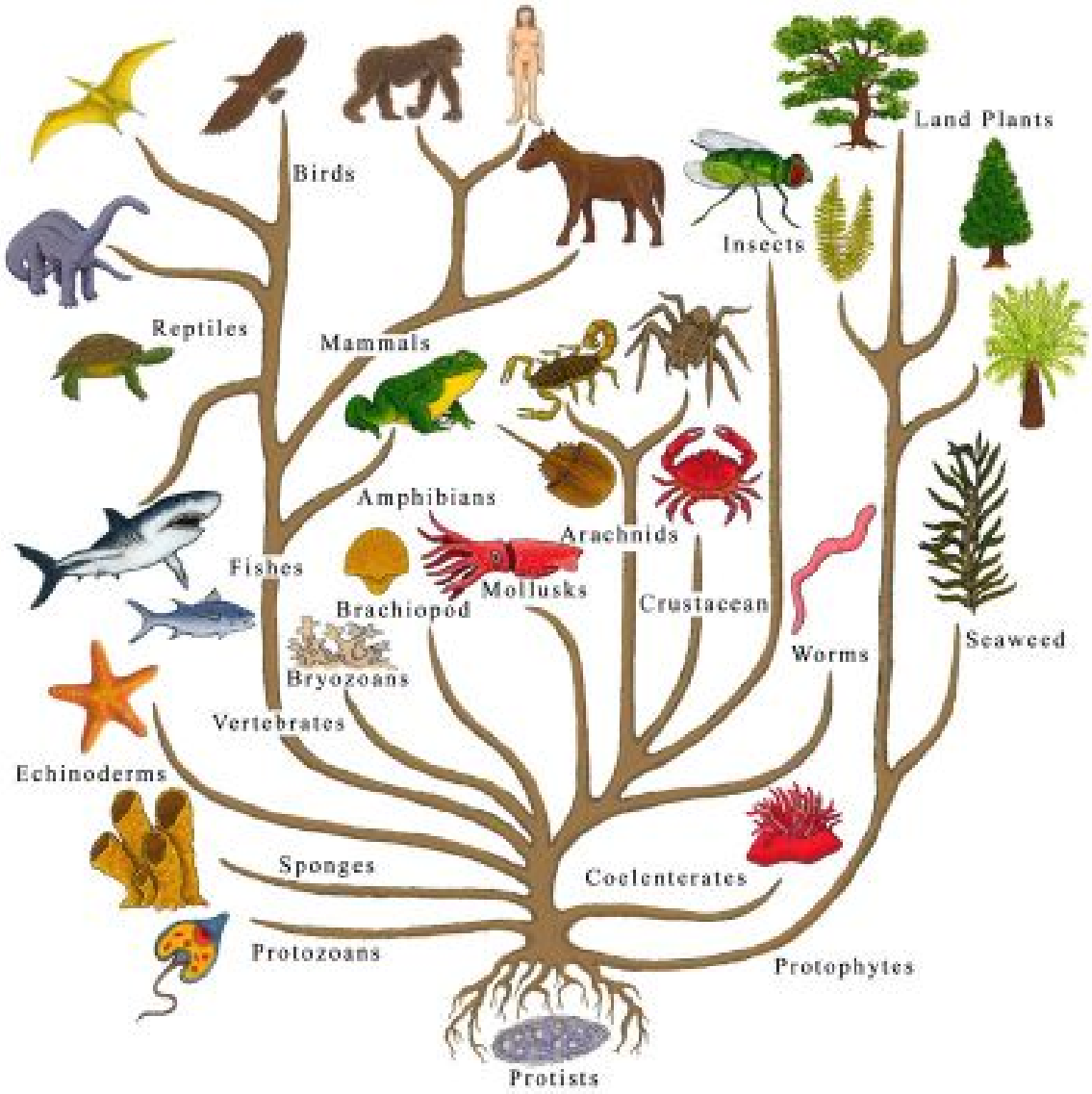
Oenothera

Oenothera

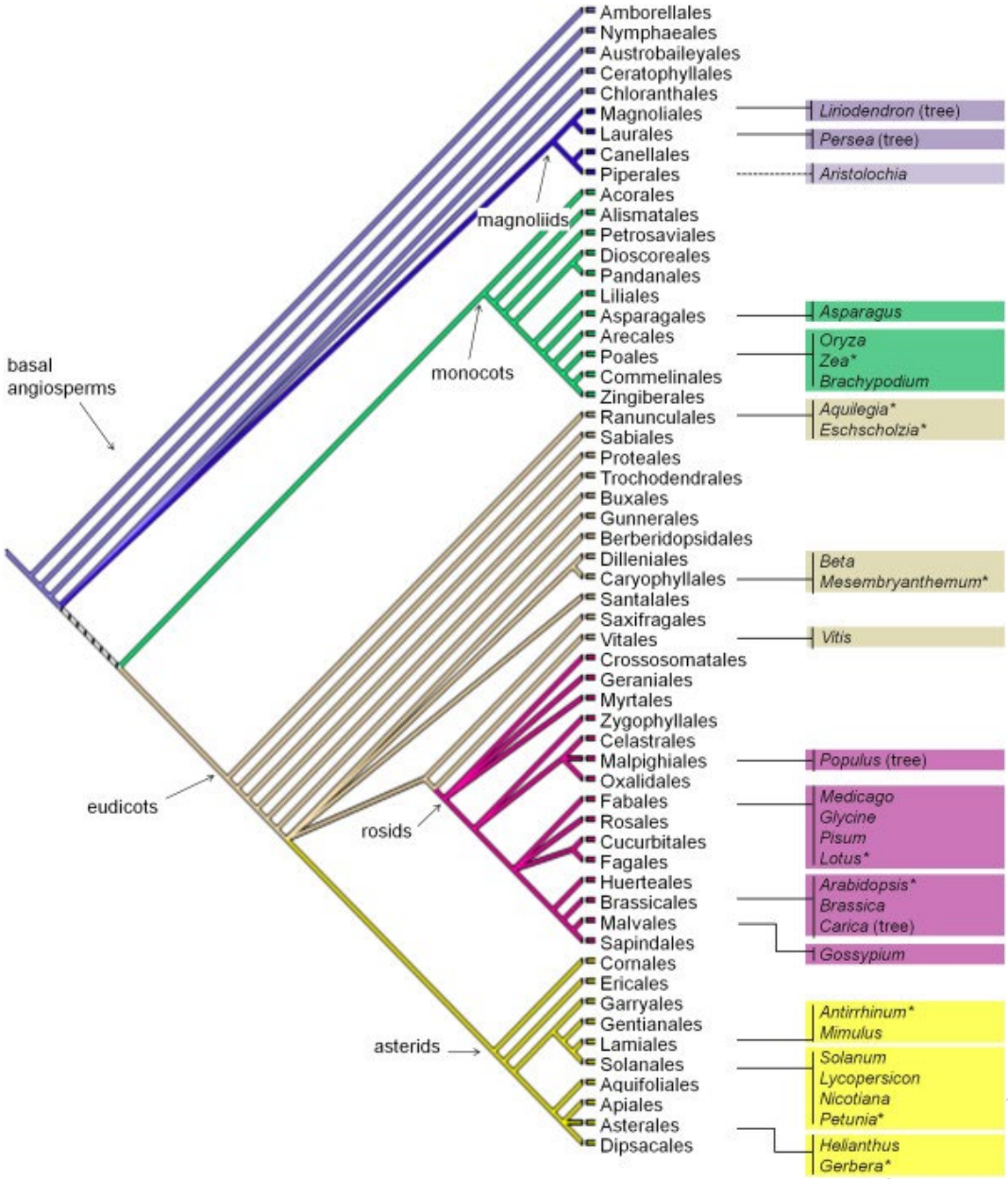
Plant Evolution



Co-evolution with Animals



Plant Classification



DICOTS

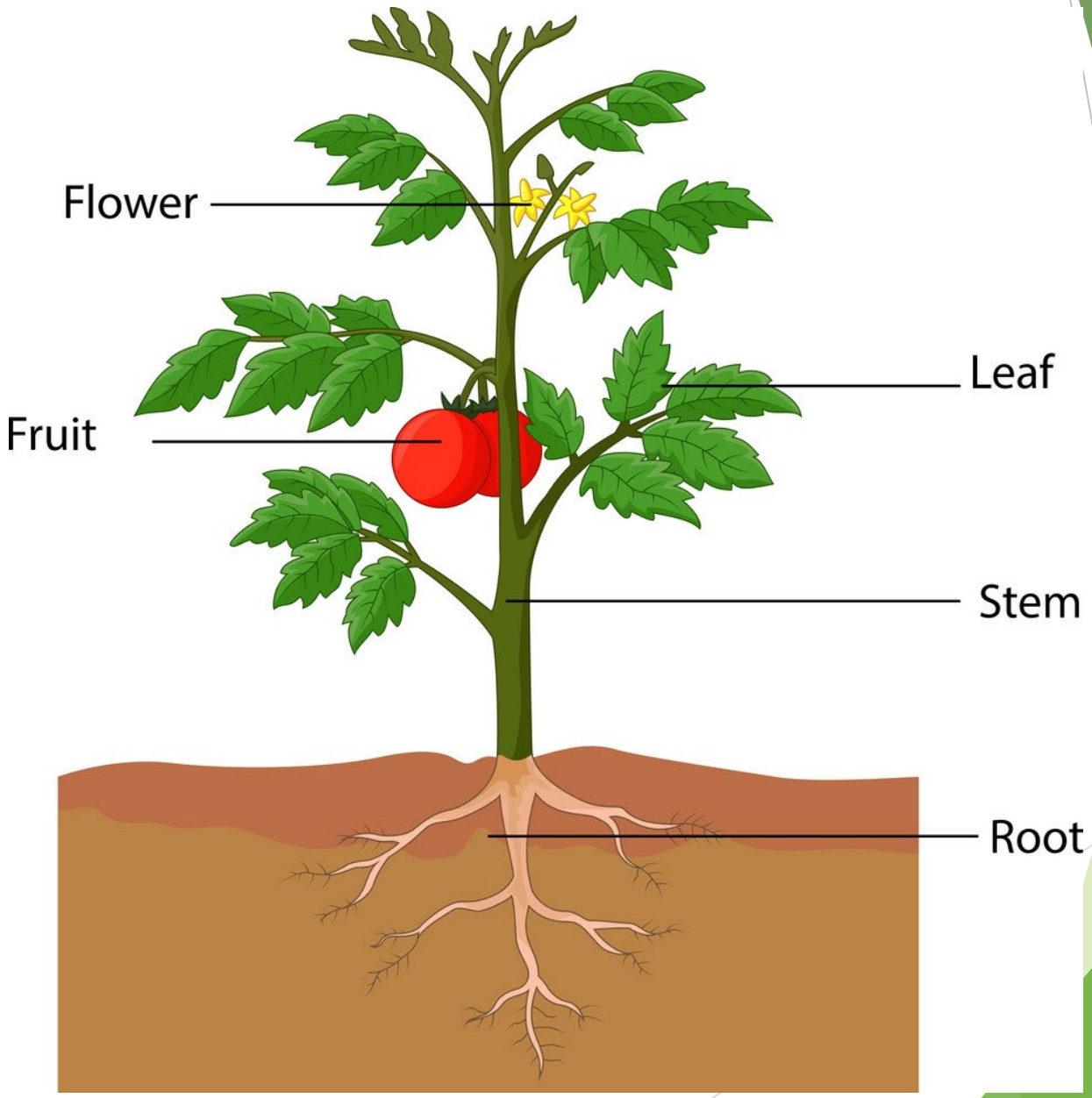
MONOCOTS

DICOTS

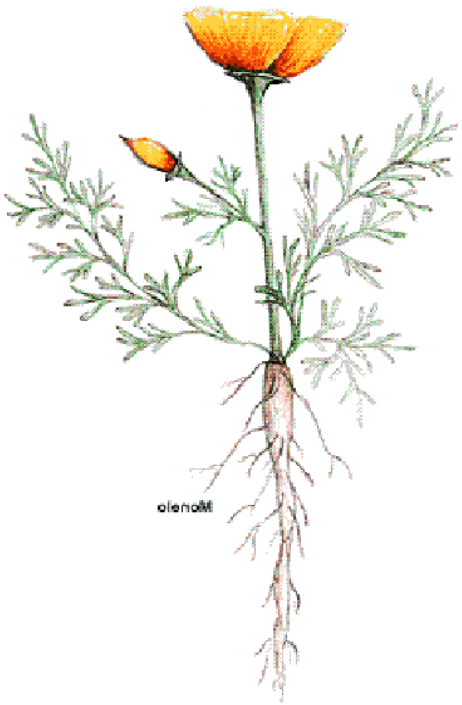
Monocot

Dicot

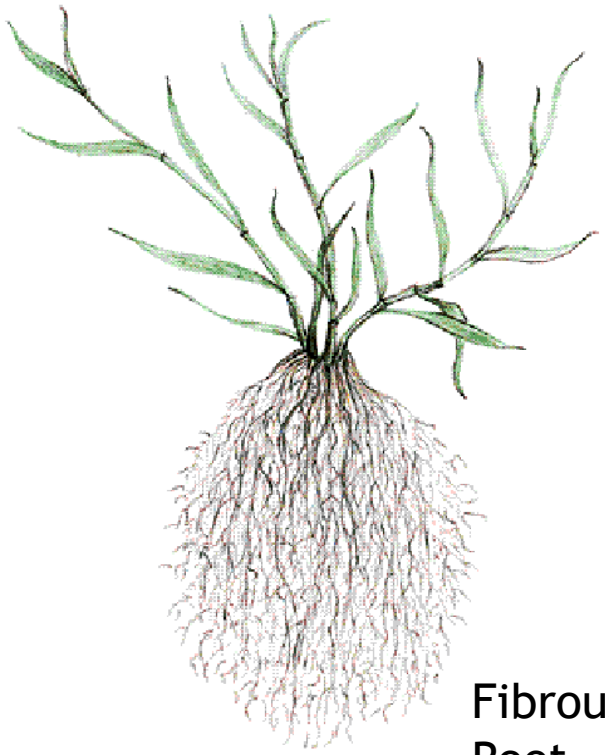
Plant Anatomy



Roots



Taproot

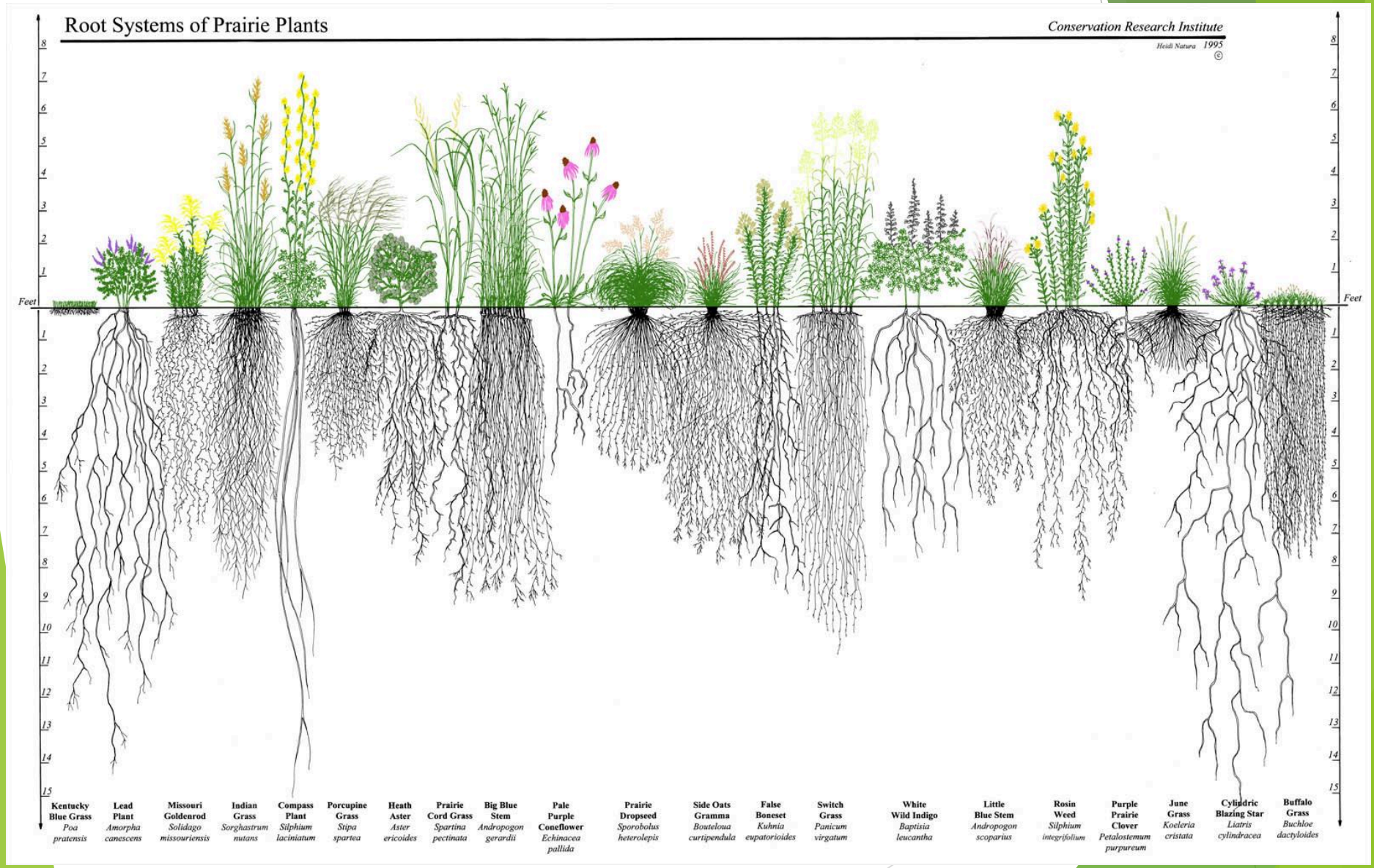


Fibrous Root

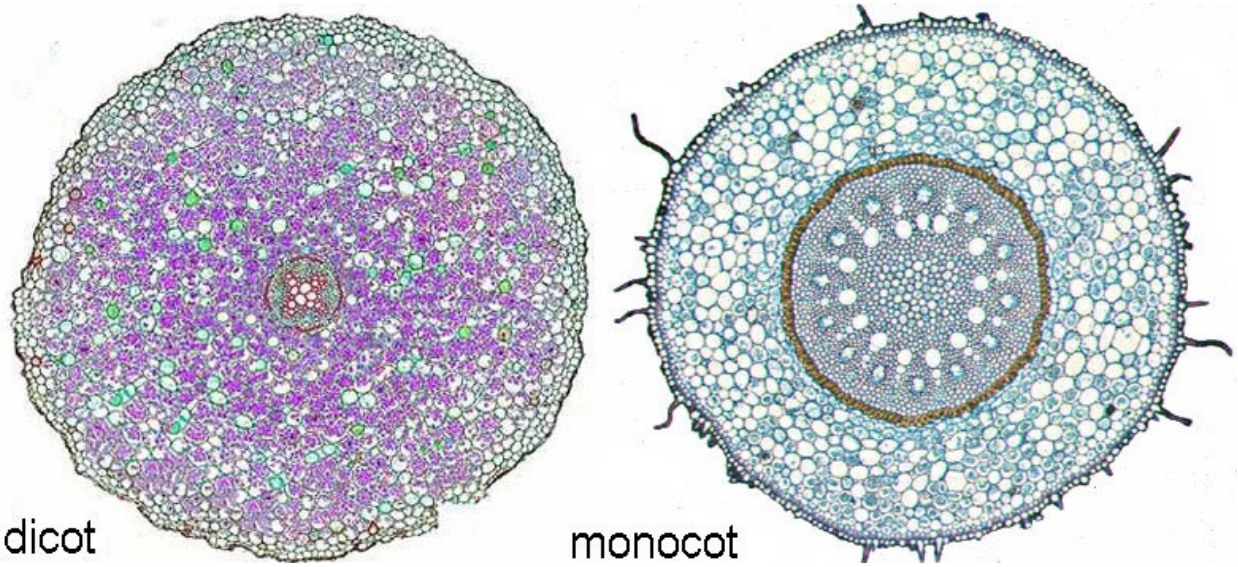
Functions

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

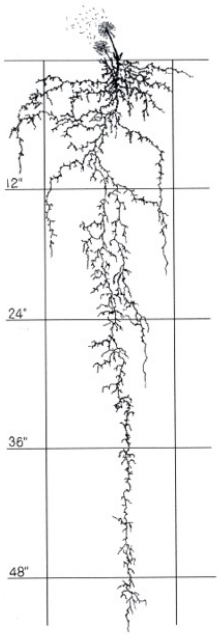
Roots

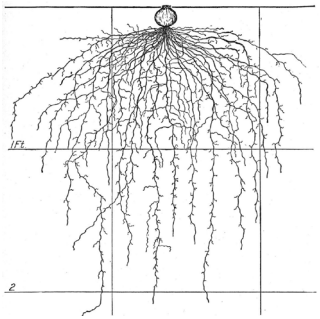

Root Systems of Prairie Plants
Conservation Research Institute
Heidi Natura 1995 ©
Feet
Feet
Kentucky Blue Grass Poa pratensis
Lead Plant Amorpha canescens
Missouri Goldenrod Solidago missouriensis
Indian Grass Sorghastrum nutans
Compass Plant Silphium laciniatum
Porcupine Grass Stipa spartea
Heath Aster Aster ericoides
Prairie Cord Grass Spartina pectinata
Big Blue Stem Andropogon gerardii
Pale Purple Coneflower Echinacea pallida
Prairie Dropseed Sporobolus heterolepis
Side Oats Gramma Bouteloua curtipendula
False Boneset Kuhnia eupatorioides
Switch Grass Panicum virgatum
White Wild Indigo Baptisia leucantha
Little Blue Stem Andropogon scoparius
Rosin Weed Silphium integrifolium
Purple Prairie Clover Petalostemum purpureum
June Grass Koeleria cristata
Cylindric Blazing Star Liatris cylindracea
Buffalo Grass Buchloe dactyloides

Roots



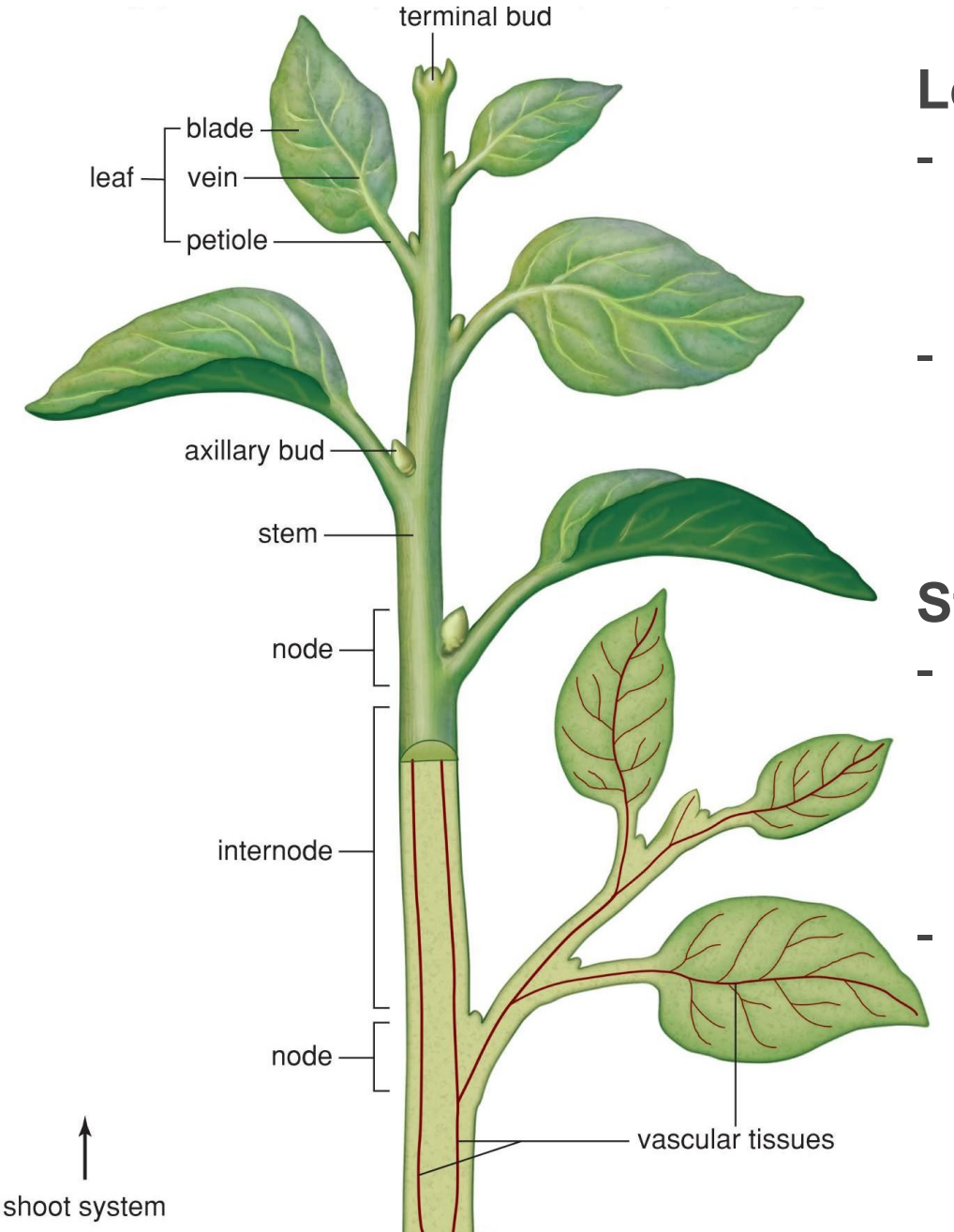
Taproots & Fibrous Roots





Fibrous Roots only

Stems & Leaves



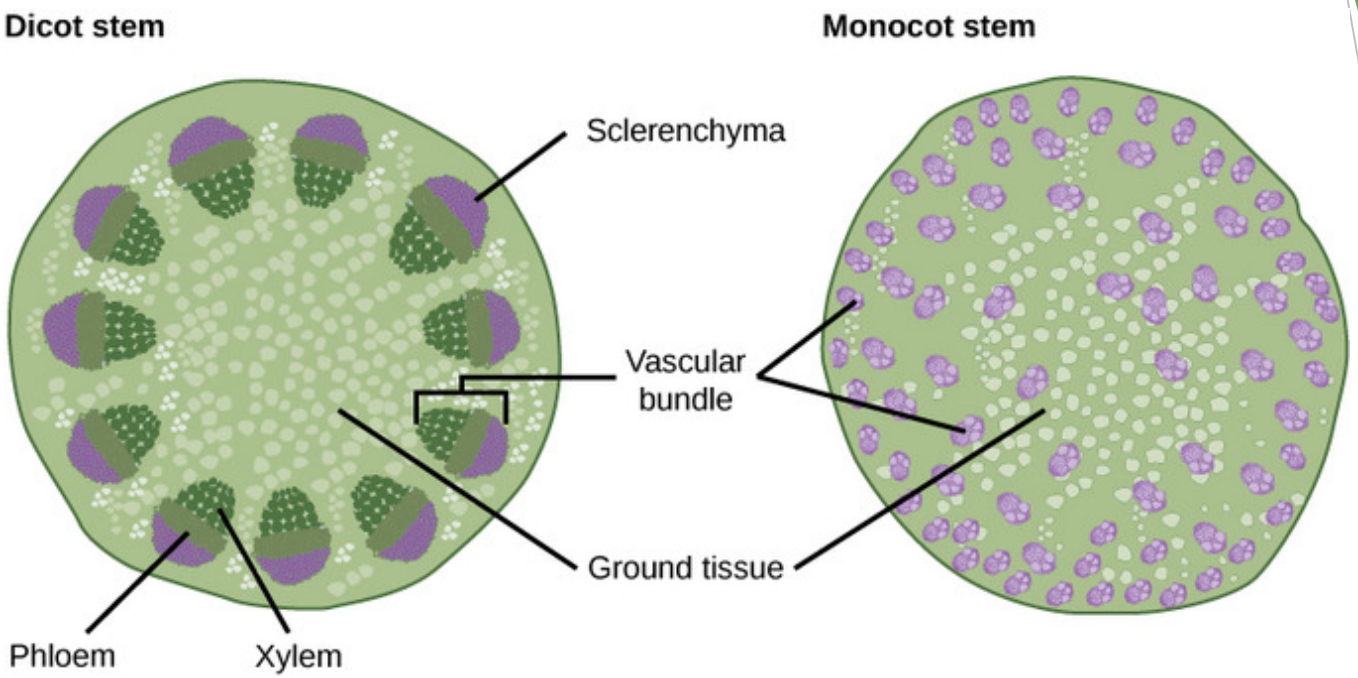
Leaf Functions

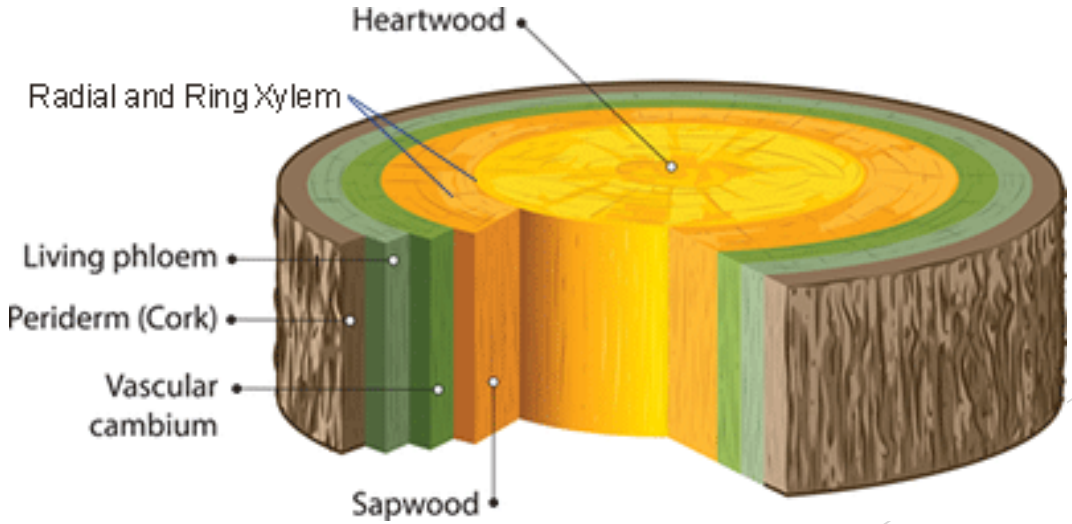
- All plants: Food production, gas exchange
- Some plants: storage, asexual reproduction

Stem Functions

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

Stem Anatomy

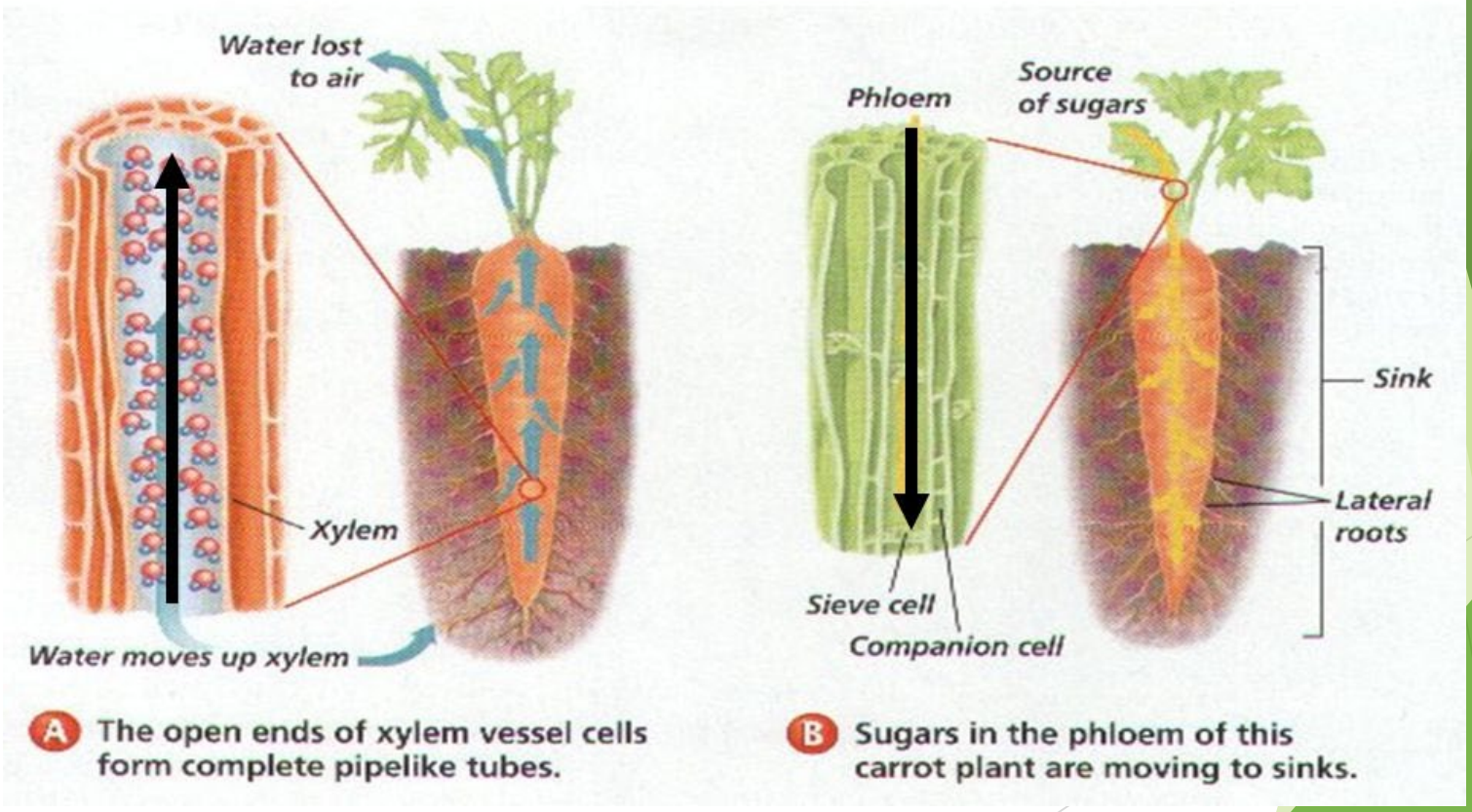




Stem Anatomy

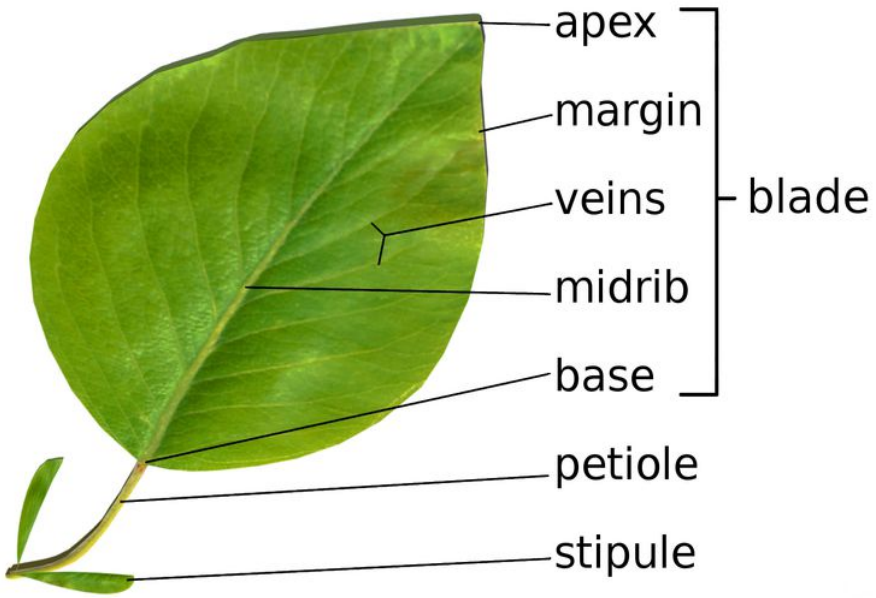
Xylem

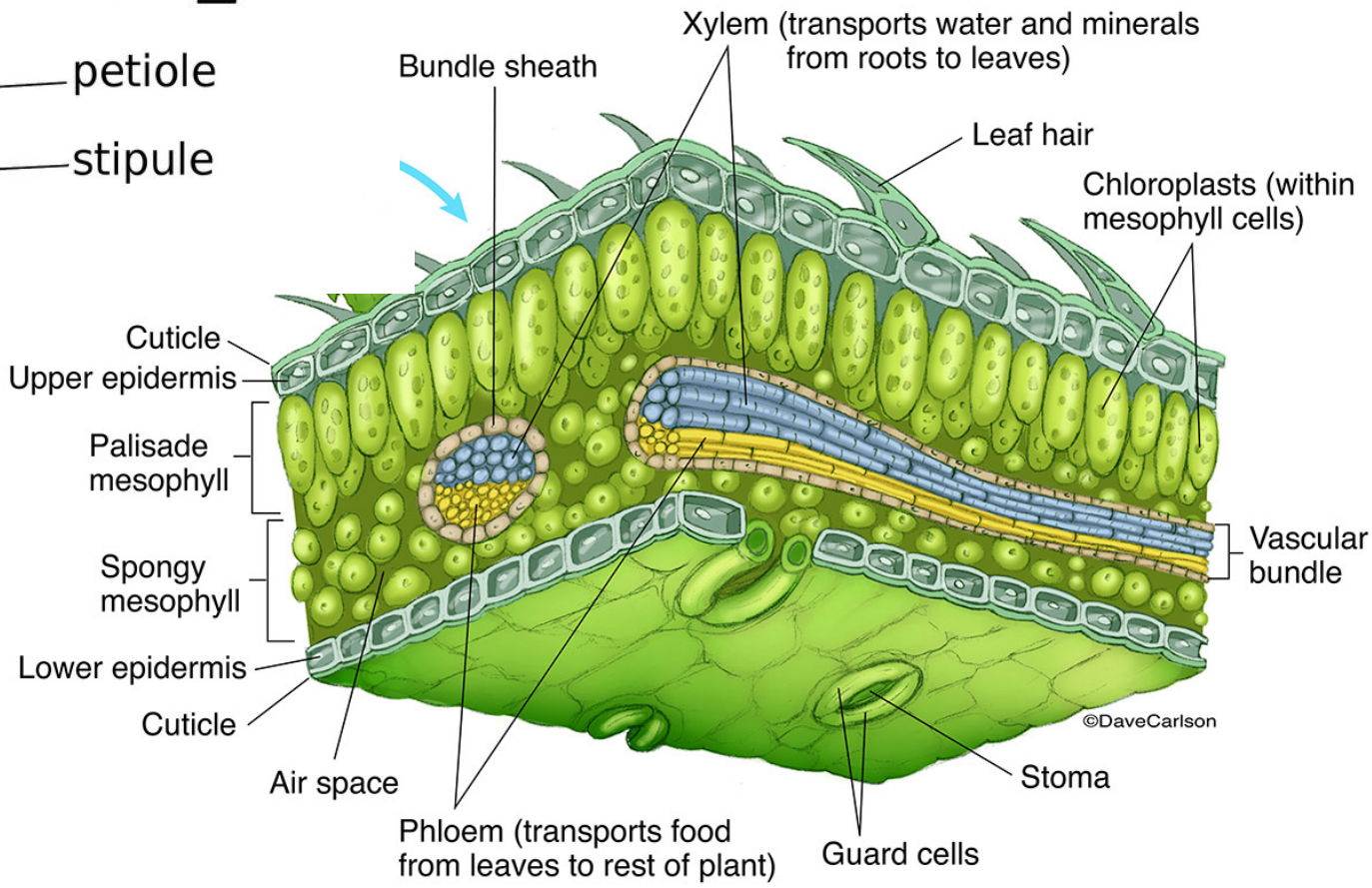
Phloem



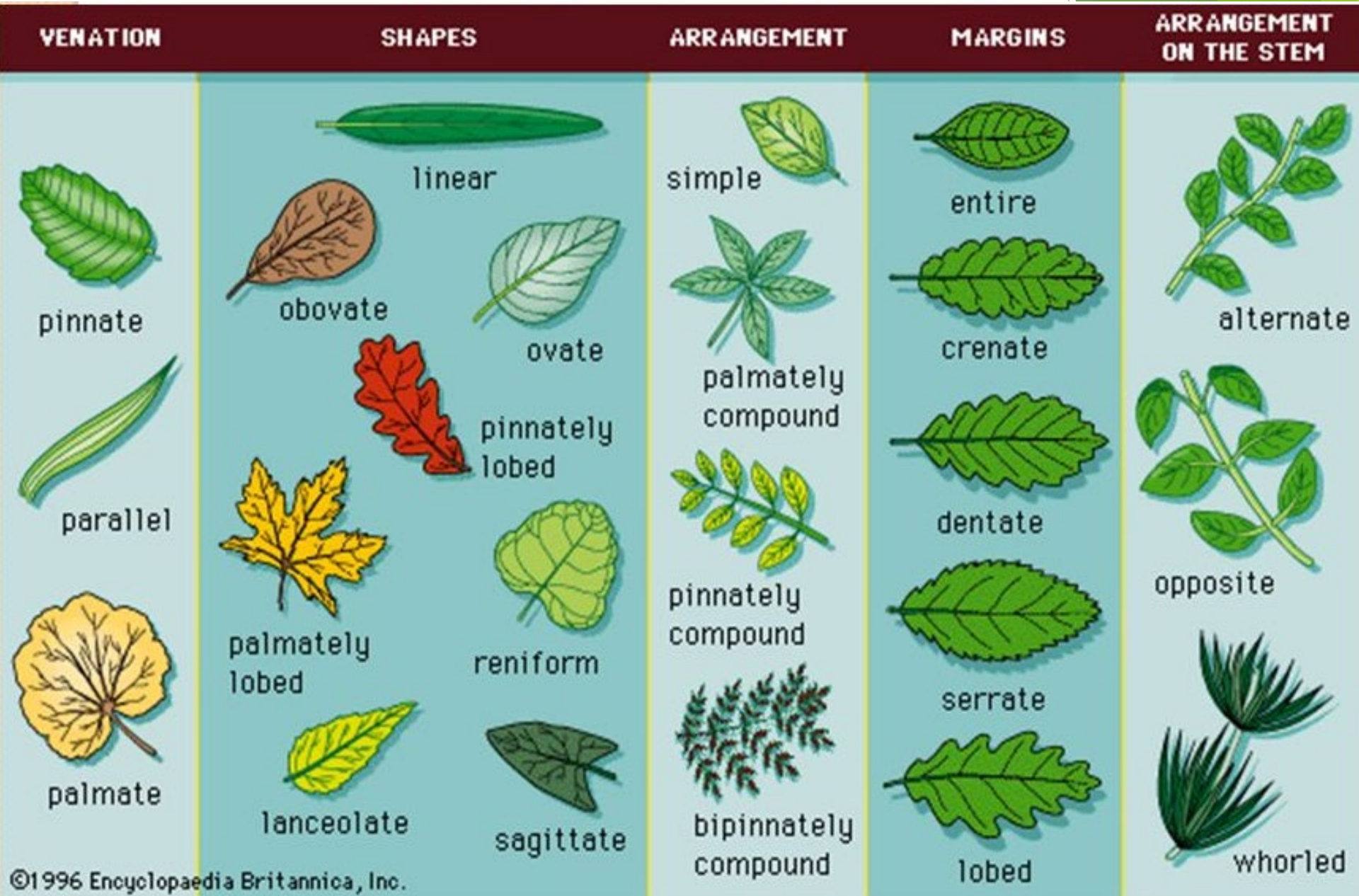
Stem Arrangement

Leaf Anatomy





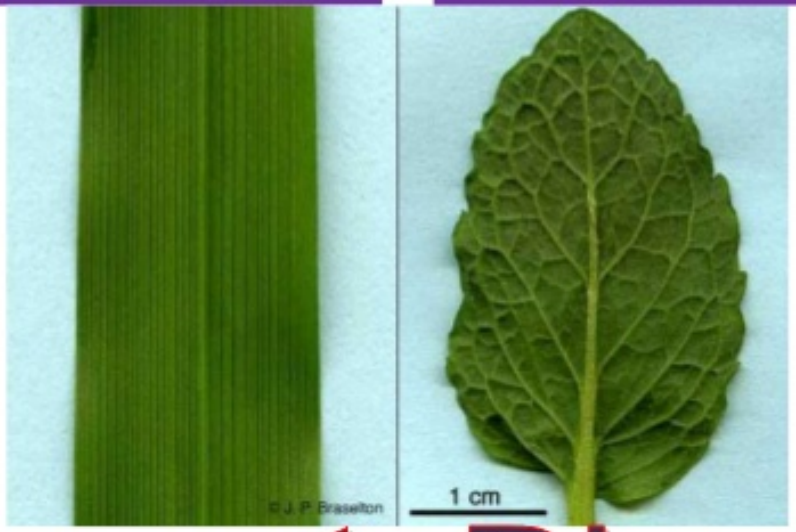
Leaf Morphology



Leaf Morphology

Monocot & Dicot leaves

Long & slender leaf Parallel veins	Broad leaf Branching veins

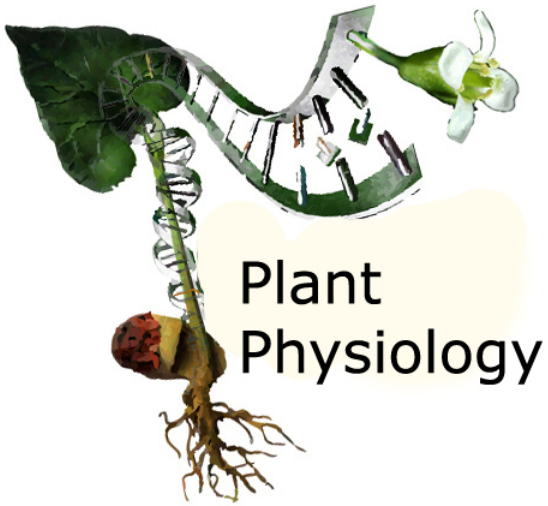


Monocot Dicot

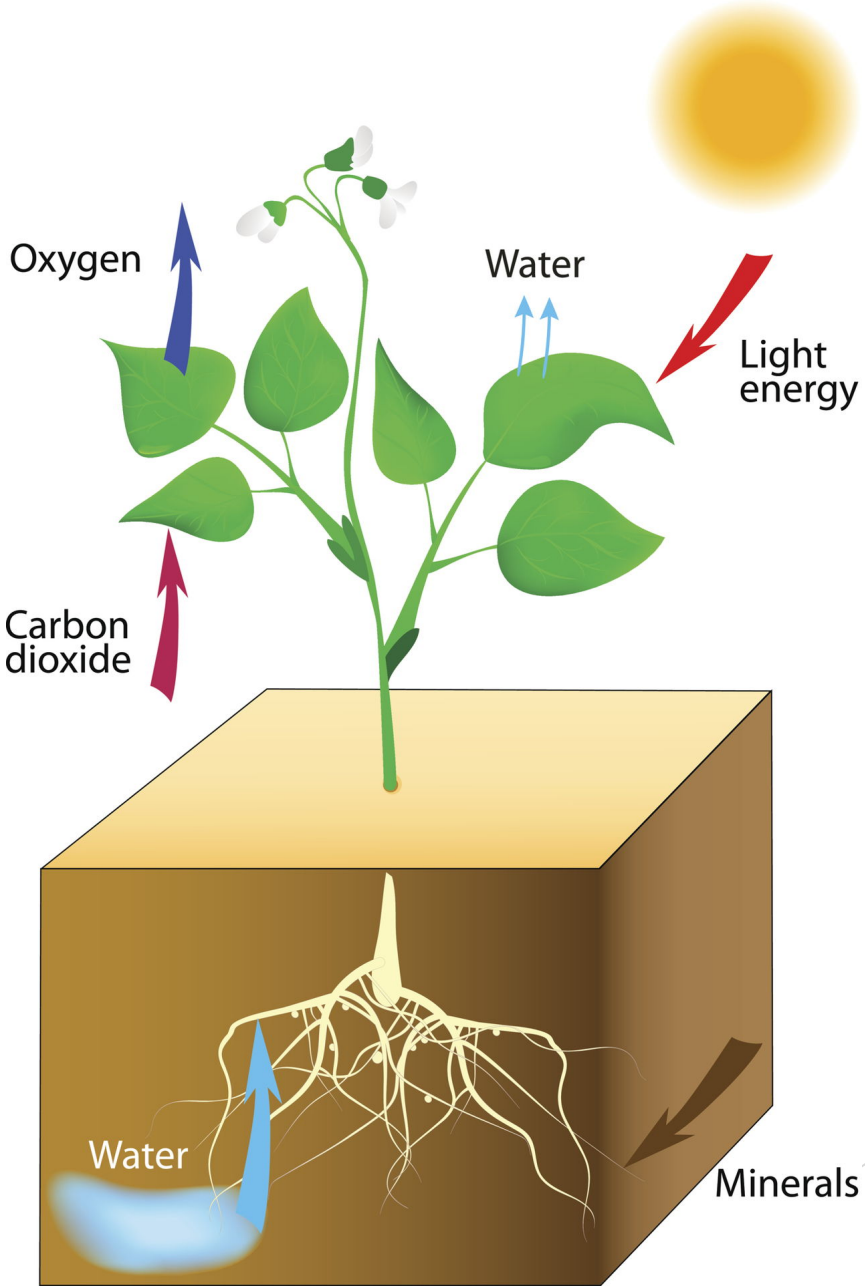
Plant Physiology

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

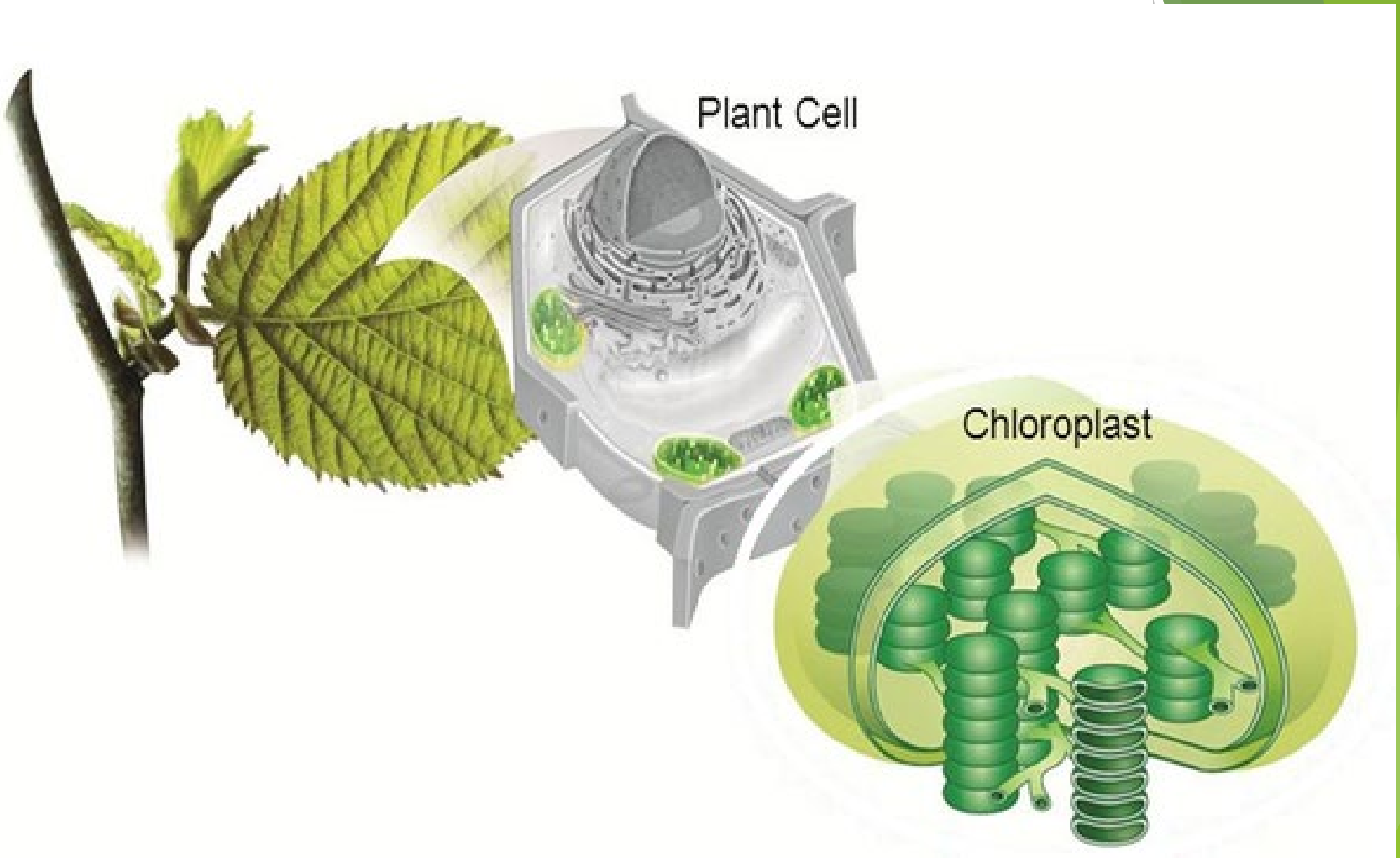
- Photosynthesis
- Hormones
- Senescence
- Nutrient uptake
- Stress responses
- Seed development & germination



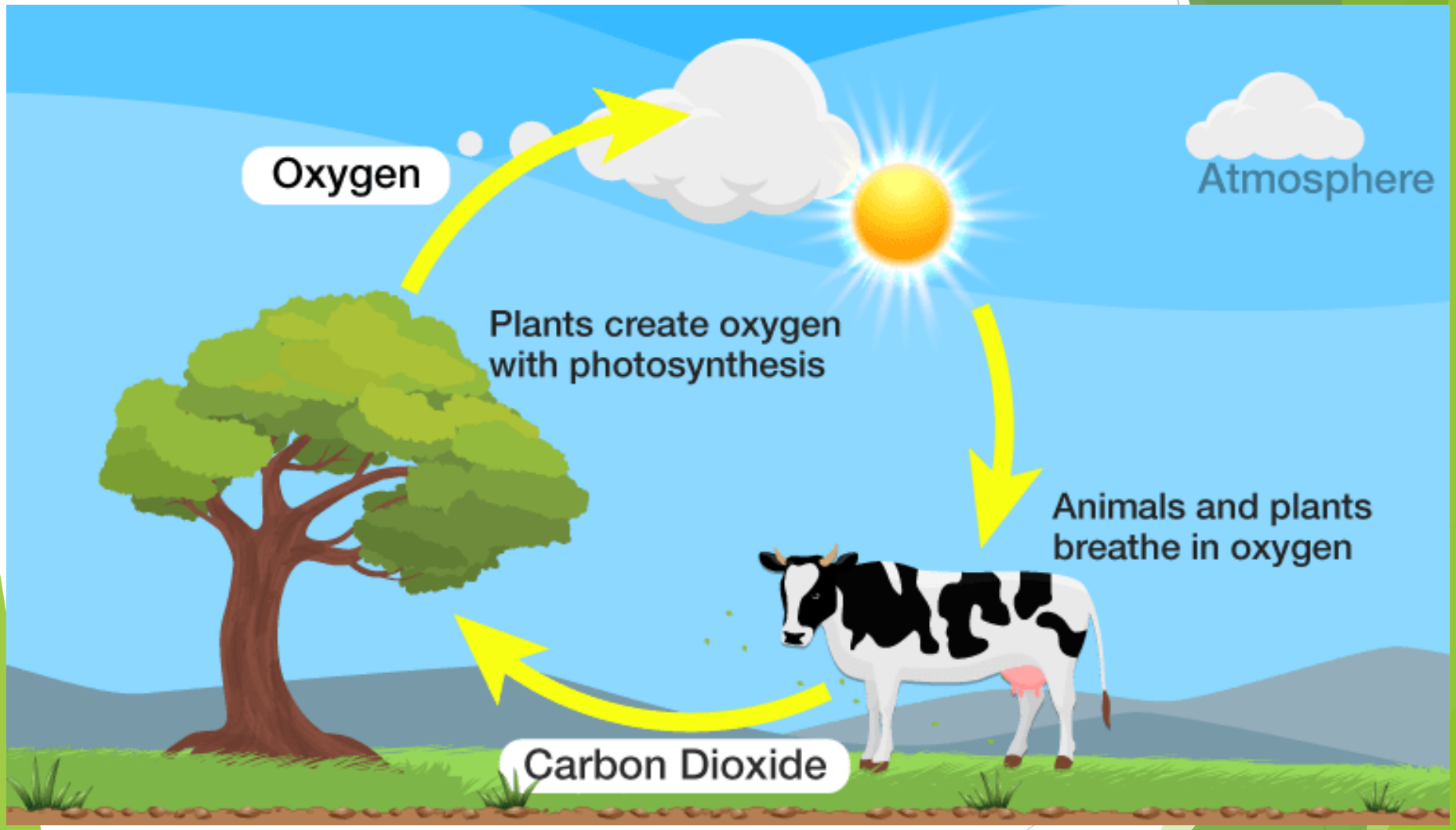
Photosynthesis



Photosynthesis

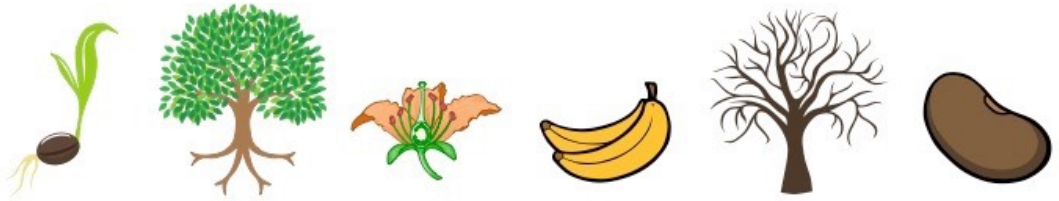


The Oxygen Cycle



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.

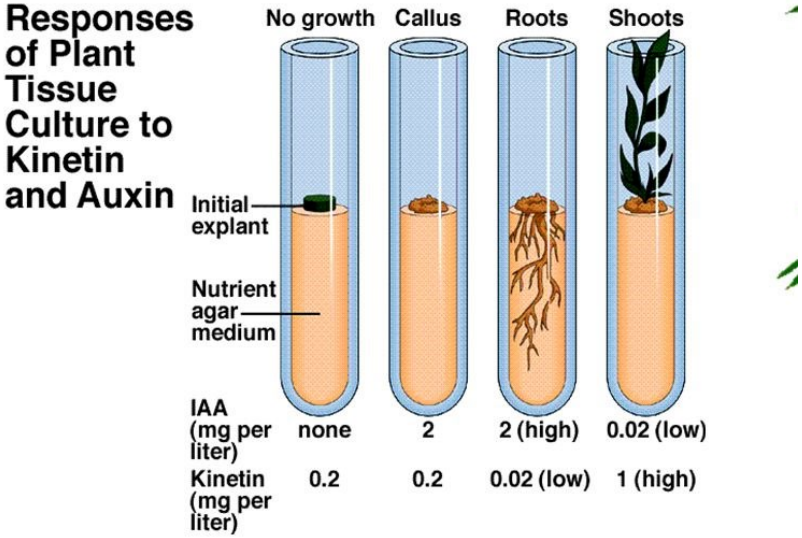


	Germination	Growth to Maturity	Flowering	Fruit Development	Abscission	Seed Dormancy
Gibberellin	✓	✓	✓	✓	✗	✗
Auxin	✗	✓	✓	✓	✗	✗
Cytokinins	✗	✓	✓	✓	✗	✗
Ethylene	✗	✗	✓	✓	✓	✗
Abscisic Acid	✗	✗	✗	✗	✓	✓

Phytohormones - Auxin

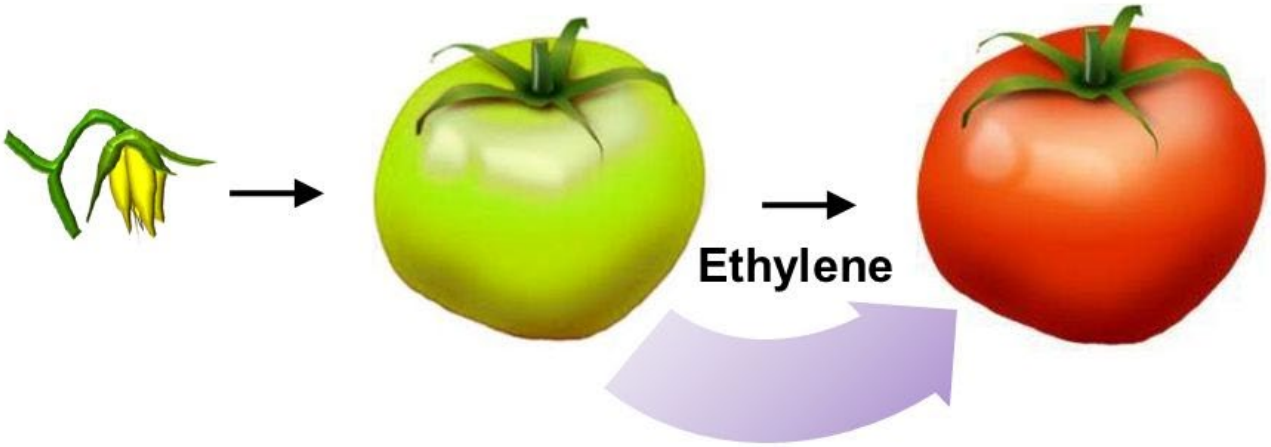
Phytohormones - Kinetin

Cytokinin & tissue culture



Phytohormones - Ethylene

Fruit ripening is induced by ethylene

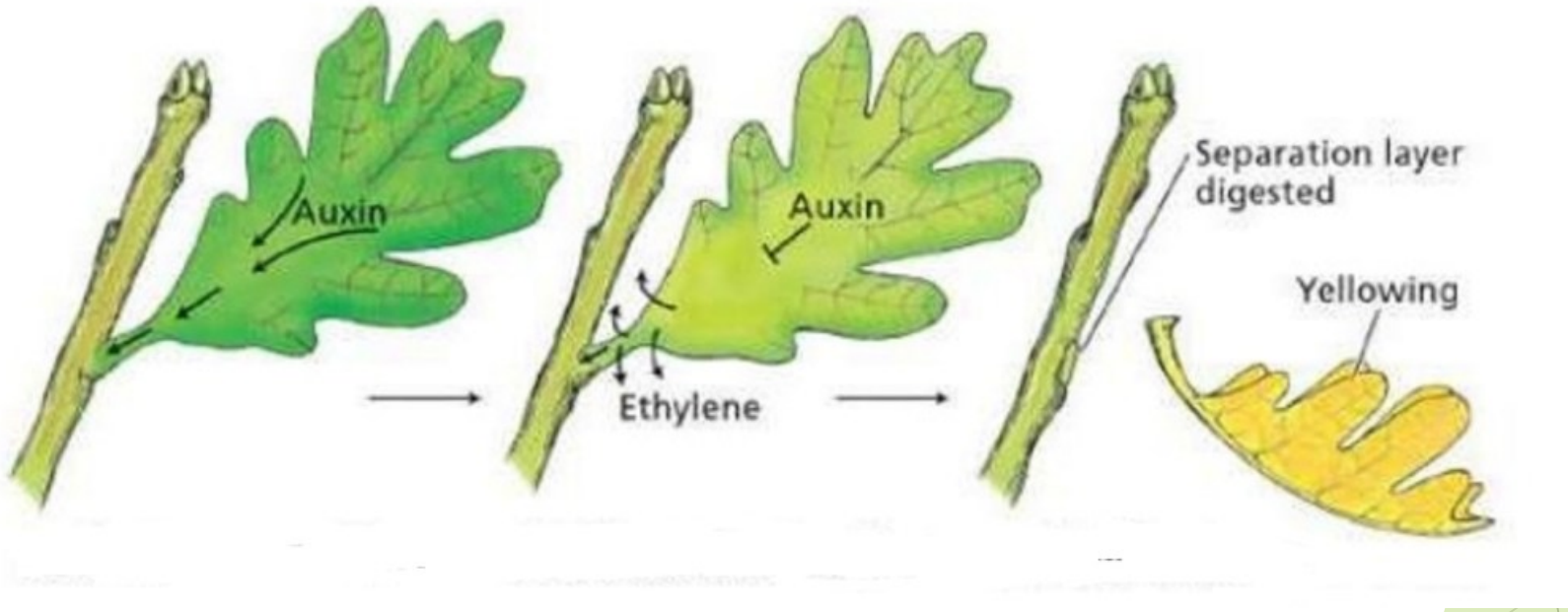


Ripening includes:

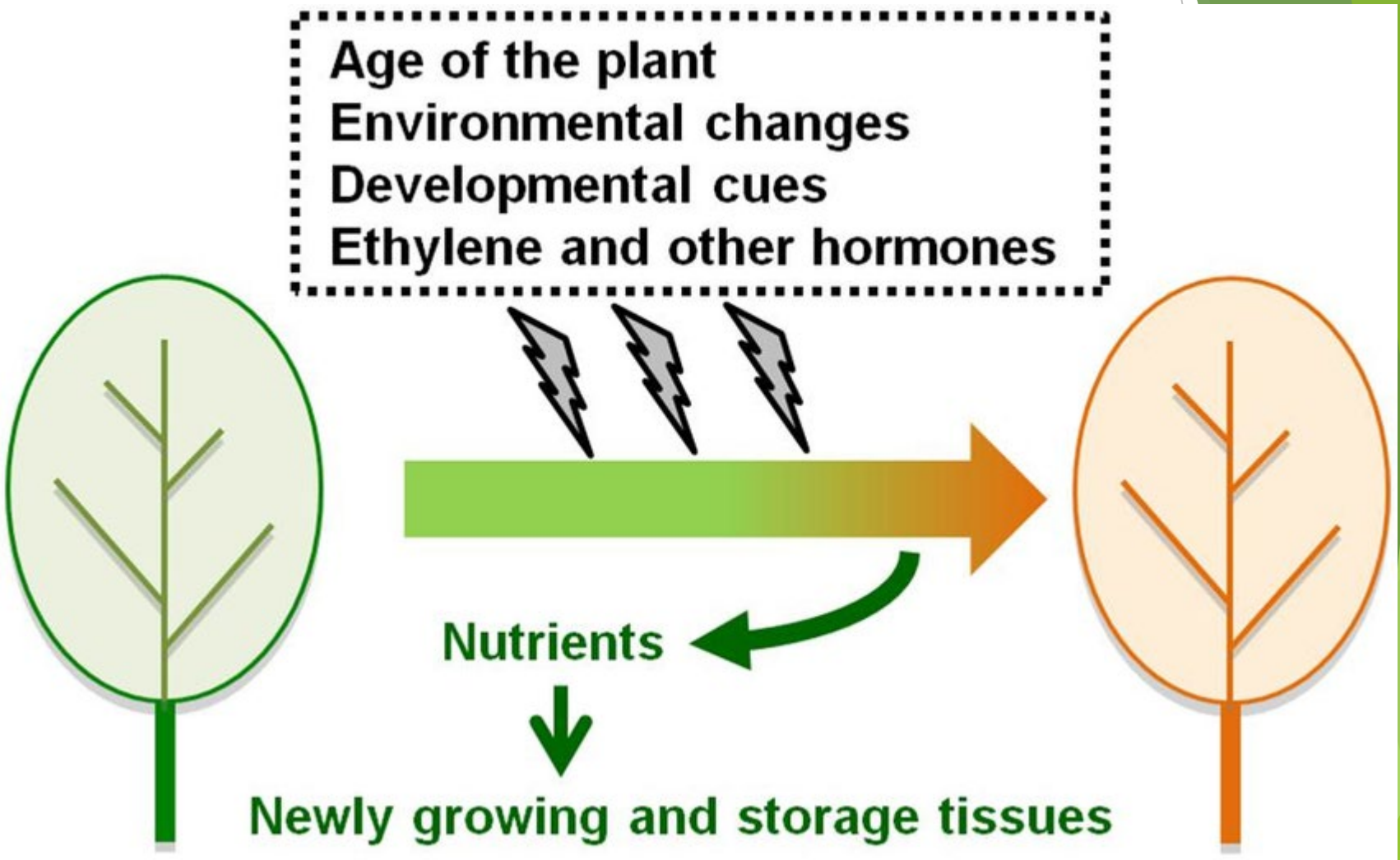
- Changes in cell wall structure
- Pigment accumulation
- Flavor and aromatic volatile production
- Conversions of starches to sugars

Phytohormones – Gibberelic Acid

Phytohormones - Abscisic Acid



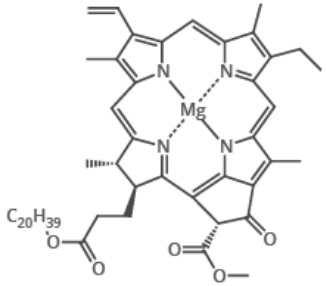
Leaf Senescence



Pigmentation

THE CHEMISTRY OF THE COLOURS OF AUTUMN LEAVES

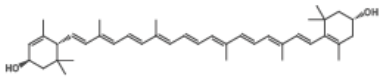
CHLOROPHYLL



CHLOROPHYLL A
A type of chlorin

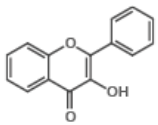
Chlorophyll is the chemical that gives plant leaves their green colour. Plants require warm temperatures and sunlight to produce chlorophyll - in autumn, the amount produced begins to decrease, and the existing chlorophyll is slowly broken down, diminishing the green colour of the leaves.

CAROTENOIDS & FLAVONOIDS

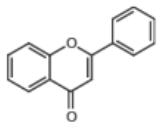


LUTEIN
A type of carotenoid

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.

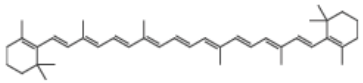


FLAVONOL
(general structure)



FLAVONE
(general structure)

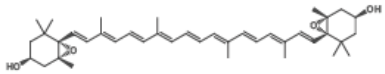
CAROTENOIDS



ß-CAROTENE
A type of carotenoid

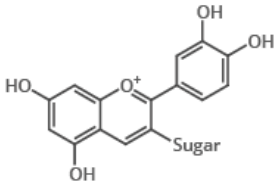
Carotenoids can also contribute orange colours. Beta-carotene is one of the most common carotenoids in plants, and absorbs green and blue light strongly, reflecting red and yellow light and causing its orange appearance. It is also responsible for the orange colouration of carrots.

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

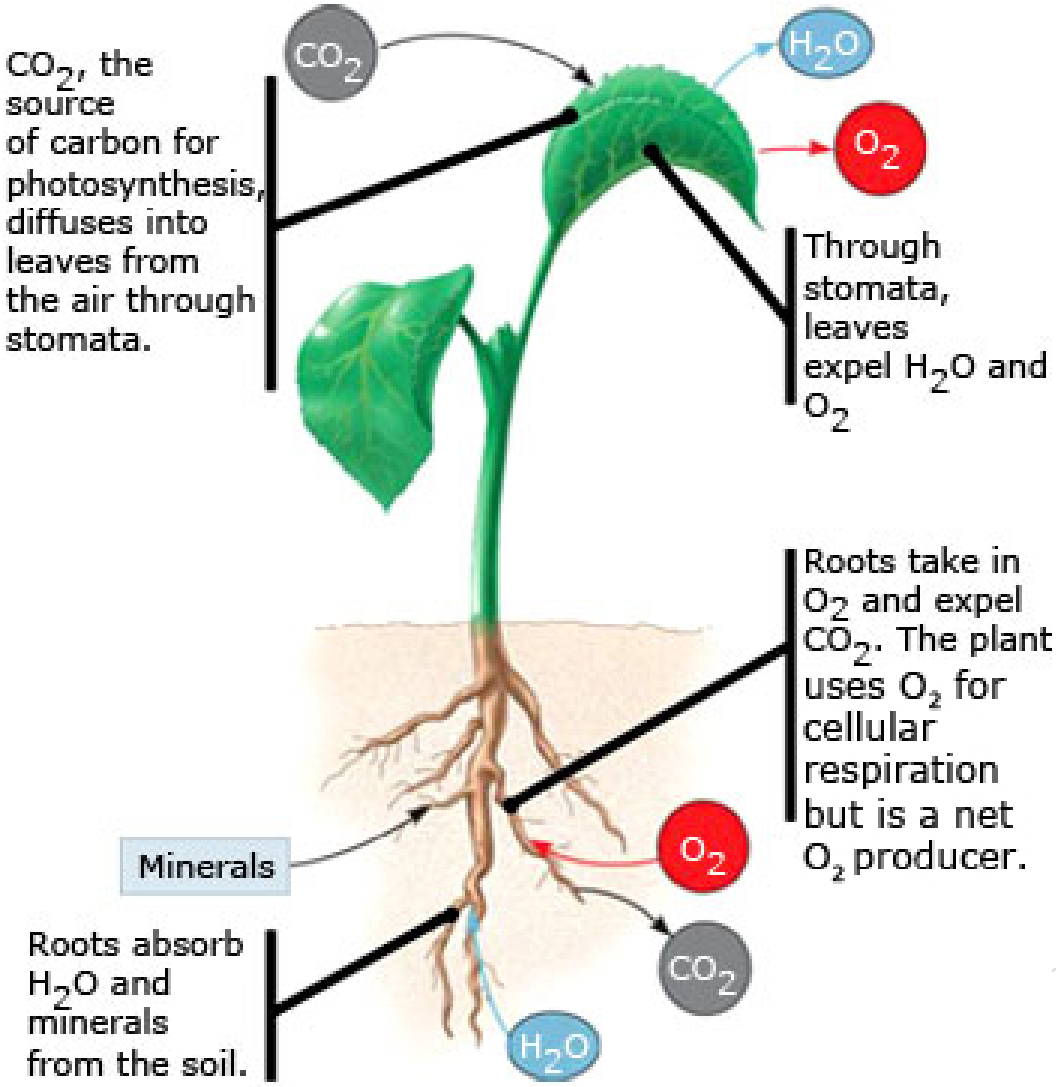


ANTHOCYANINS
(general structure)

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

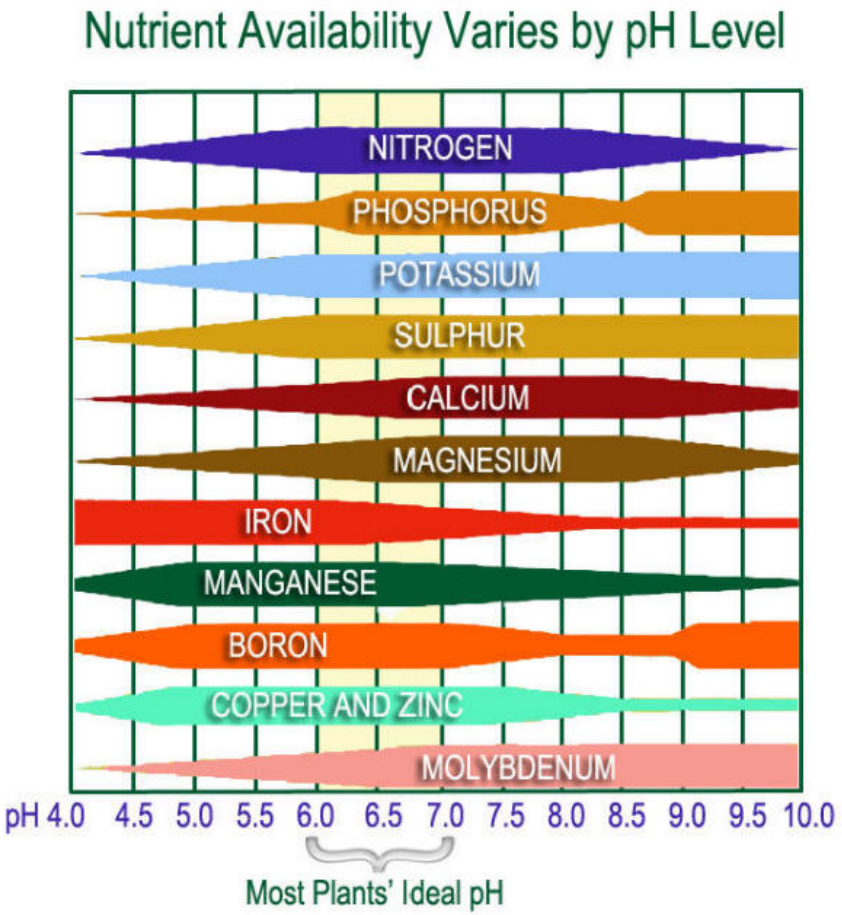
Nutrient Uptake

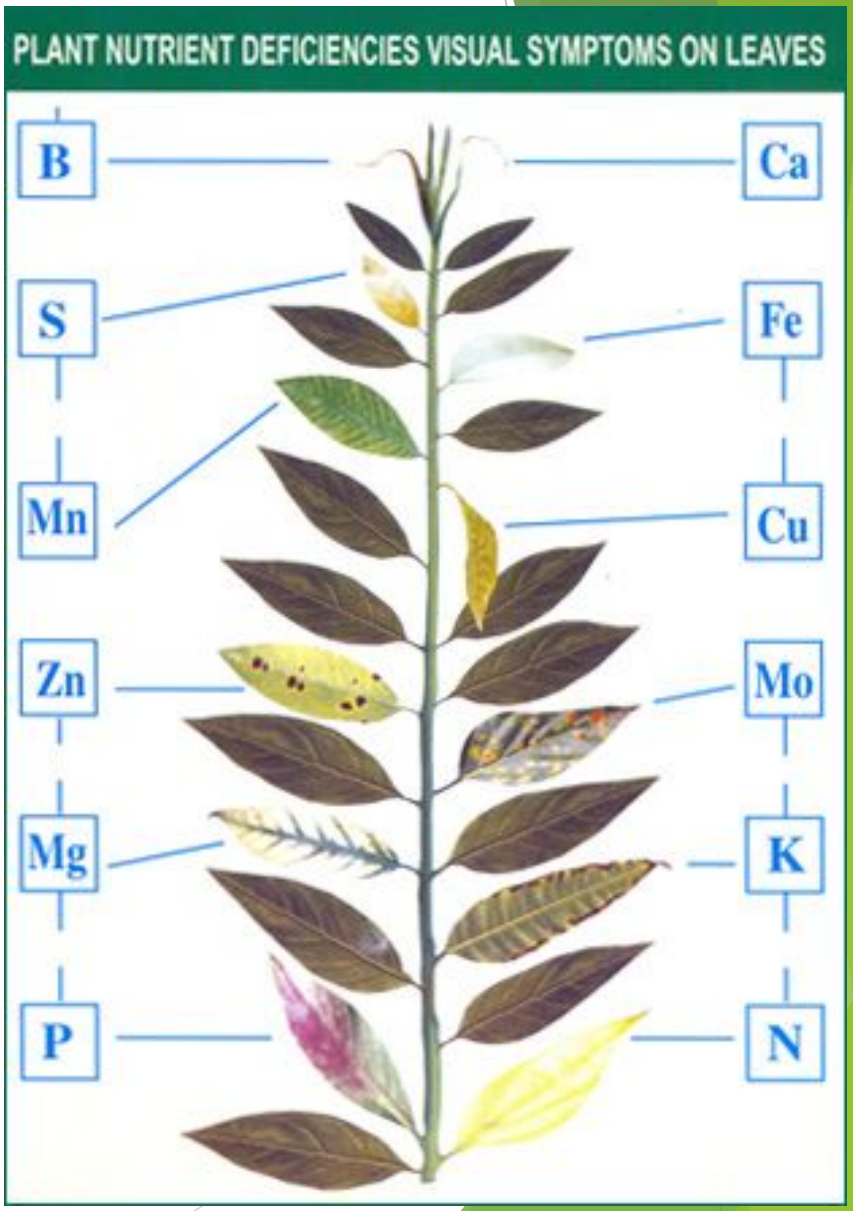


Macronutrients

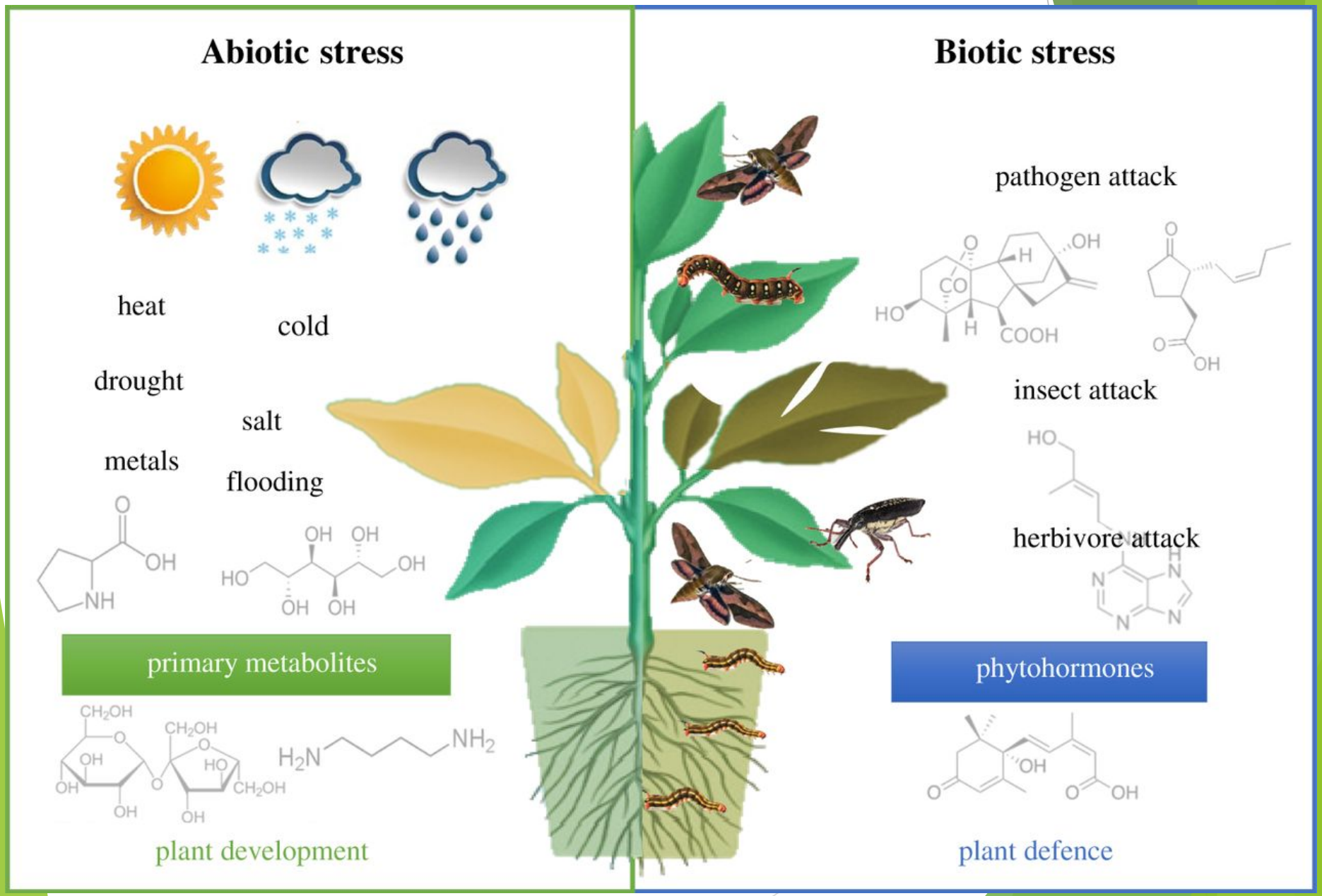
N Nitrogen	Healthy foliage. Chlorophyll production. Vegetative Growth.	
P Phosphorus	Development of flowers DNA/RNA Synthesis Strong Roots	
K Potassium	Hearty Growth Synthesize Proteins & Carbohydrates	

Nutrient Uptake



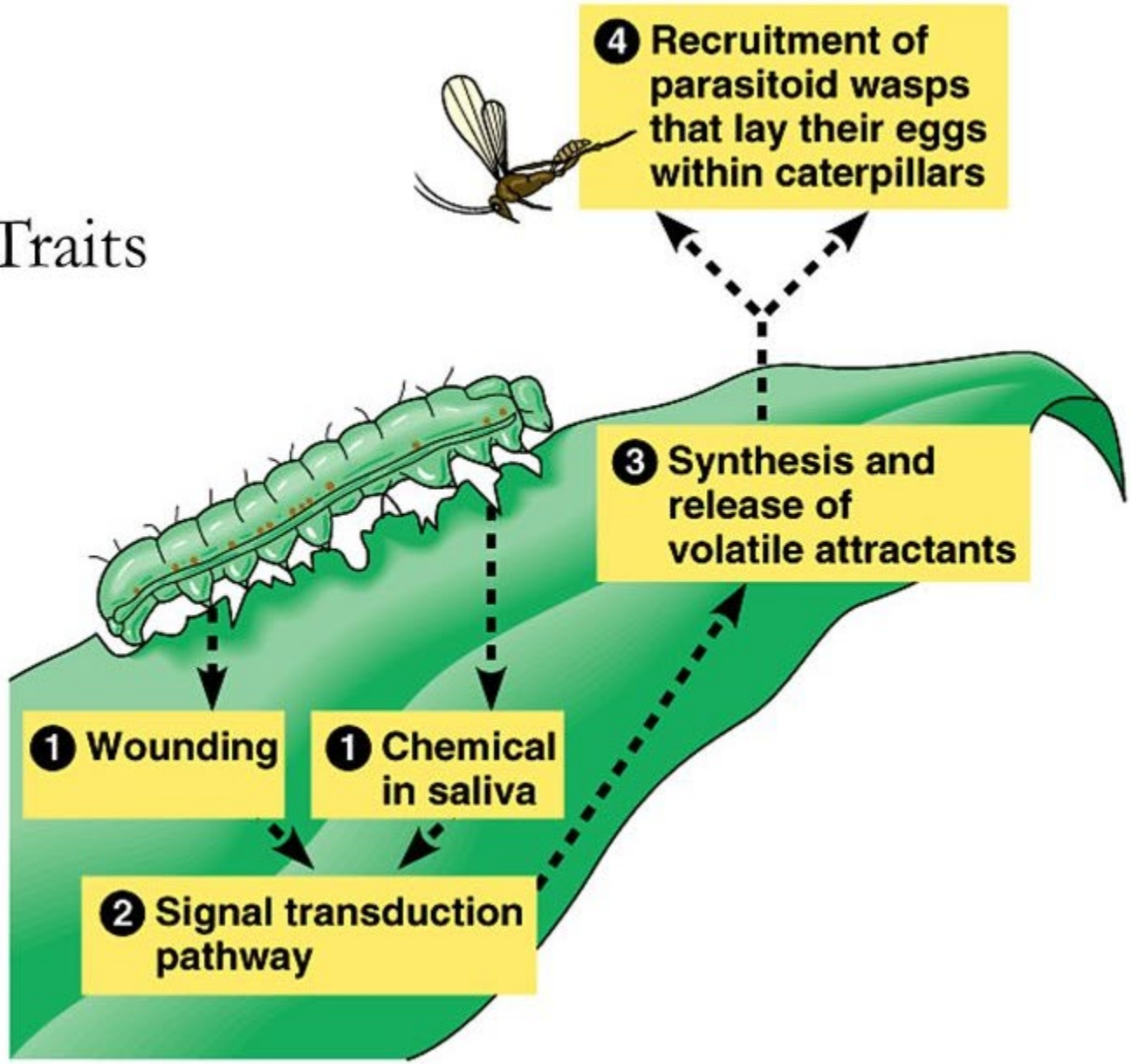


Plant Stress Responses

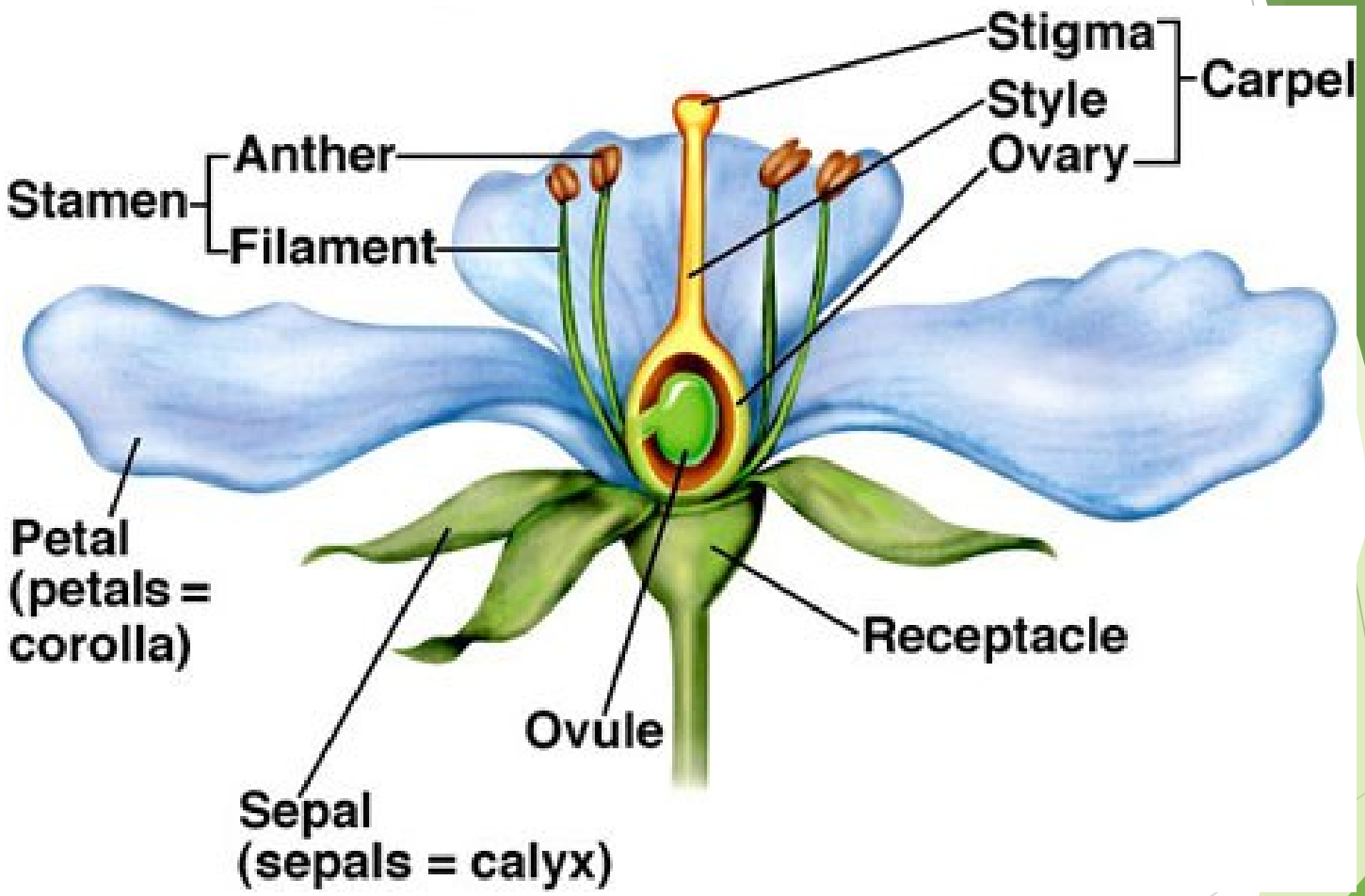


Plant Stress Responses

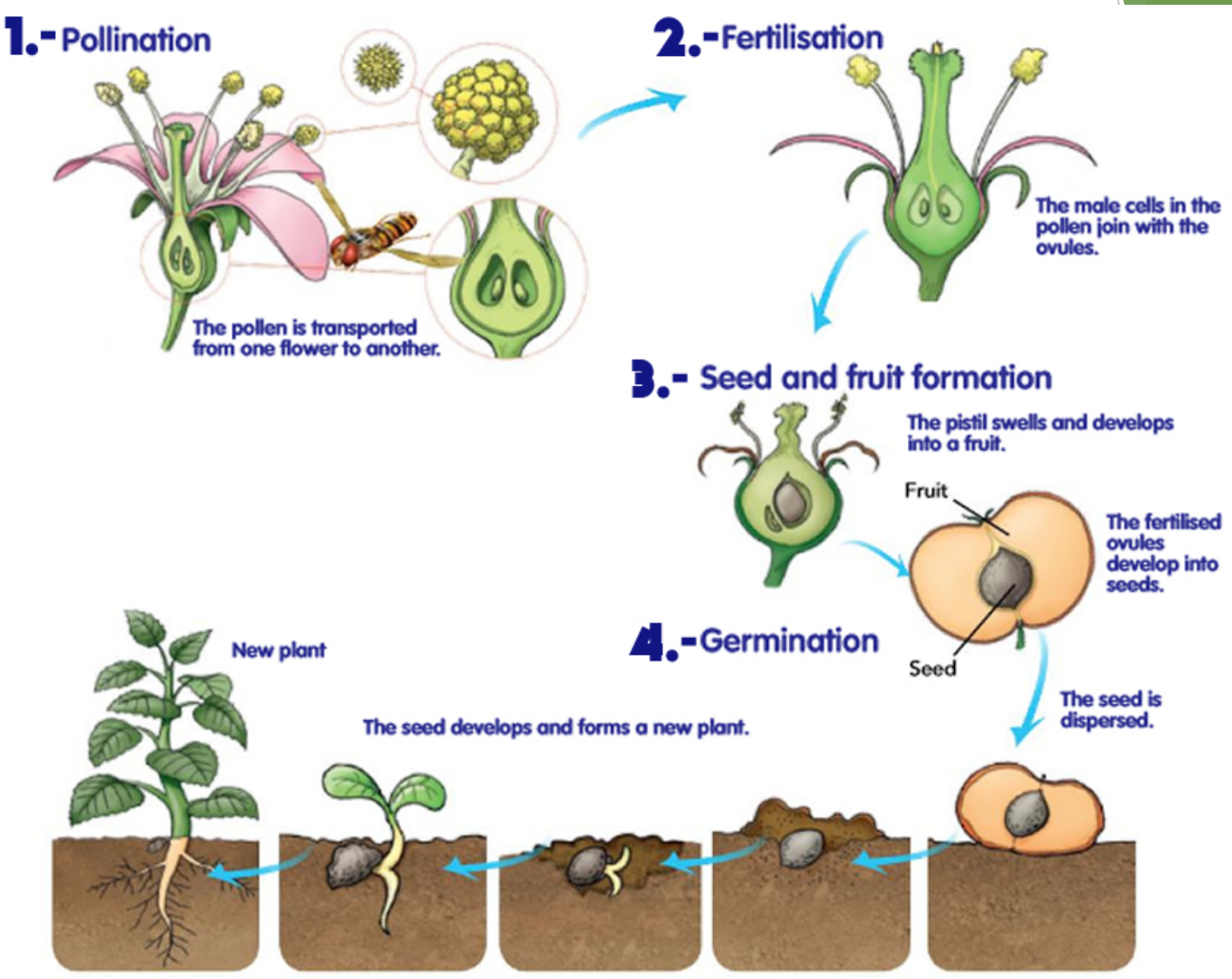
Plant Defense Traits



Plant Reproduction

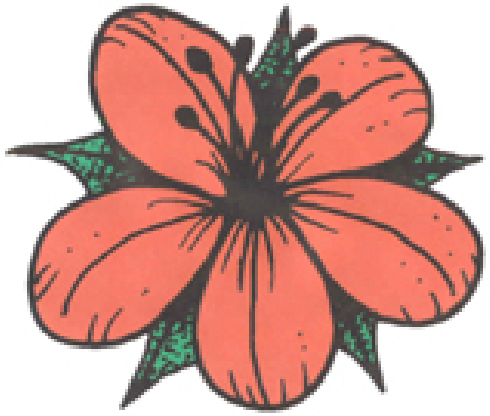


Plant Reproduction

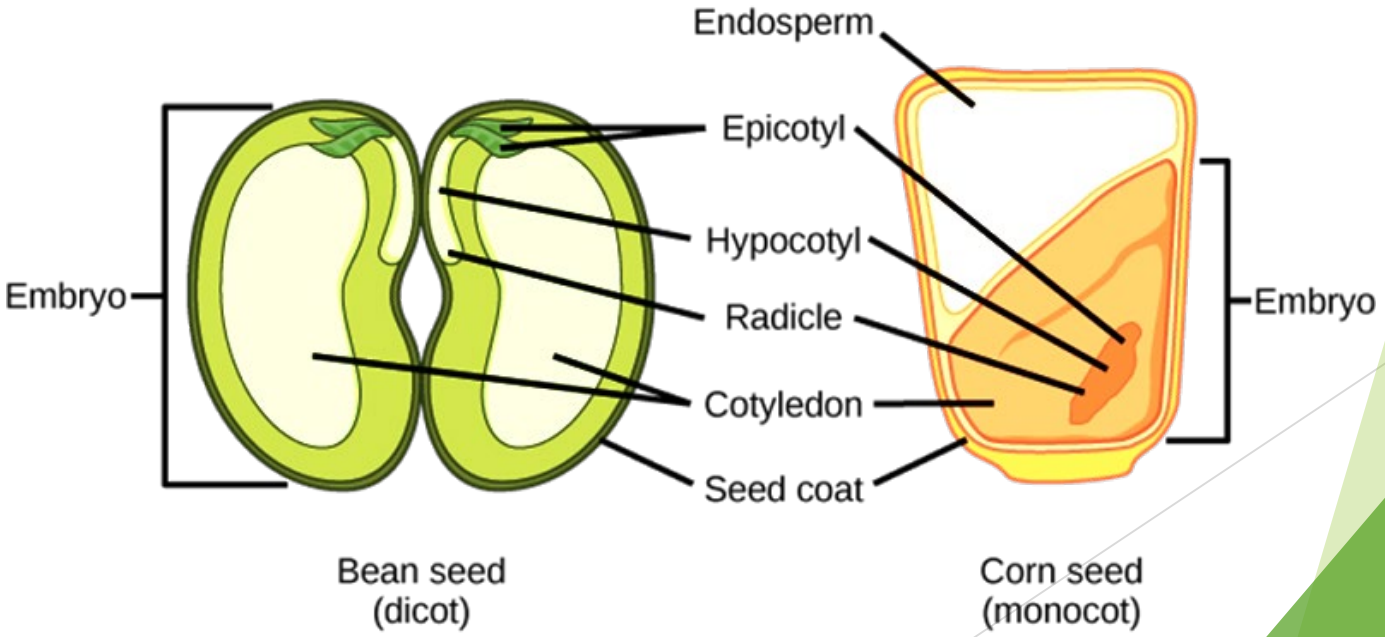


Monocots vs. Dicots

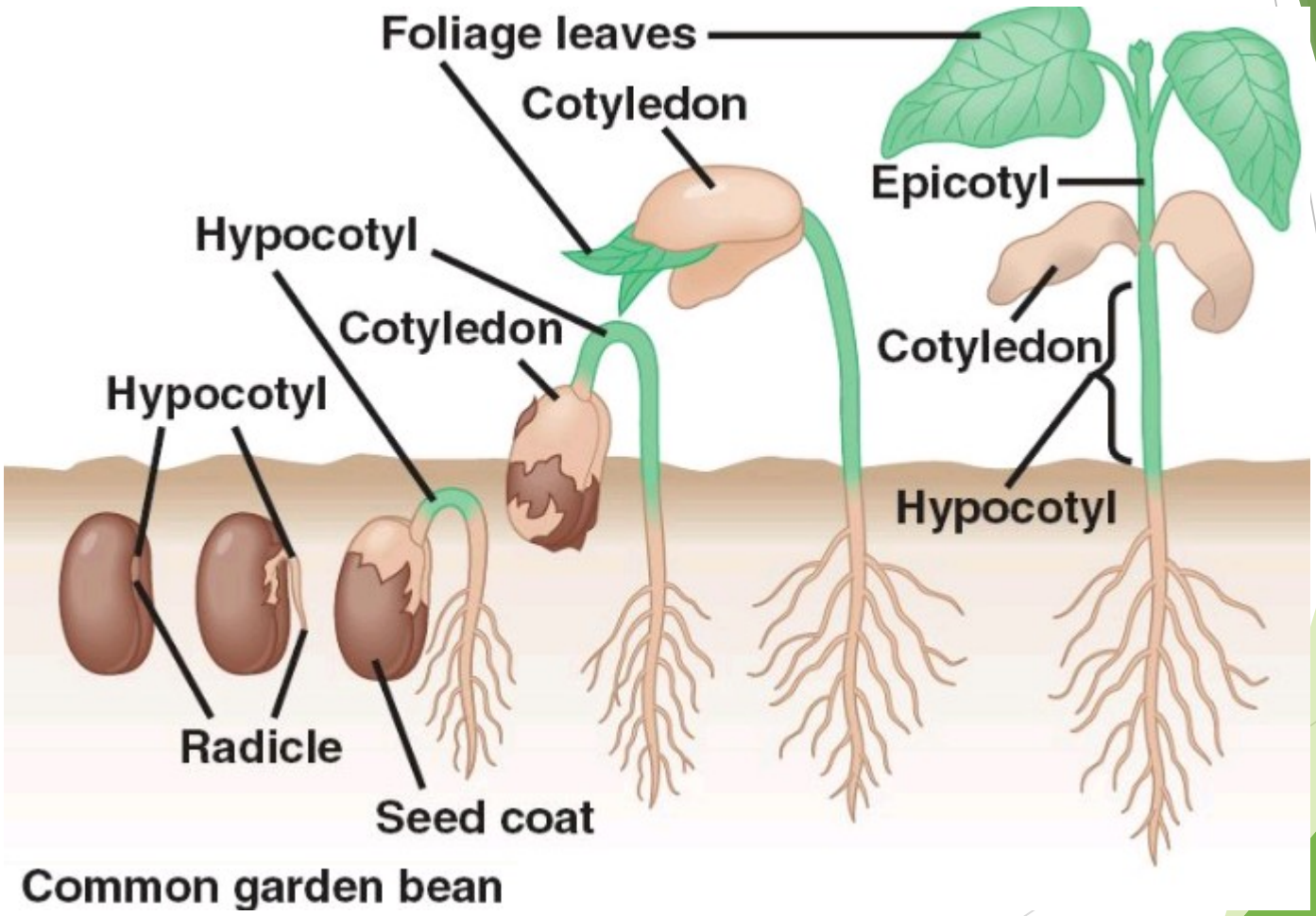
Monocots
Parts in 3s



Dicots
Parts in 4s or 5s



Seed Germination



Common garden bean