



Basic Botany and Horticulture

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Cooperative Extension*

Botany



**A Basic
Biological
Science**



- Anatomy
- Physiology
- Taxonomy
- Ecology

Horticulture



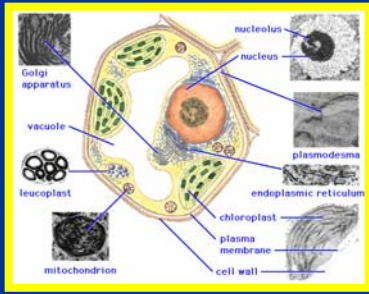
- Intensive culture of fruits, vegetables, and ornamentals



Part 1

Plant Structures and Functions





Cells



Roots



Stems



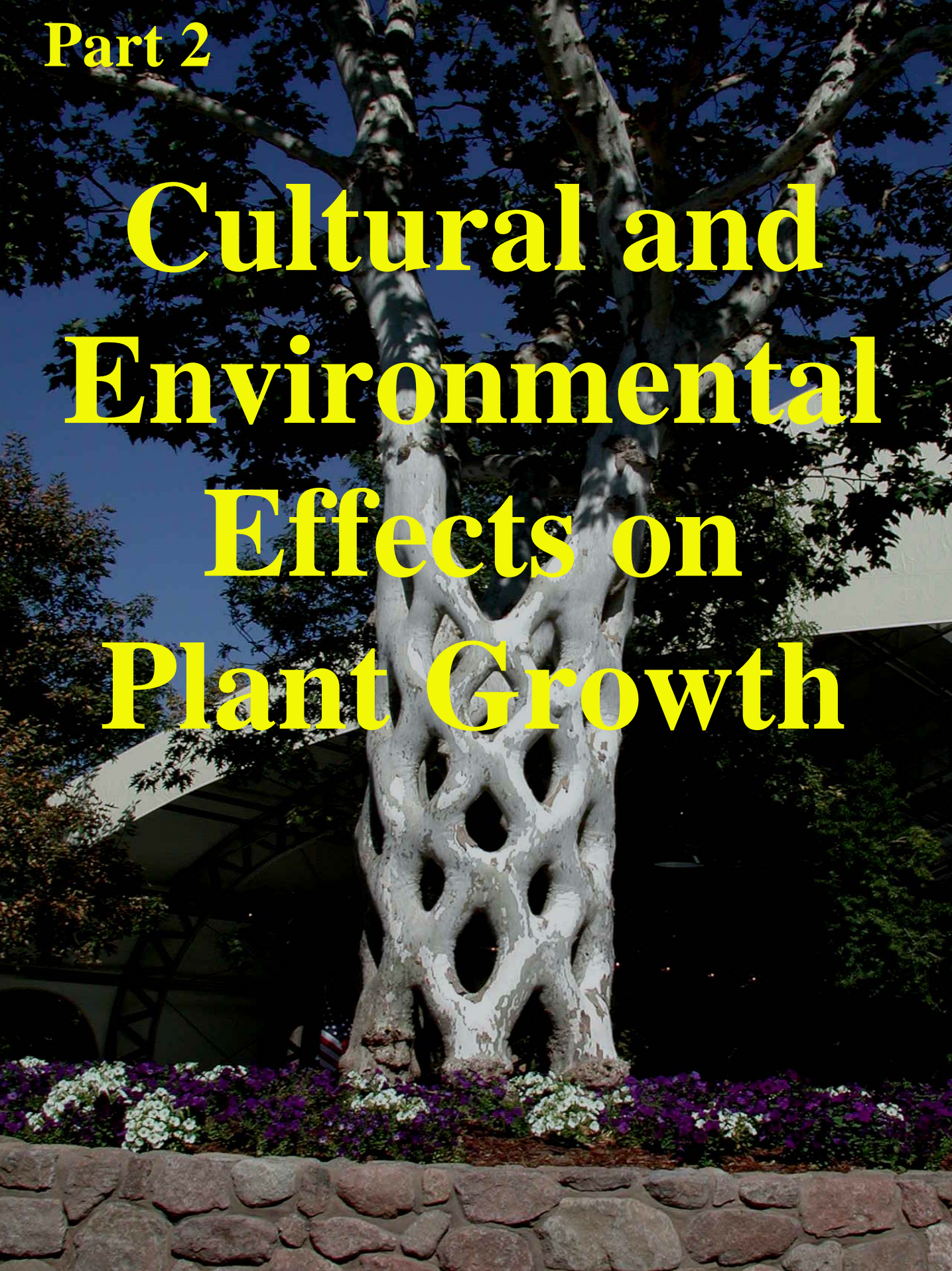
Leaves



Flowers

Part 2

Cultural and Environmental Effects on Plant Growth





Temperature



Light



**Environmental
Stress**



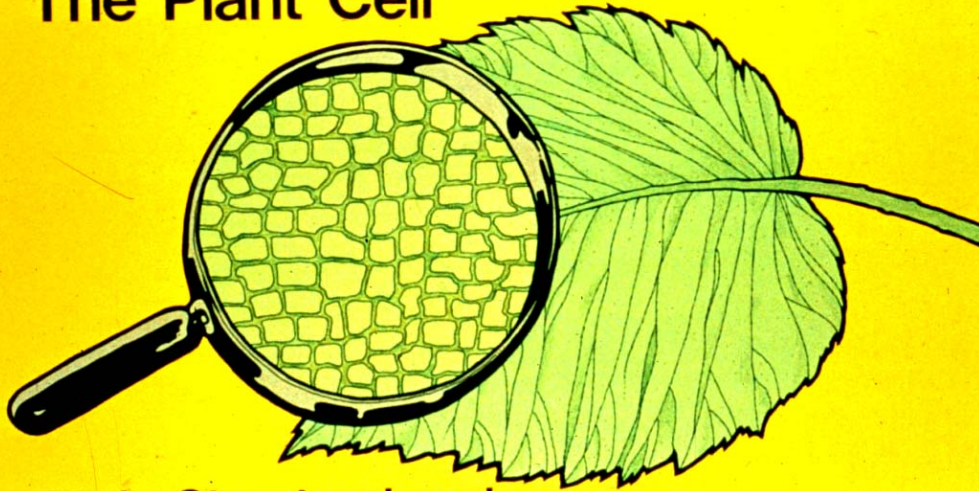
**Plant
Hormones**

Part 1

Plant Structures and Functions



The Plant Cell

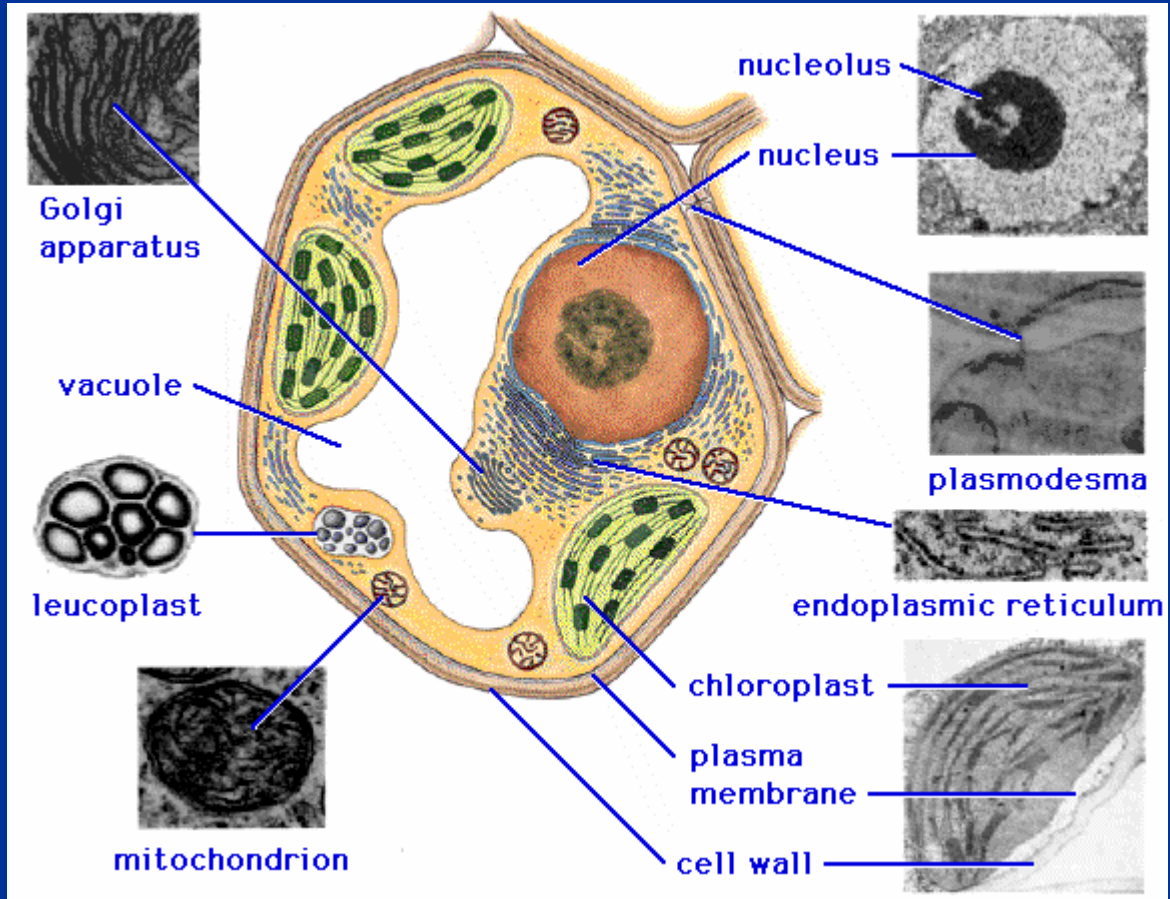


Basic Structural and
Functional Unit of the Plant

Cell Functions:

- Absorbs and secretes metabolites
- Light energy to chemical energy
- Respires and releases energy
- Processes and transforms foods
- Synthesizes complex chemicals and amino acids

Cell Structure

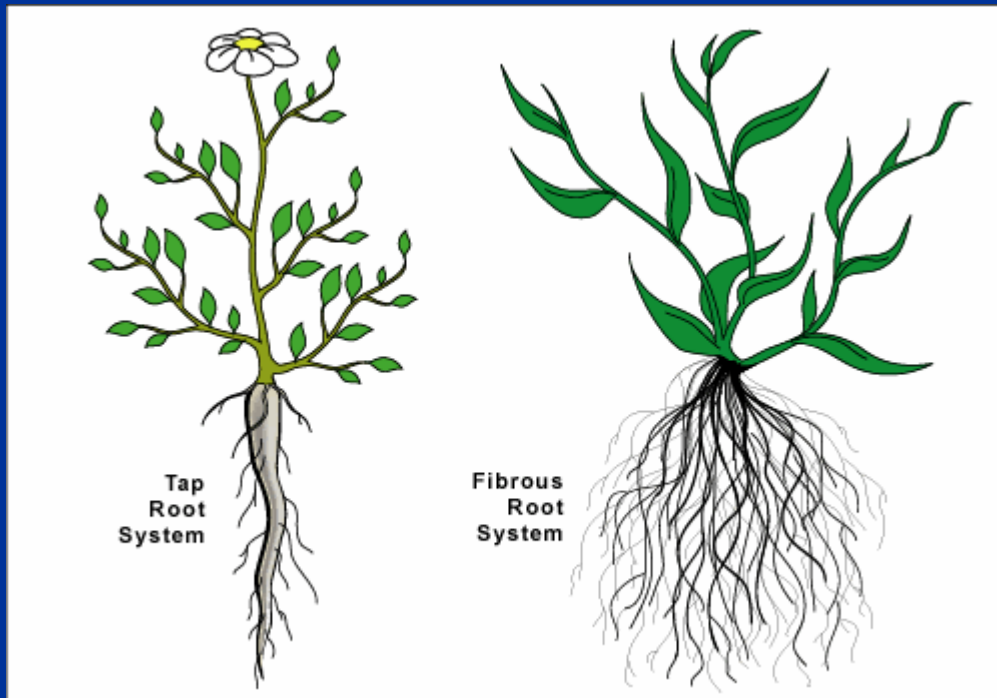


- **Water:** 70-95% of plant by weight
- **Cell wall:** gives some support to the cell.
- **Plasma membrane:** the skin of the protoplast, water, substances transported across.
- **Vacuoles:** store substances: salts, wastes, and sugars
- **Nucleus:** contains DNA
- **Chloroplasts:** capturing and storing light energy
- **Mitochondrion:** energy production
- **Endoplasmic reticulum:** protein production
- **Golgi apparatus:** processes proteins

ROOTS



Root System Structure



Factors Influencing Root Growth

- Light
- Gravity
- Temperature
- Mineral nutrition, salinity
- Soil type
- Oxygen
- Moisture

Root Functions



Anchorage



Storage of food



**Regeneration of new
plants**



**Absorption of water
and nutrients**

Root Anchorage



Problems with poor root anchorage !

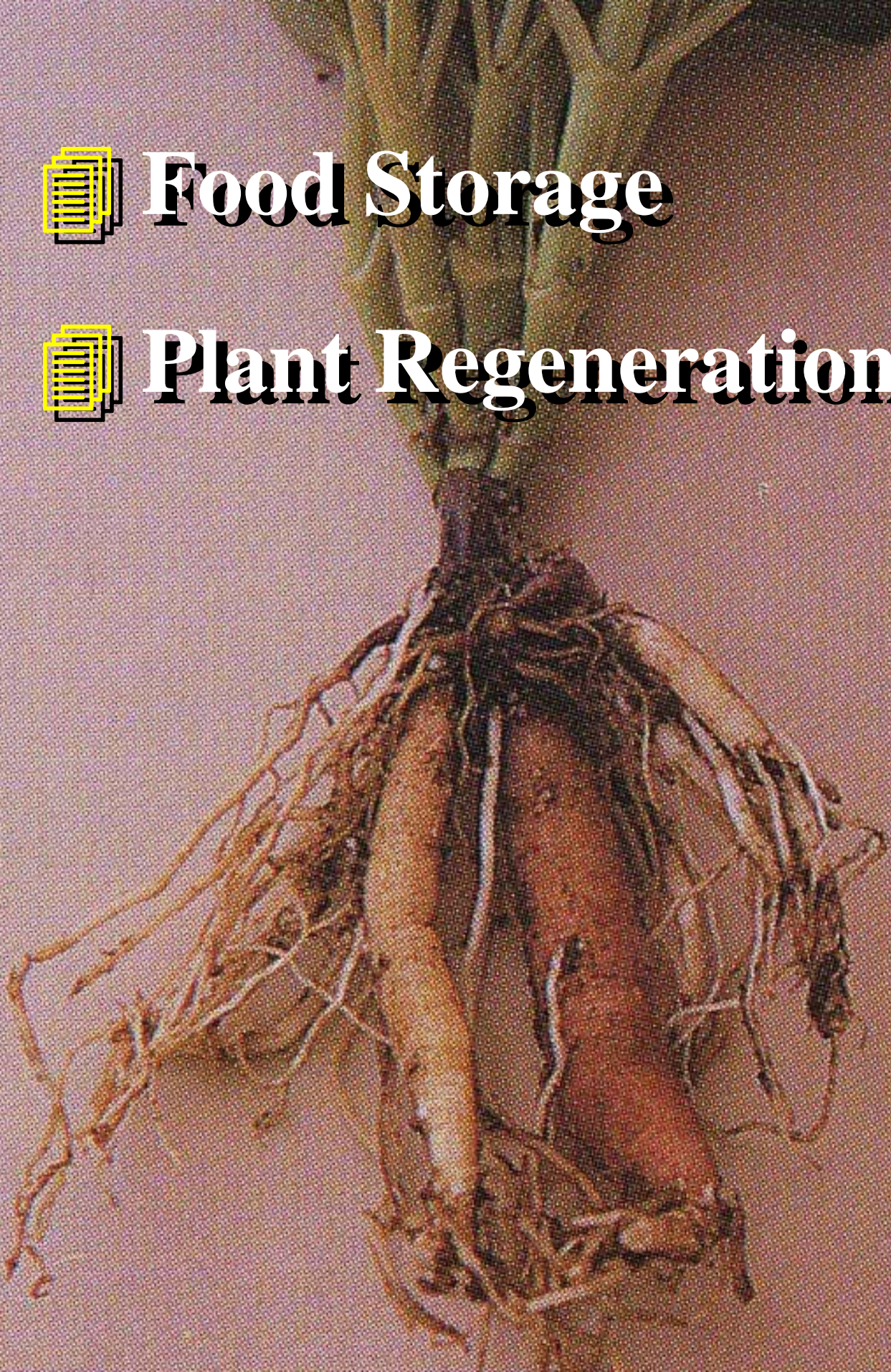




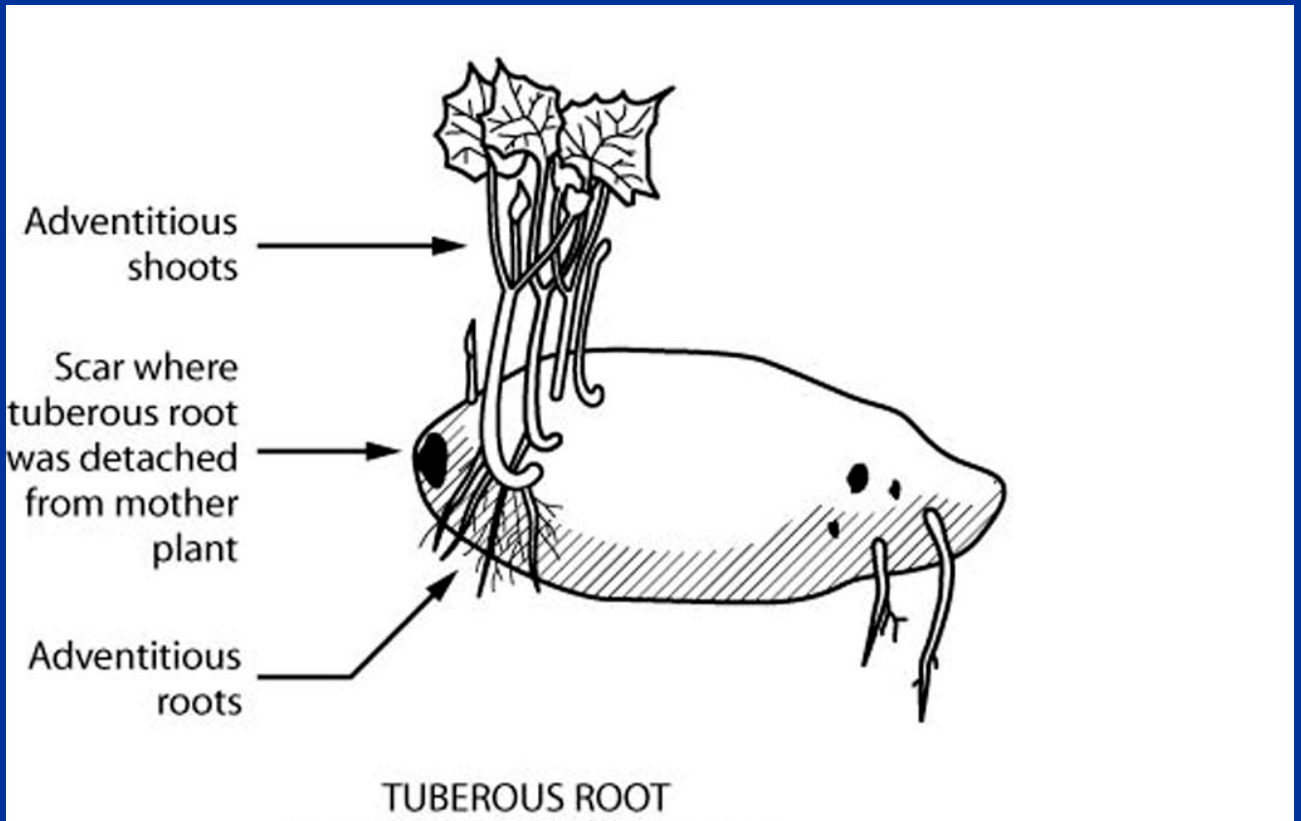
Food Storage



Plant Regeneration



Modified Roots

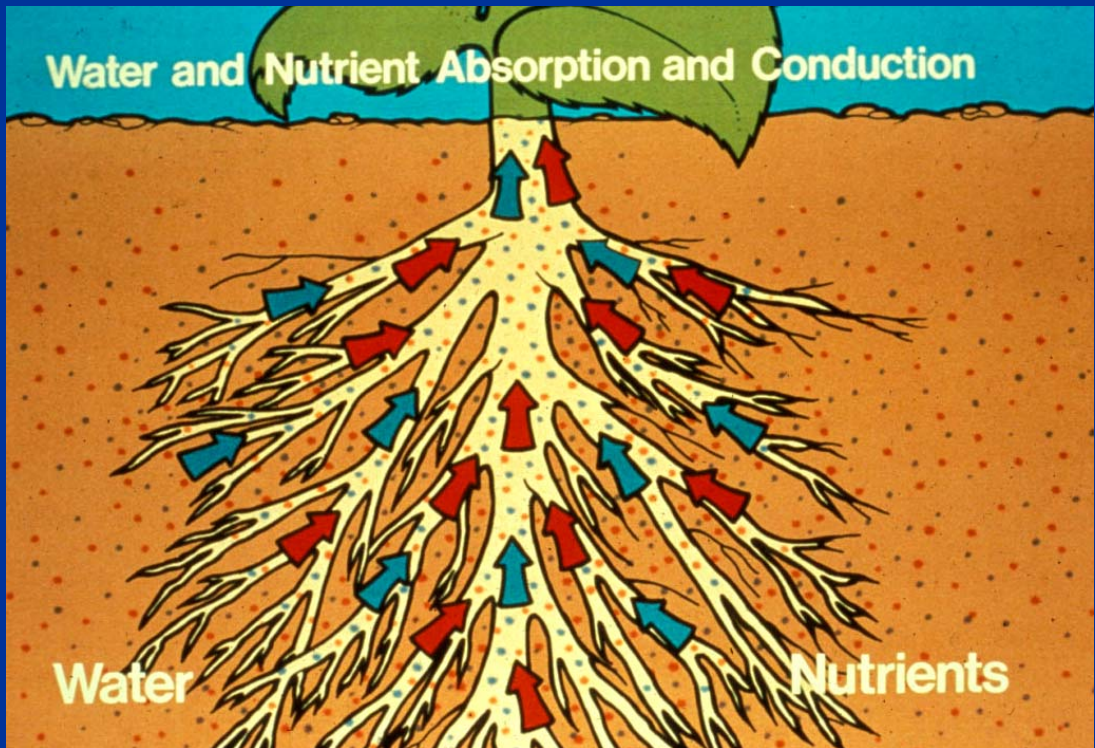


Dahlia

Tuberous begonia

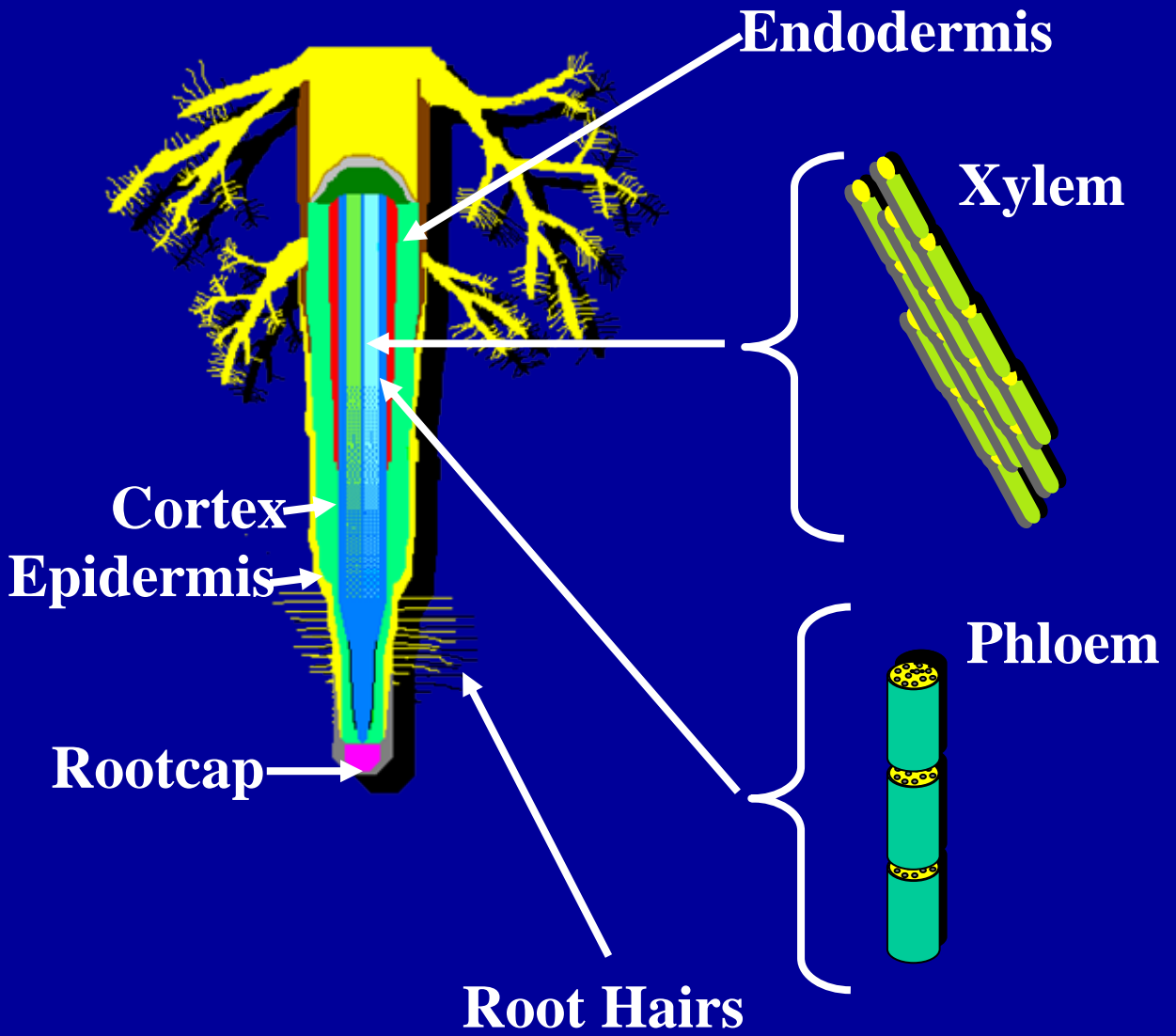
Sweet potato

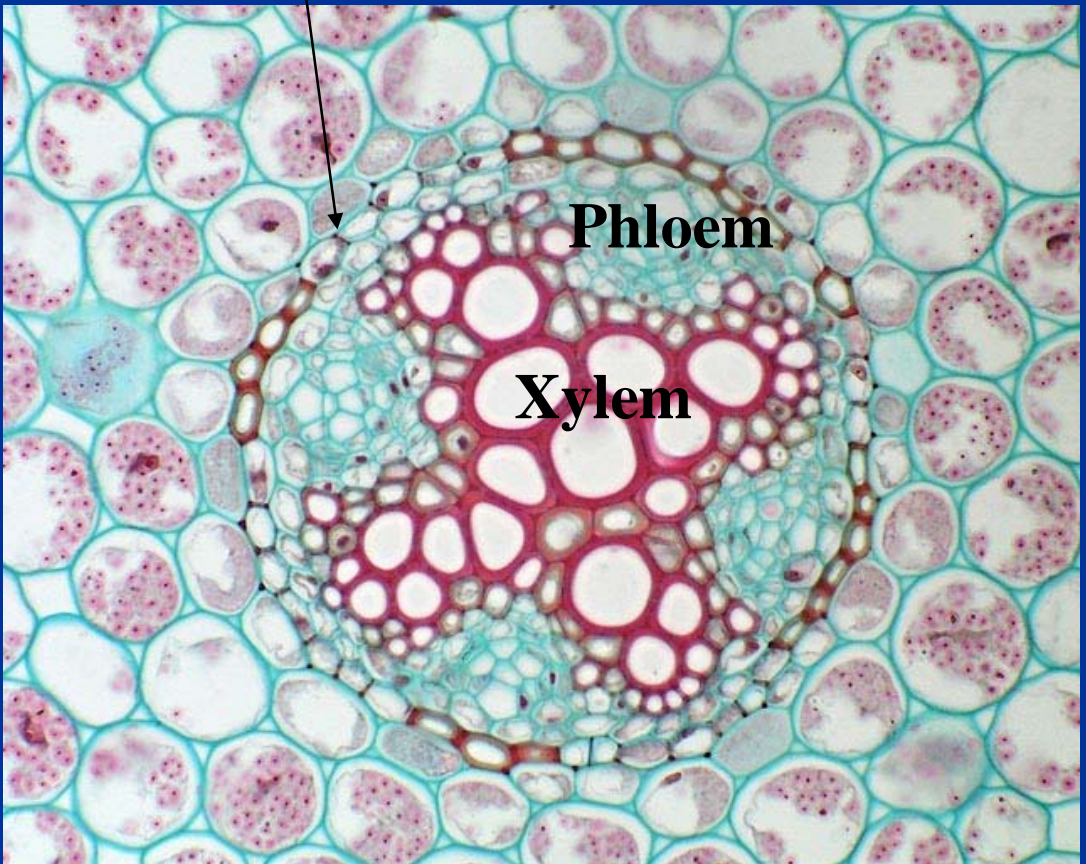
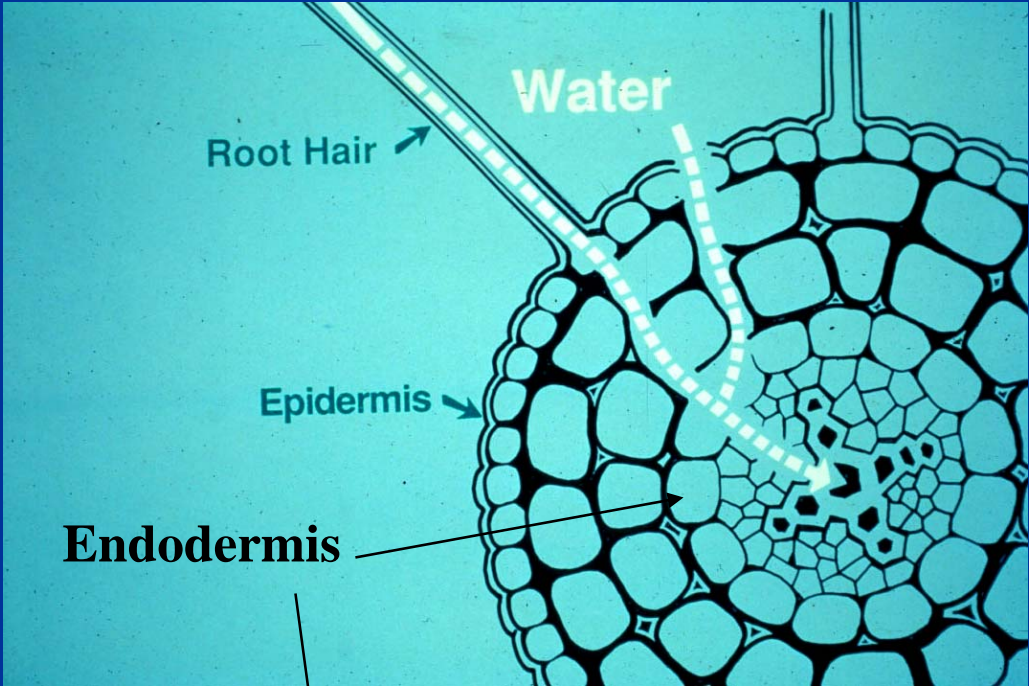
Water and Nutrient Absorption and Movement



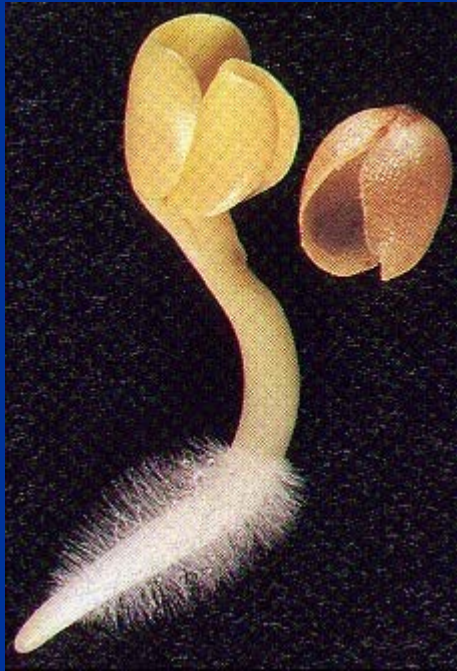


Water and Nutrient Uptake

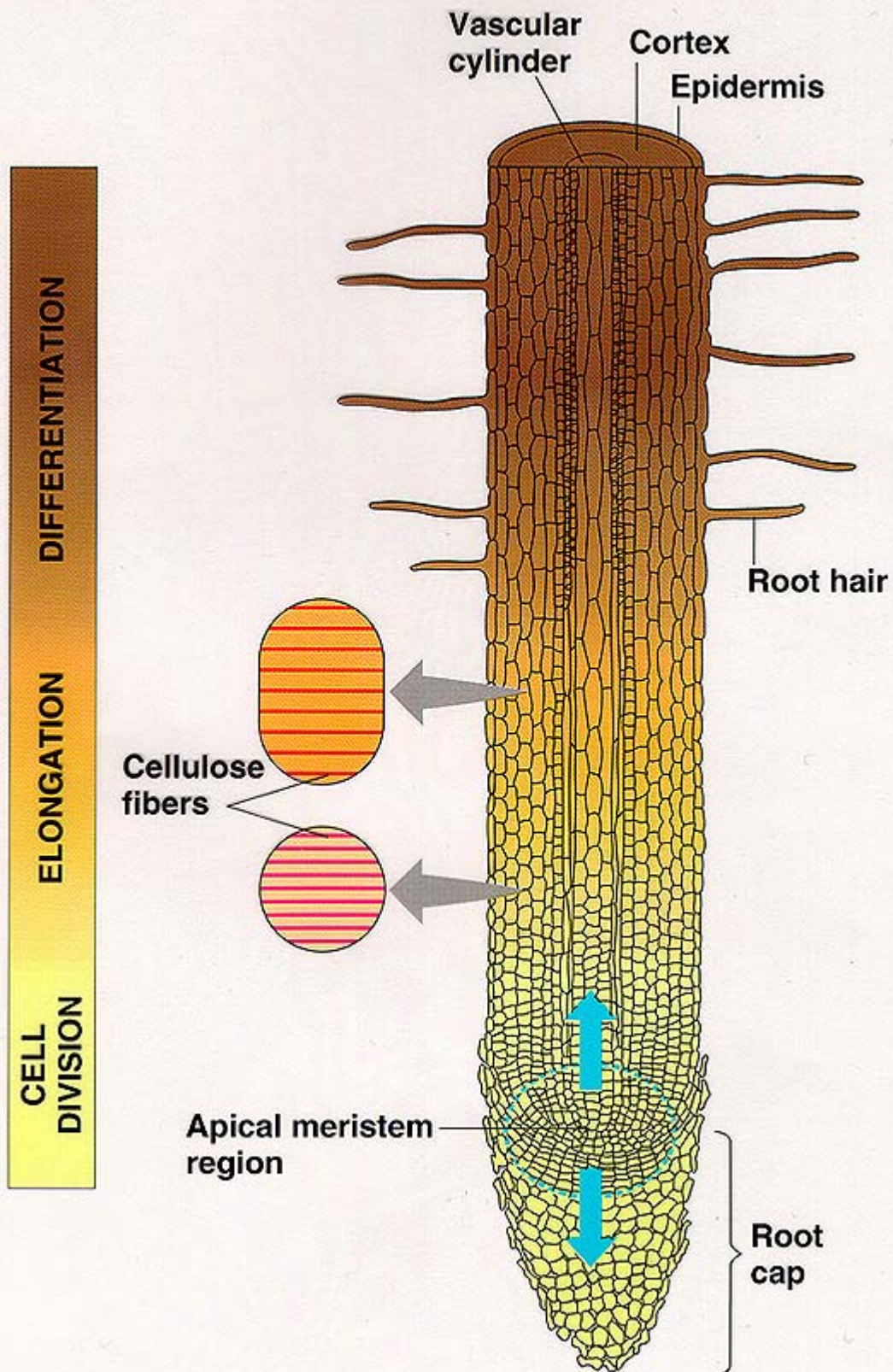




Root hairs

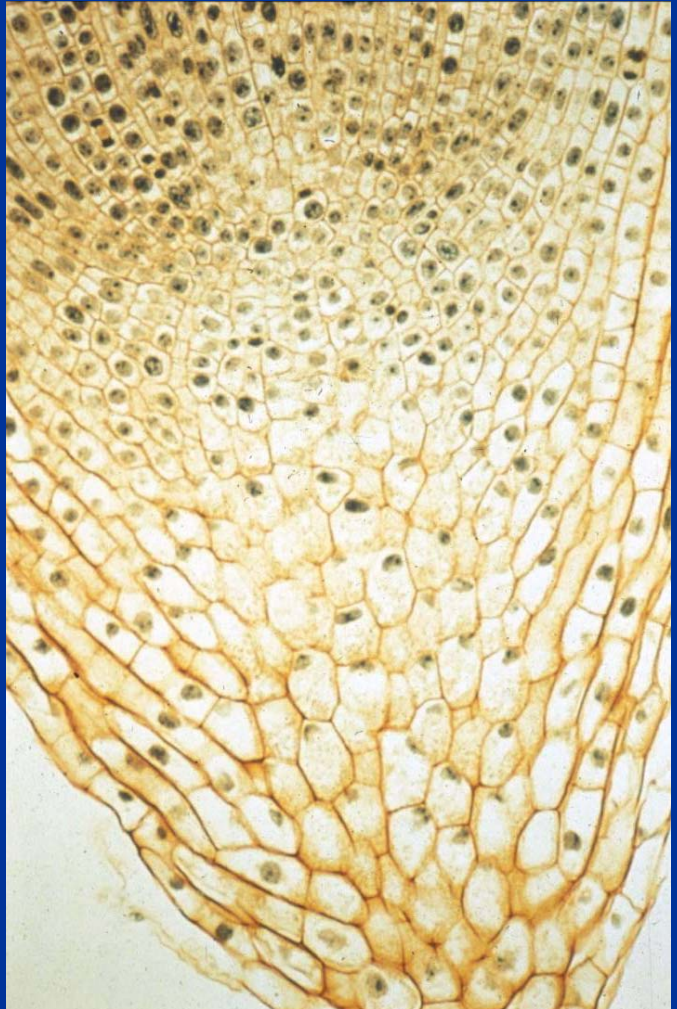


Are the root tips and hairs healthy ?



Root Meristems

- Apical
- Vascular
Cambium
- Cork
Cambium



Nutrient Uptake



Passive: flows along with conduction of water



Selective: roots can actively distinguish one nutrient from another nutrient

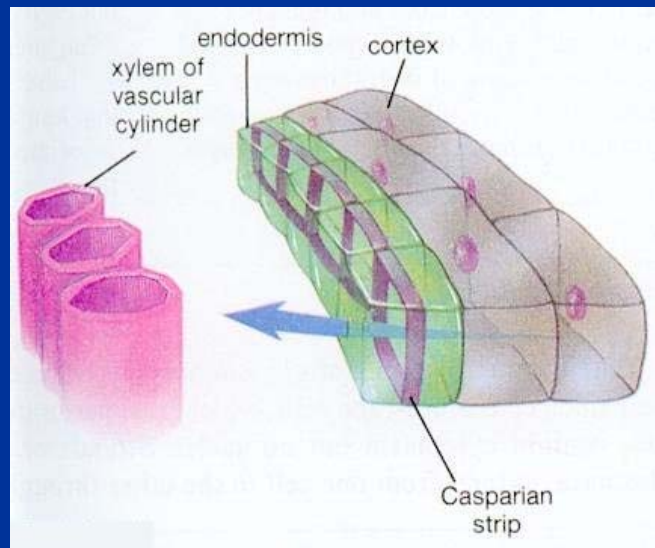
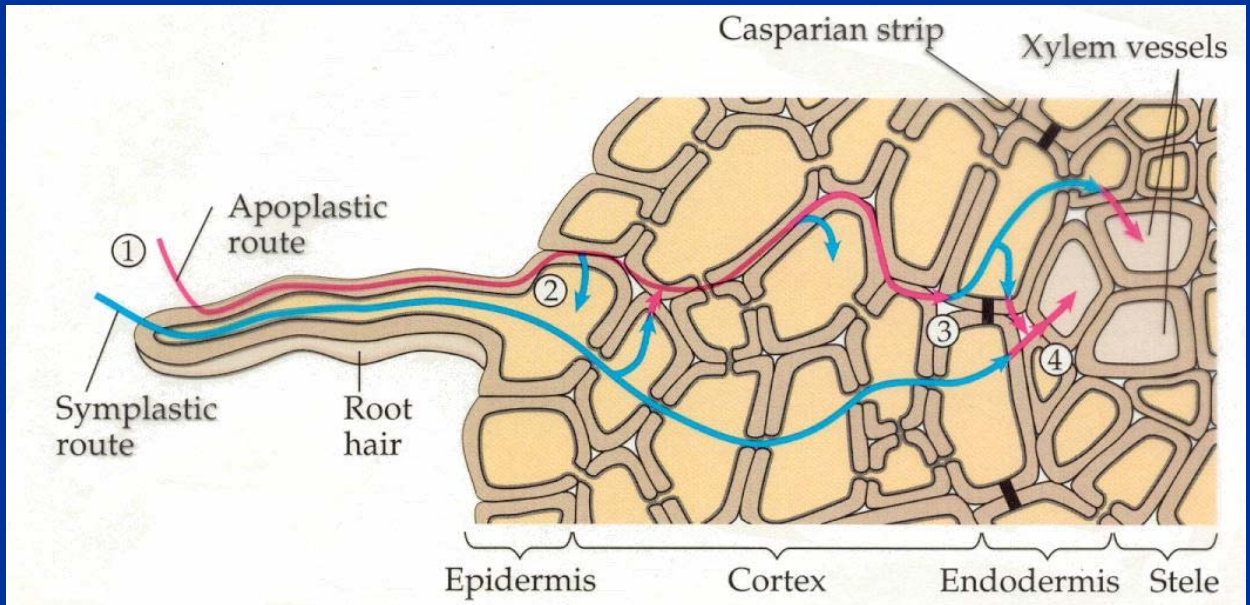


Selective uptake: requires energy and therefore sugars and starches



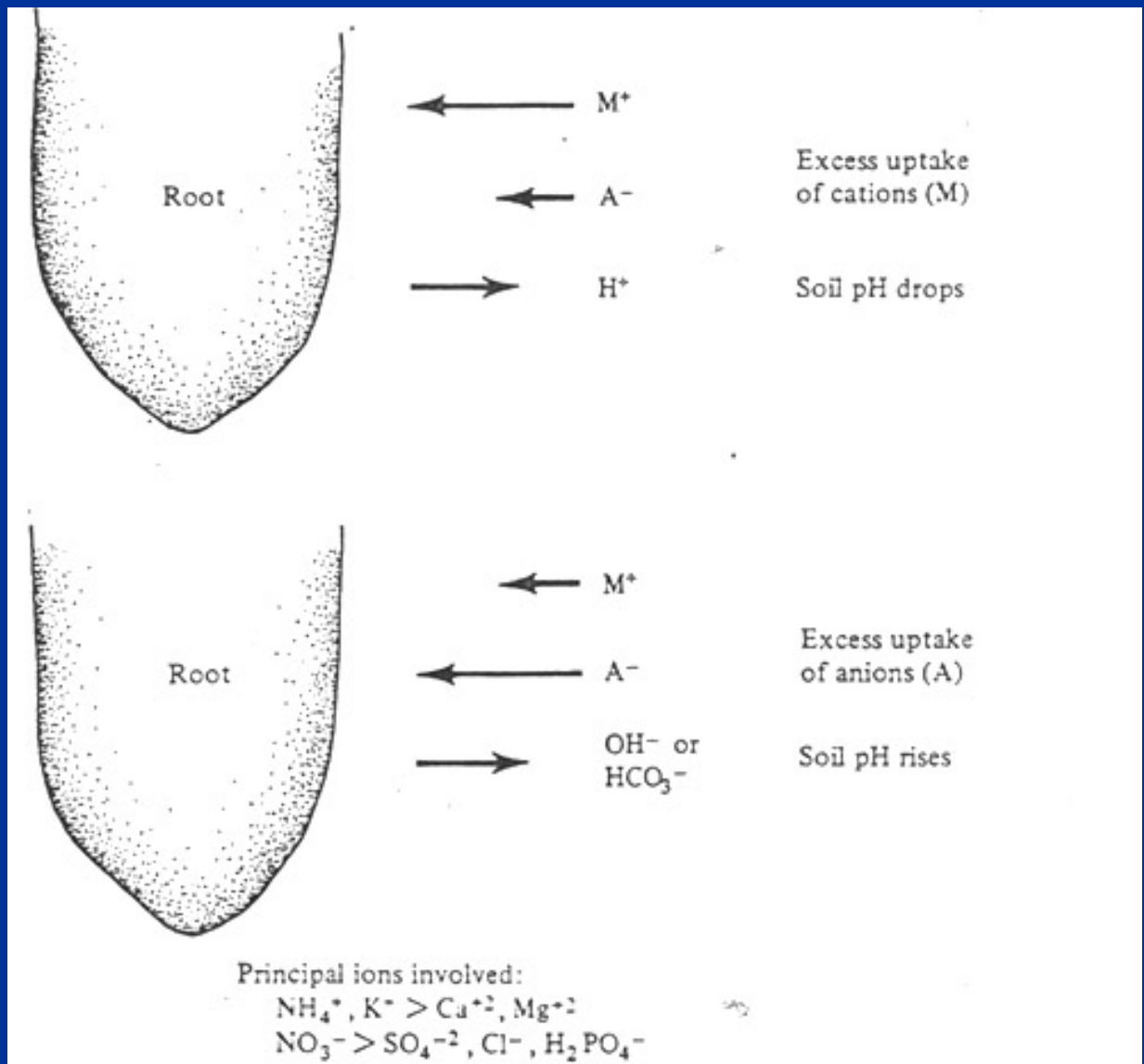
Selective

- roots can distinguish one nutrient from another nutrient





Physiological Acid Nitrogen Fertilizers



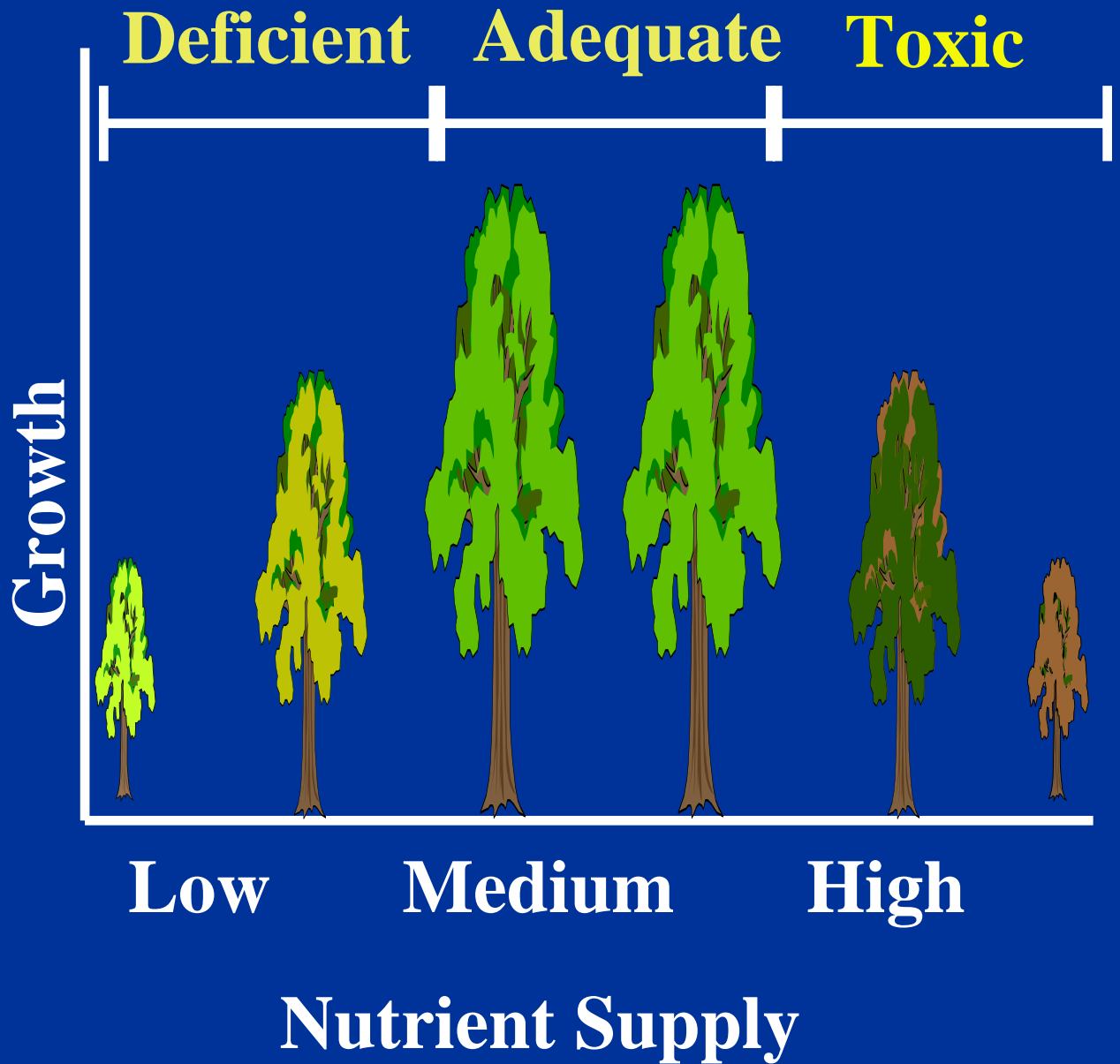
Plant Mineral Nutrients (Fertilizer)

 **Nutrient quantity**

 **Nutrient balance**

 **Nutrient mobility**

Nutrient Quantity

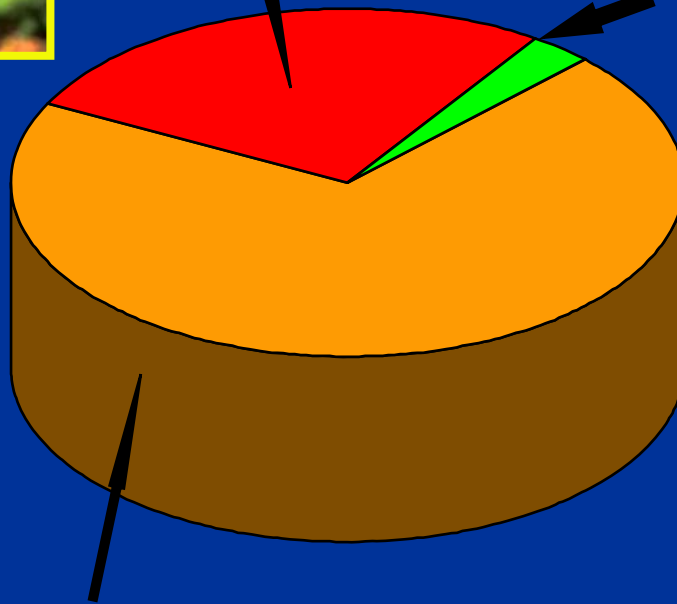


Nutrient Balance based on Plant Composition

Organic matter - 27%
(carbon, sugars)



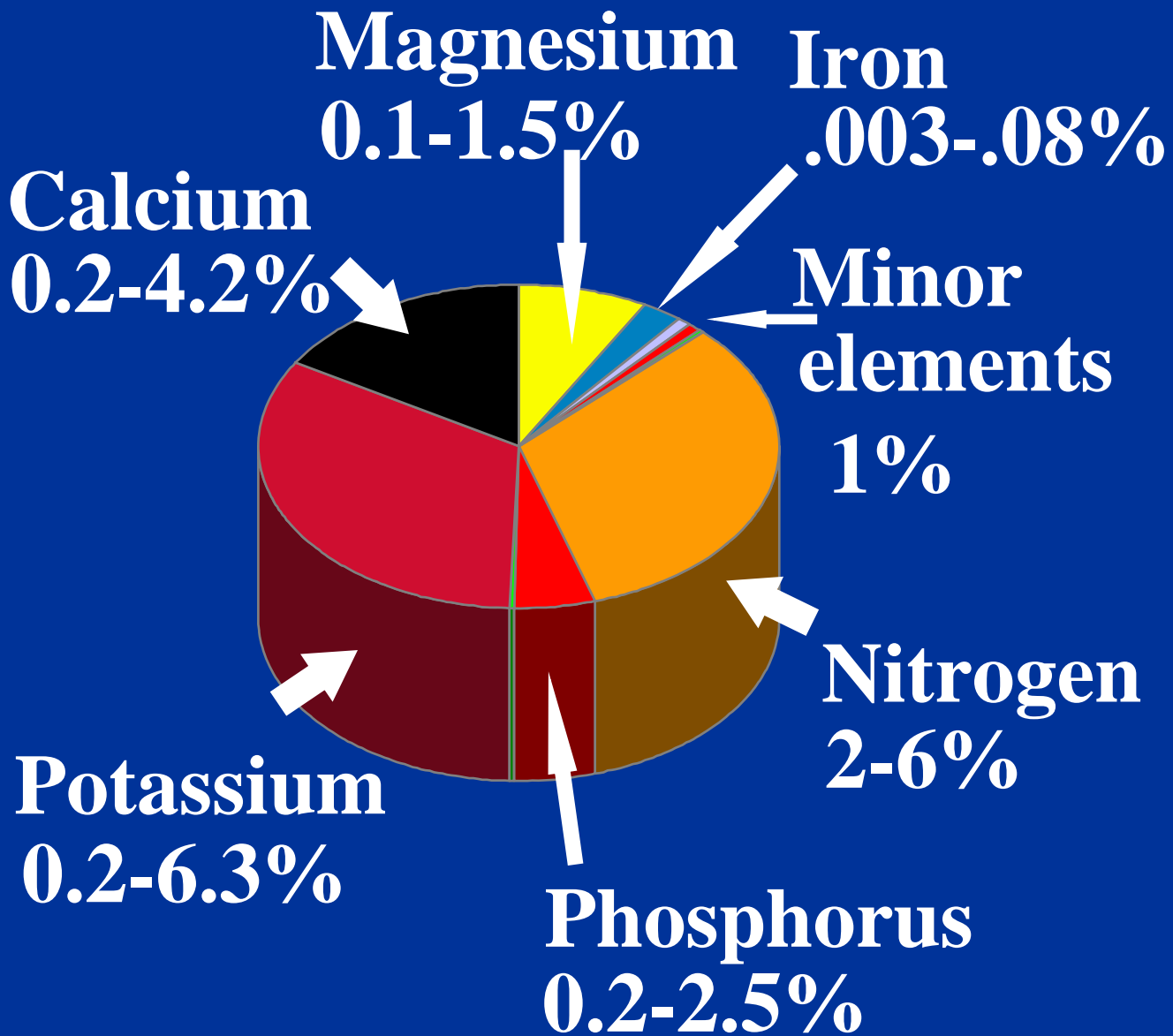
Minerals - 3%
from soil by roots



Water - 70%
from soil by roots

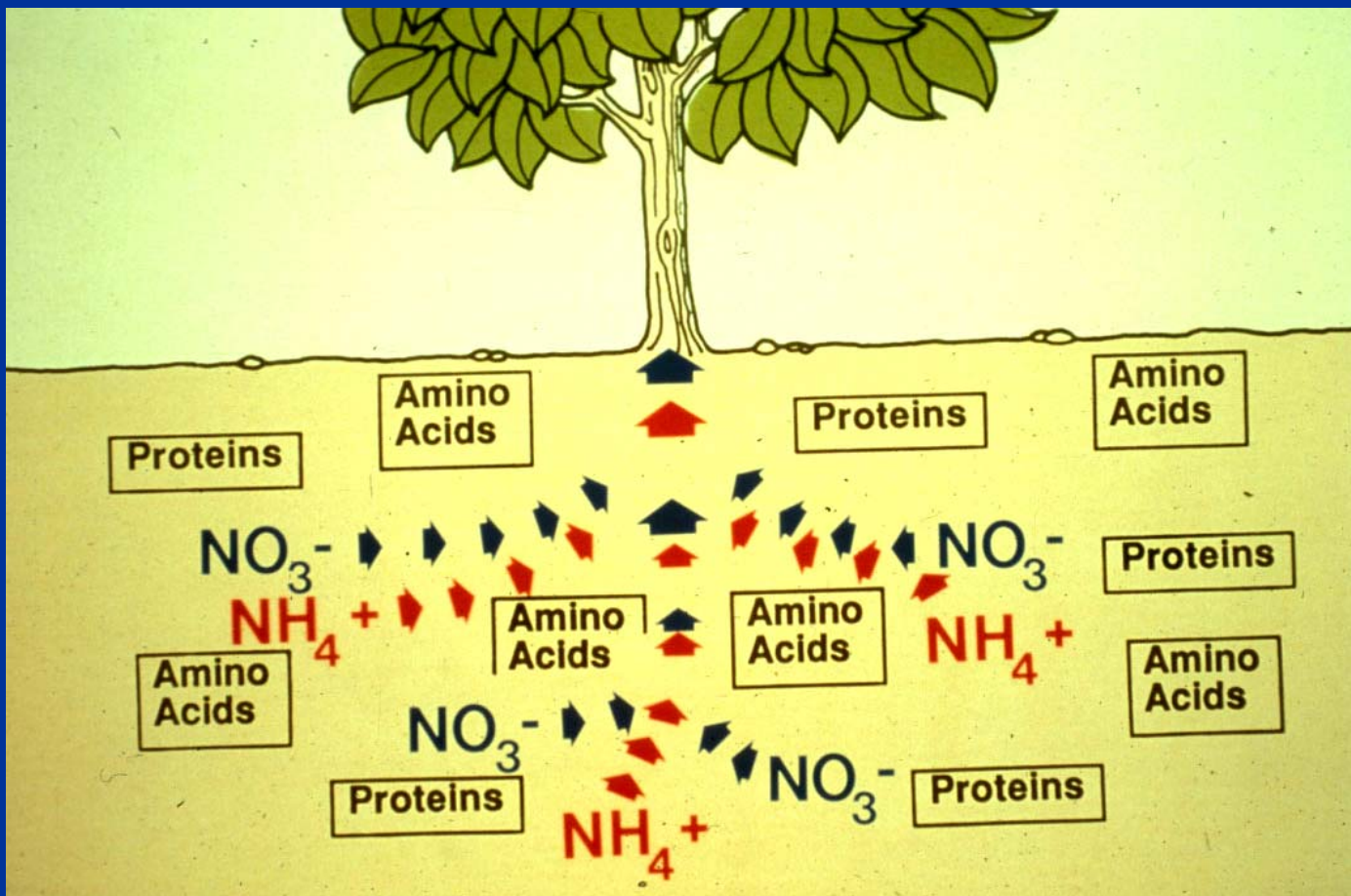


Mineral Composition



NPK = Nitrogen, Phosphorus, Potassium

Nitrogen Sources



Homework

- Select a bag of fertilizer
- What are the mineral nutrients and their relative proportions?
- Do the proportions fit what you would suspect?

Nutrient Mobility In Plant

Mobile

Nitrogen (N)

Phosphorus (P)

Potassium (K)

Magnesium

Immobile

Calcium

Iron

Manganese

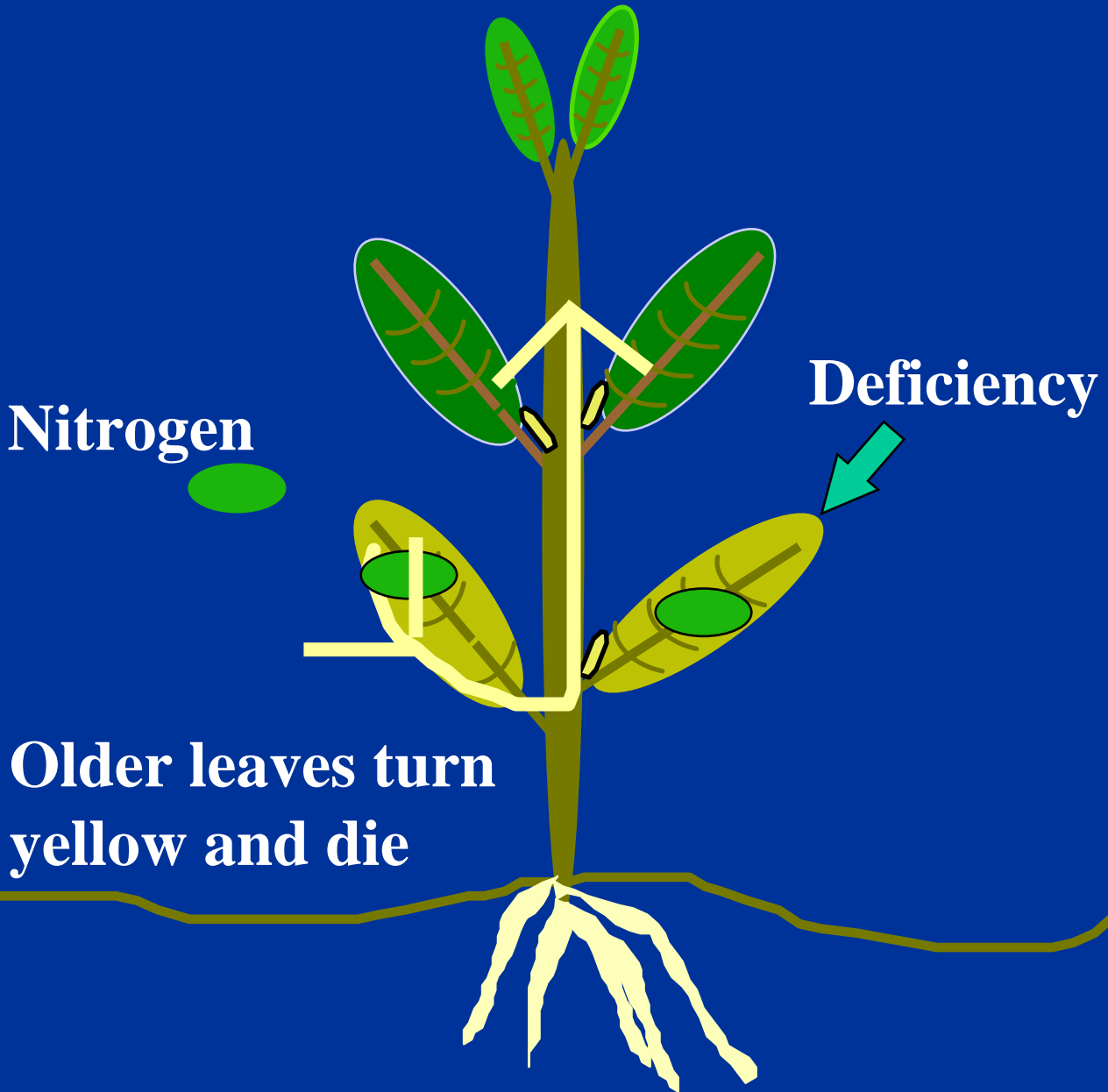
Boron

Copper

Zinc

Molybdenum

Mobile Nutrients



Scenario: Nitrogen depleted from soil

Immobile Nutrients



Scenario: Iron depleted from soil

Iron Deficiency (Imobile)



Boron Deficiency (Imobile nutrient)



Nitrogen Deficiency, Mobile



STEMS



Stem Functions



**Supports leaf canopy
and flowers**



**Produces and stores
sugars**



Shoot regeneration



**Pathway for water and
nutrient transport**



Pathway for food transport

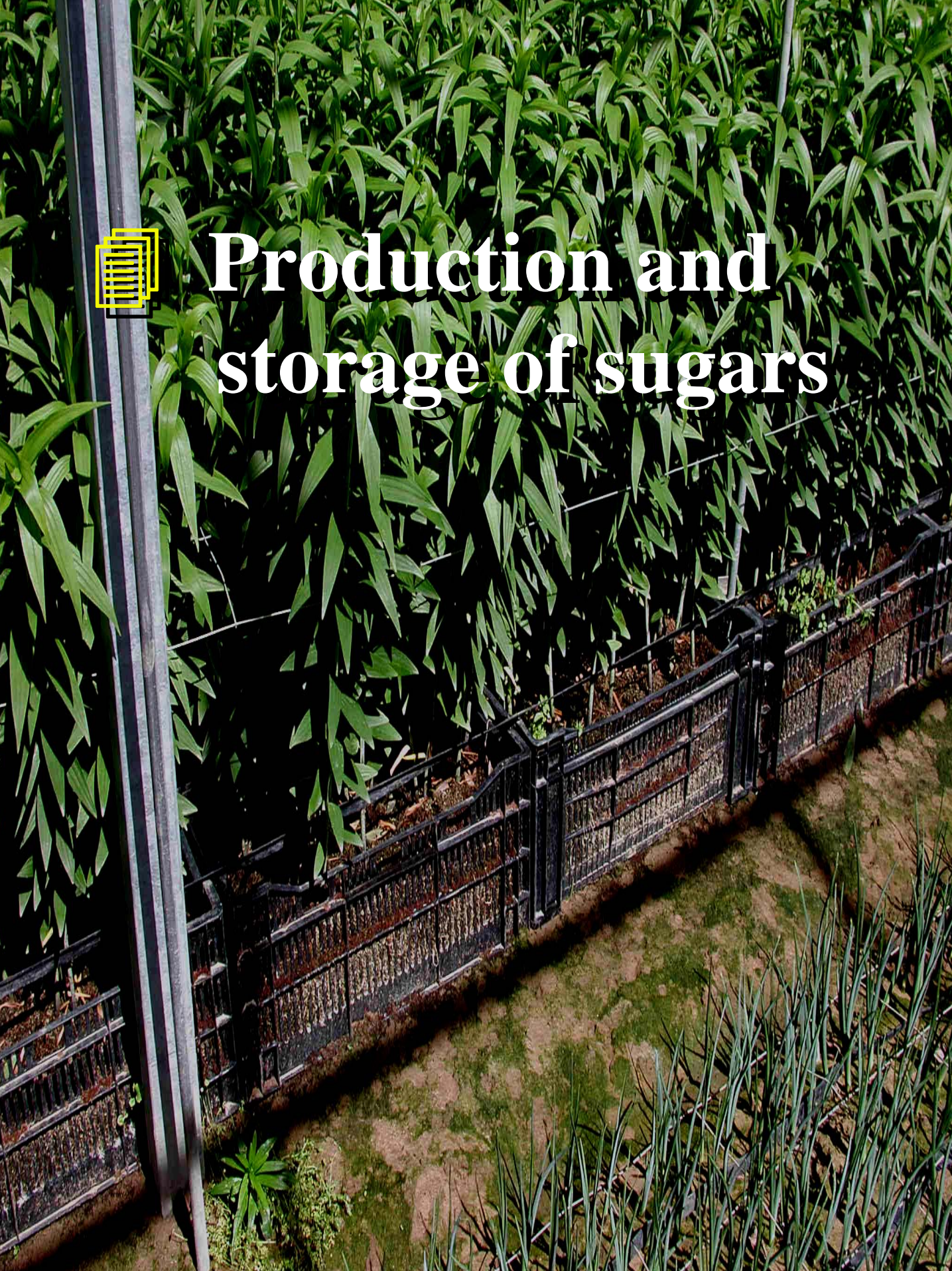


Support



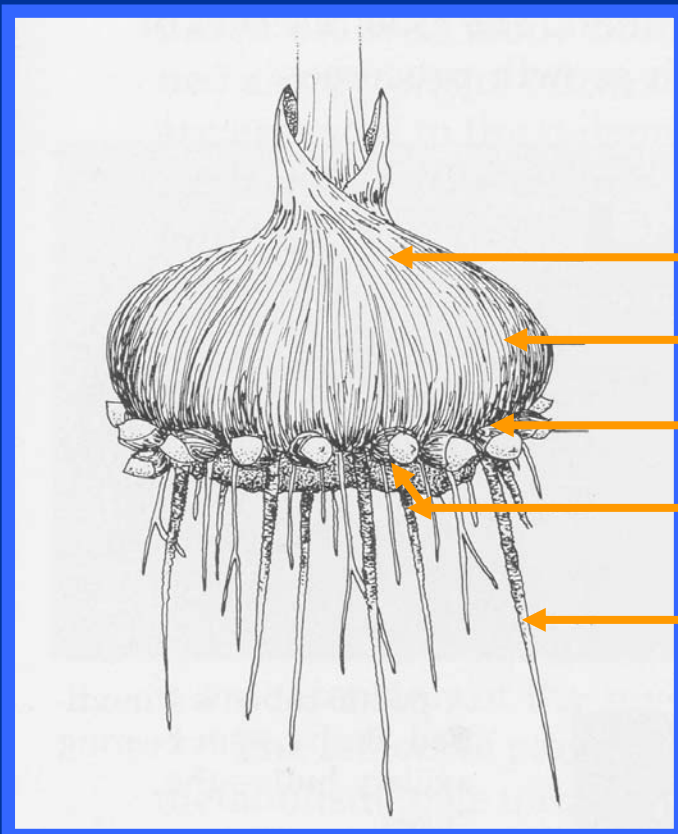


Production and storage of sugars





Production and storage of sugars



Dry leaf bases

Daughter corm

Cormel

Mother corm
(from previous year)

Contractile root

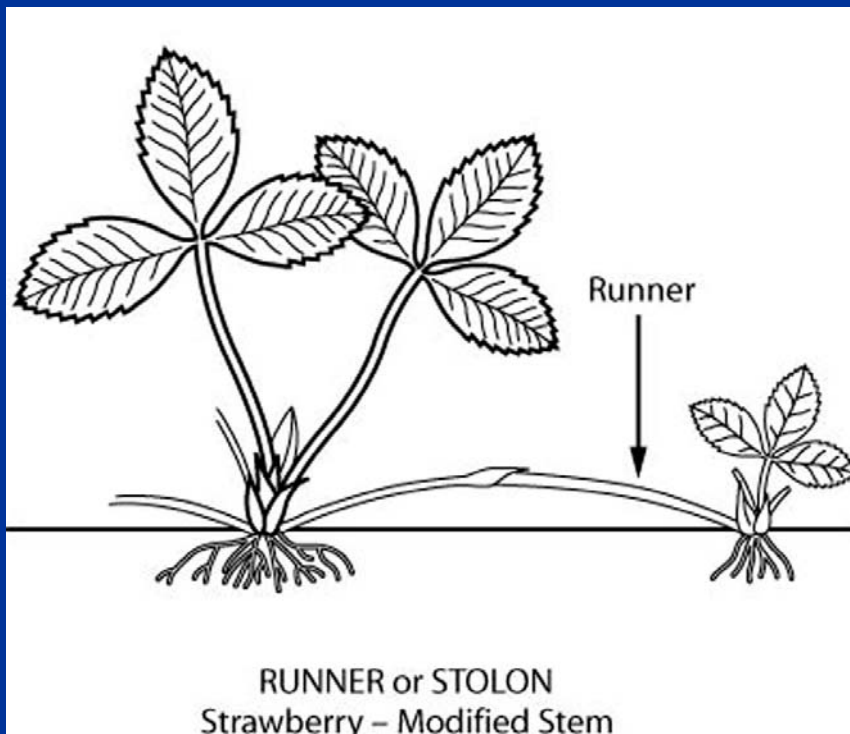
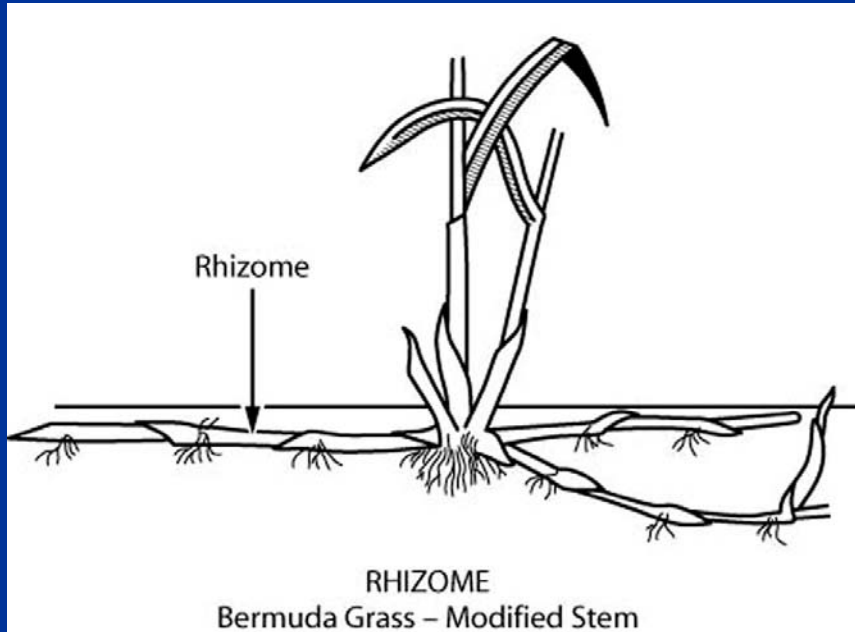


Shoot Regeneration

Rhizomes and Stolons



Modified Stems



Stem Functions

 Supports leaf canopy and flowers

 Produces and stores sugars

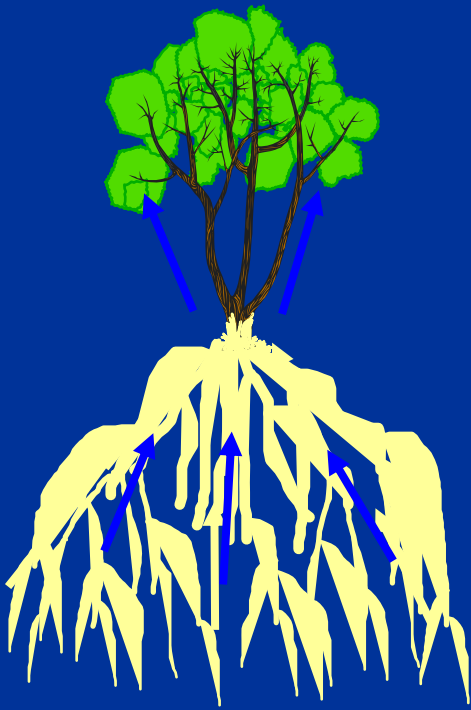
 Shoot regeneration

 Pathway for water and nutrient transport

 Pathway for food transport

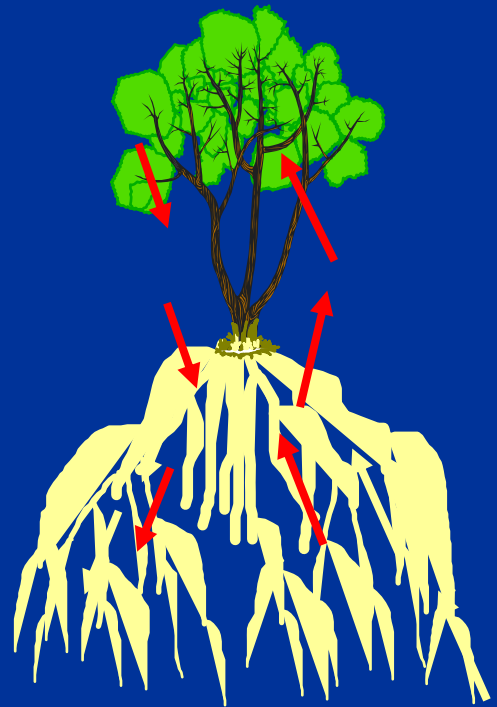
Vascular System

water



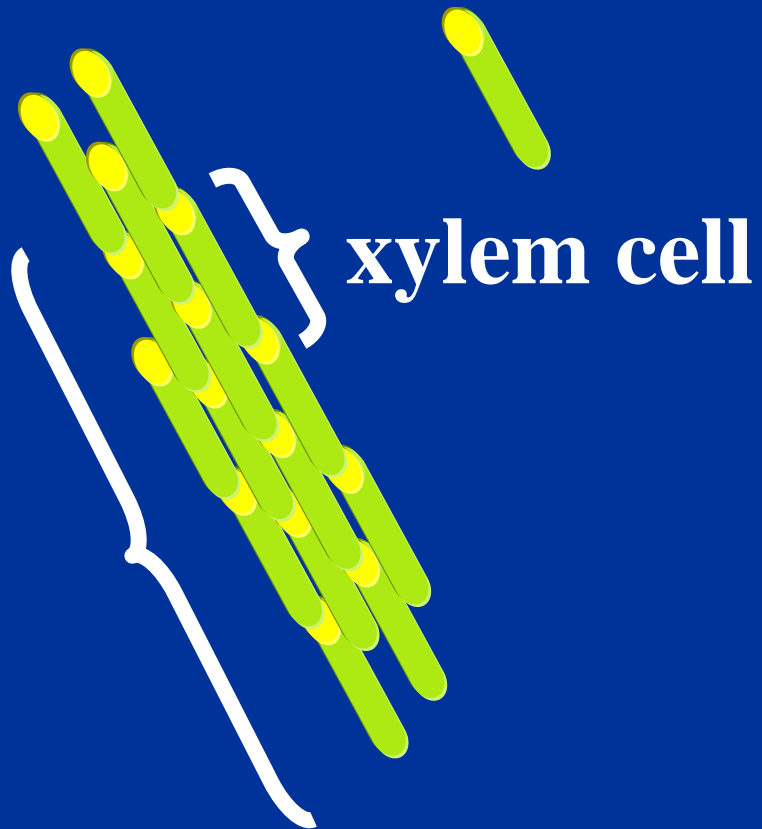
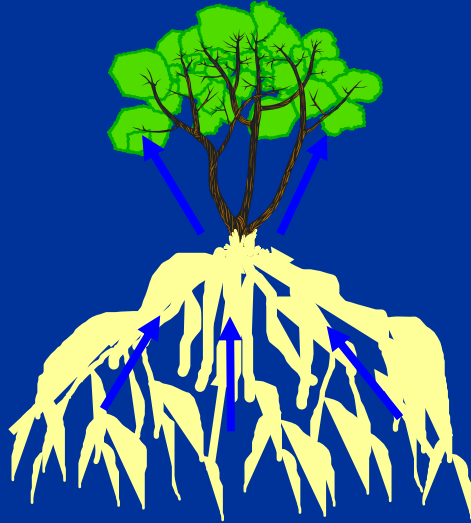
Xylem tissue

sugars
(food)



Phloem tissue

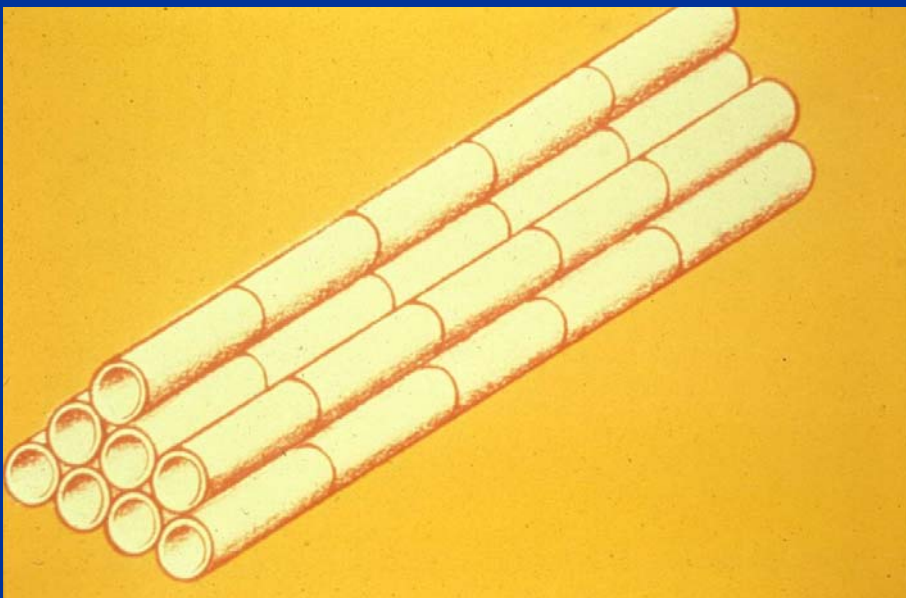
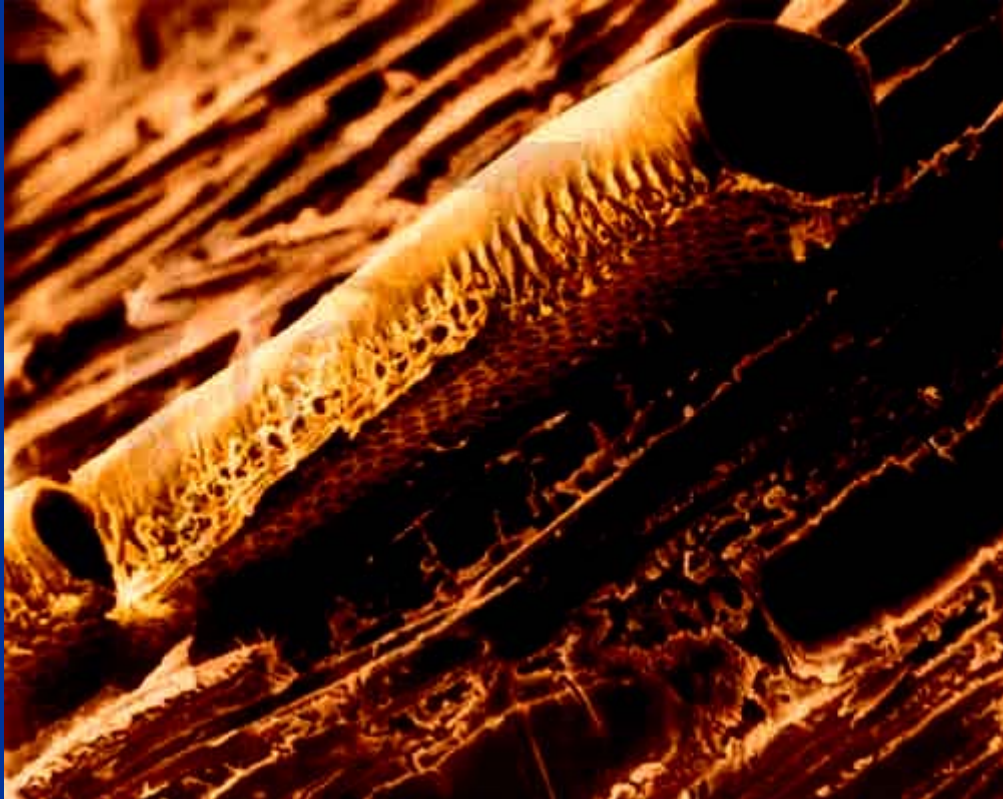
Xylem

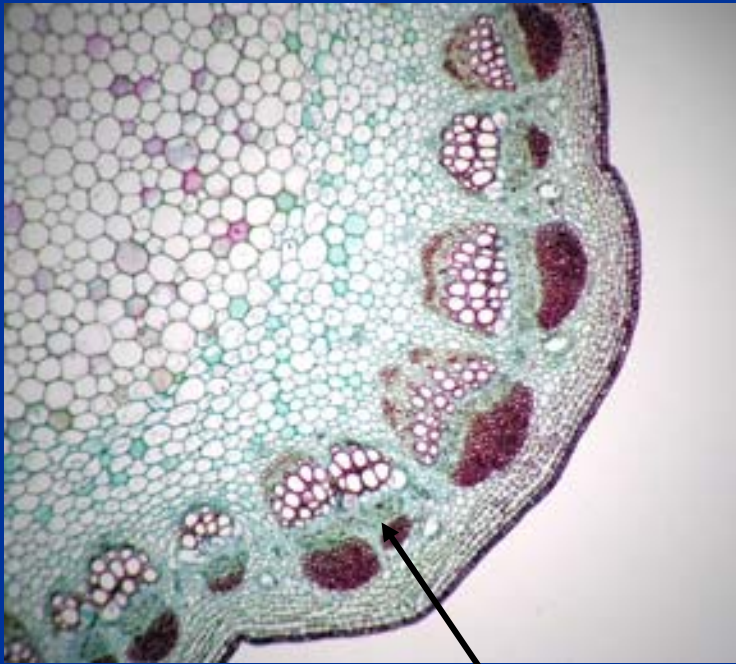


4 xylem
vessels

xylem cell

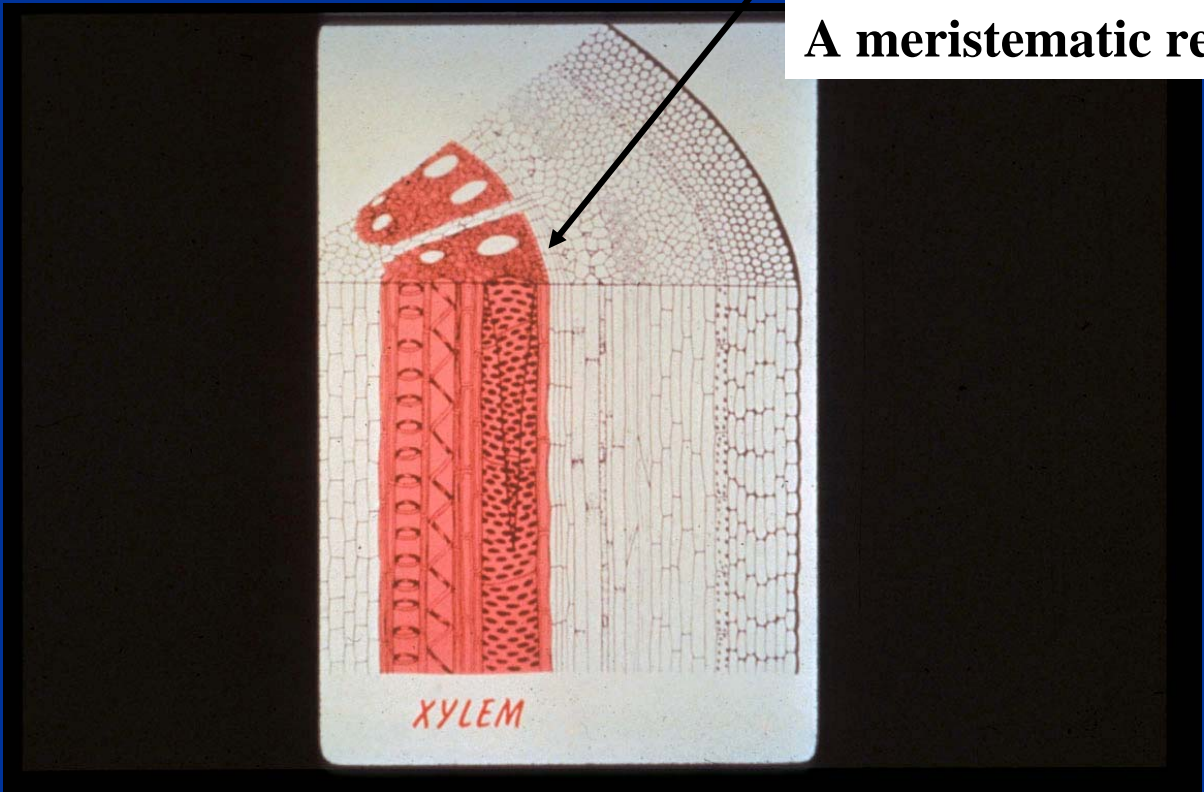
Xylem



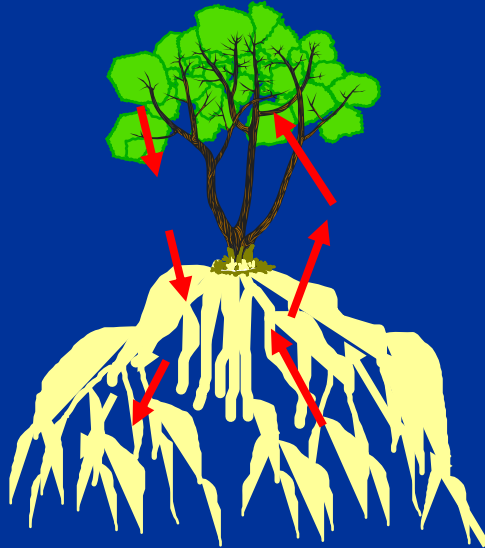


Xylem

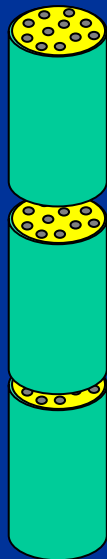
Vascular Cambium
A meristematic region



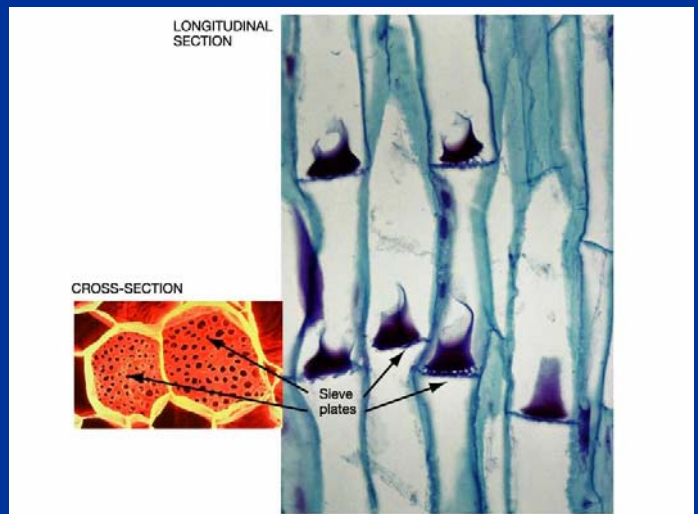
Phloem



Sieve
plate →

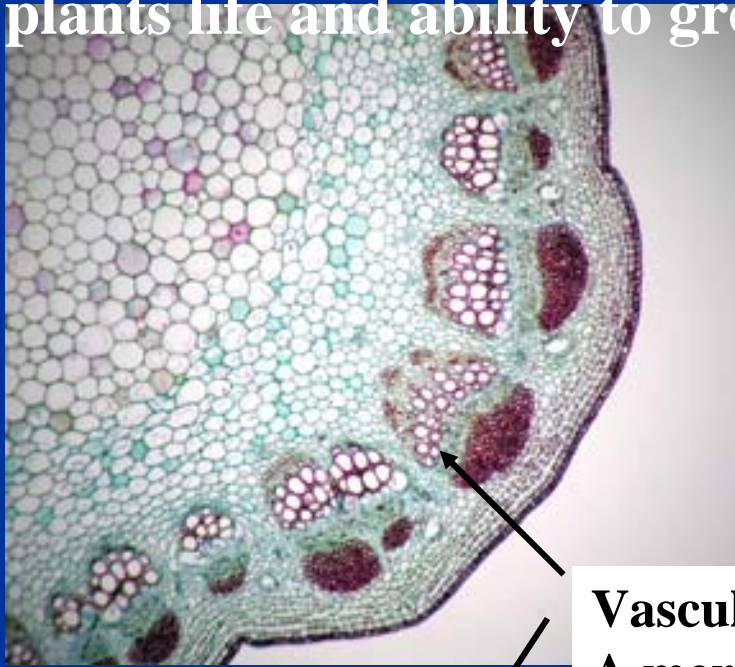


phloem
cell

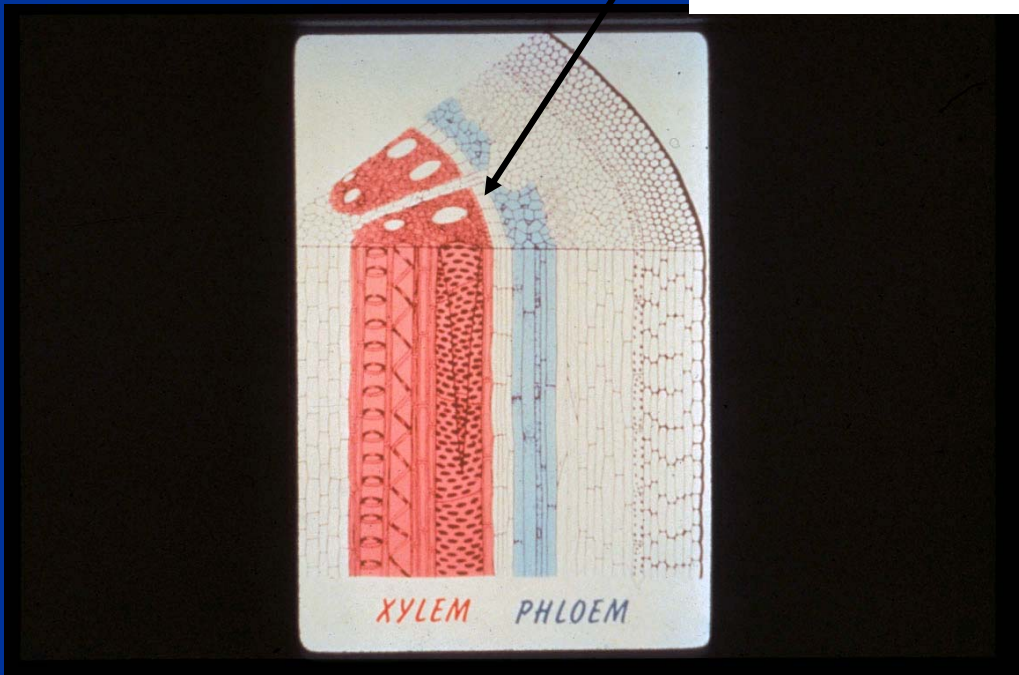


Vascular System

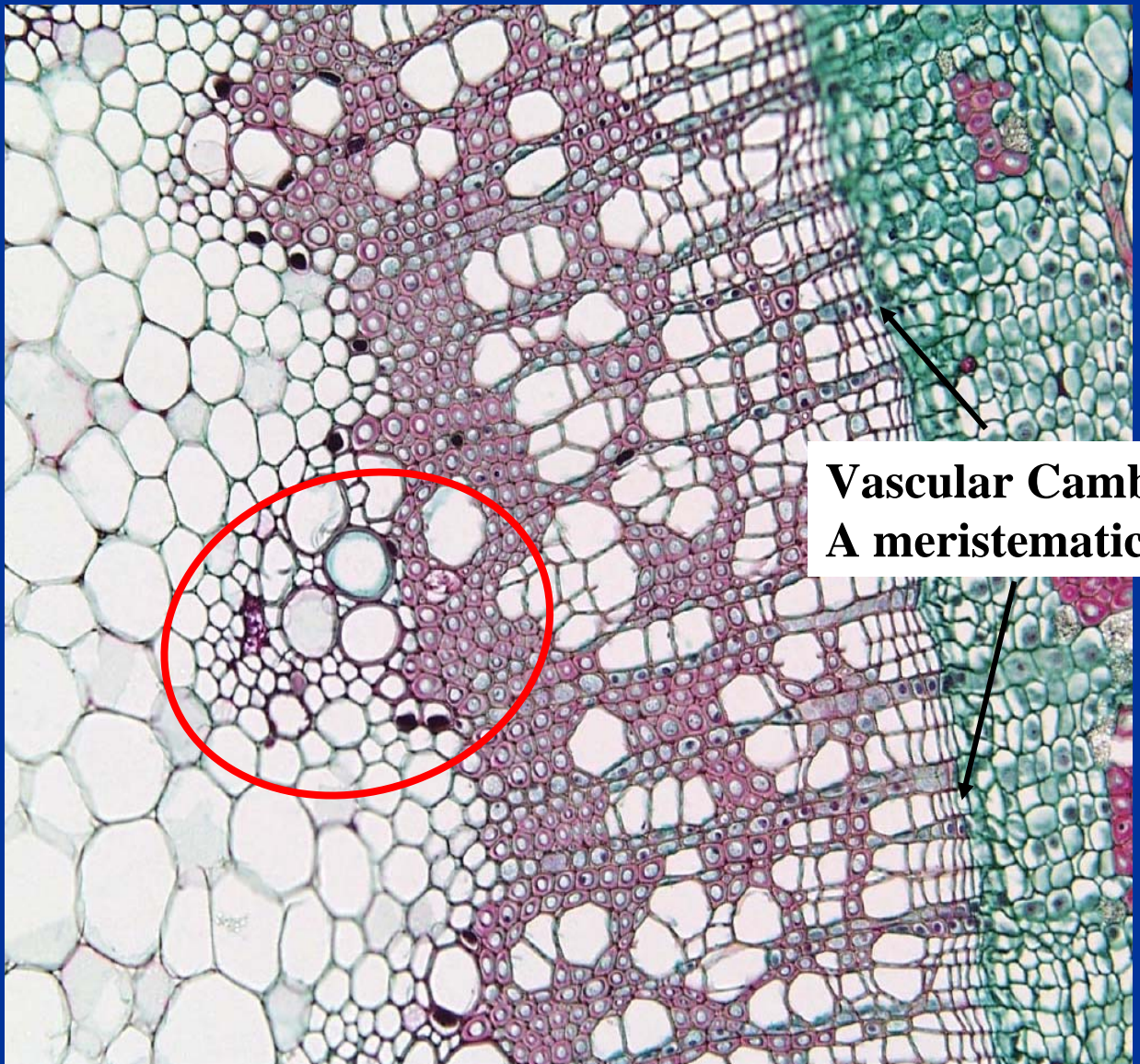
- **Primary growth** is in bundles. Growth in girth is limited.
- **Herbaceous annual plants:** primary growth limits the plants life and ability to grow in girth



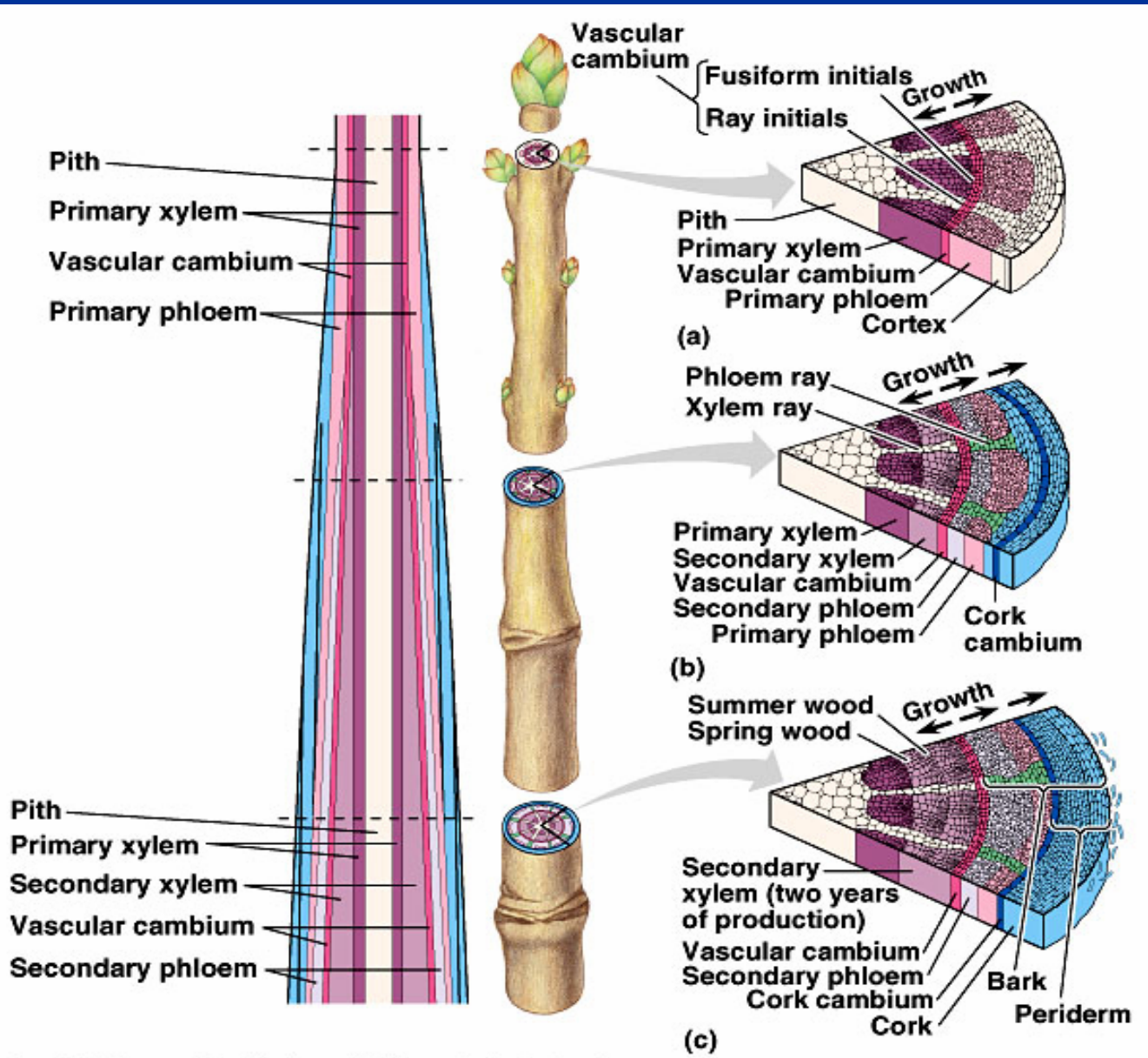
Vascular Cambium
A meristematic region



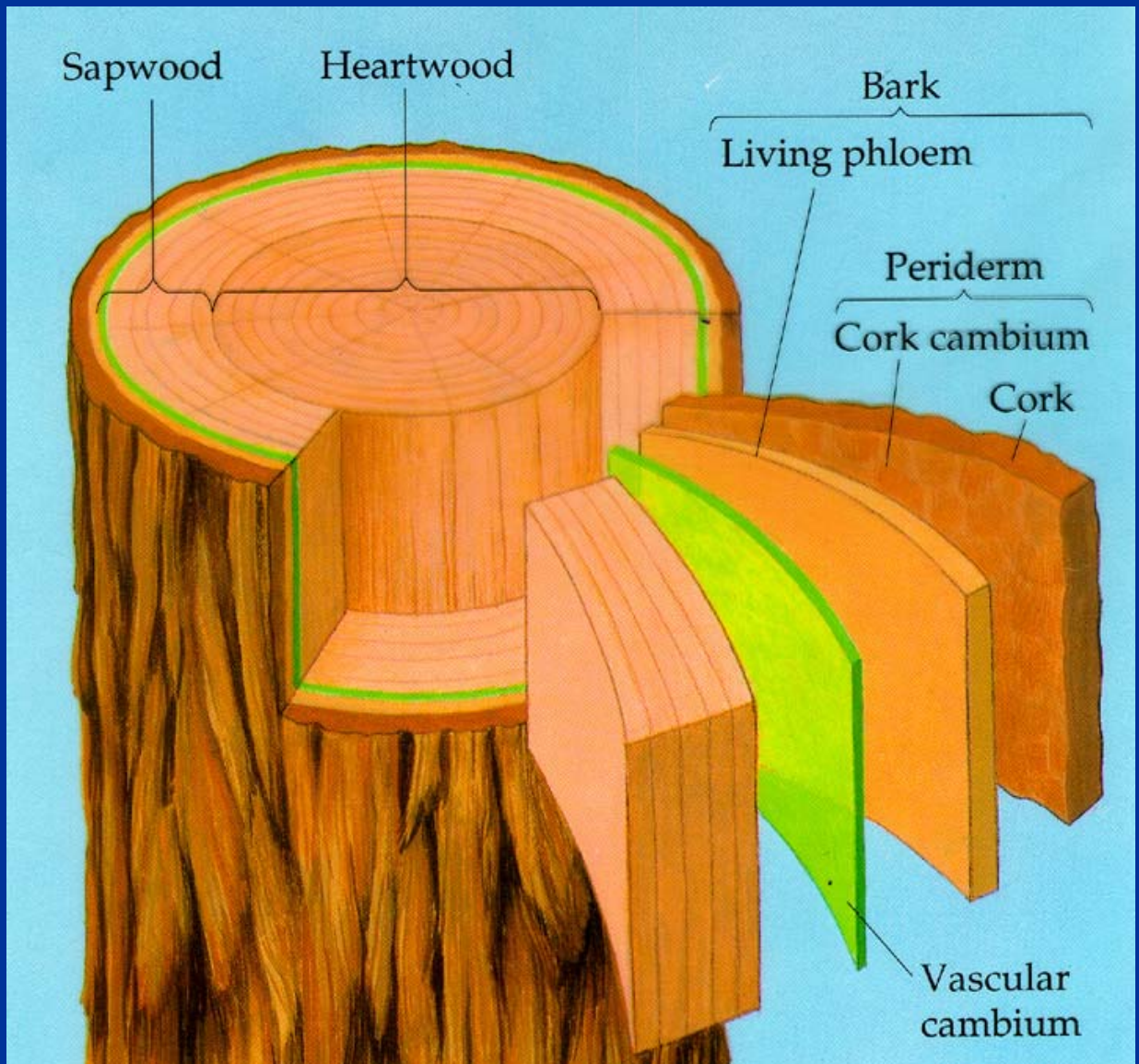
Primary and secondary growth



Secondary growth allows for growth in girth and a continuous connection of living cells from top to bottom



Tree Anatomy

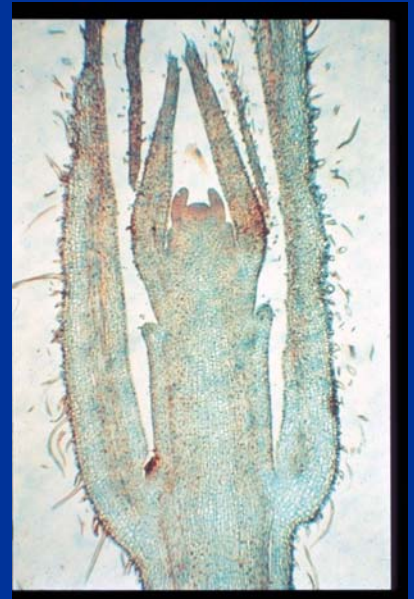




Remember

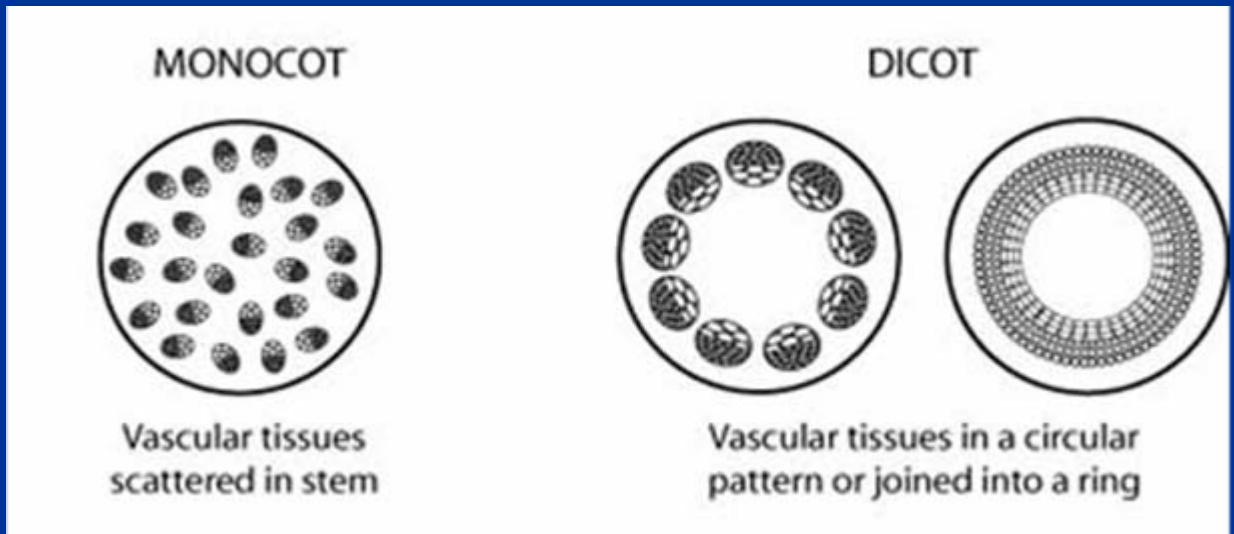
The Meristems

- Shoots
 - Apical
 - Vascular Cambium
 - Cork Cambium
- Roots
 - Apical
 - Vascular Cambium
 - Cork Cambium



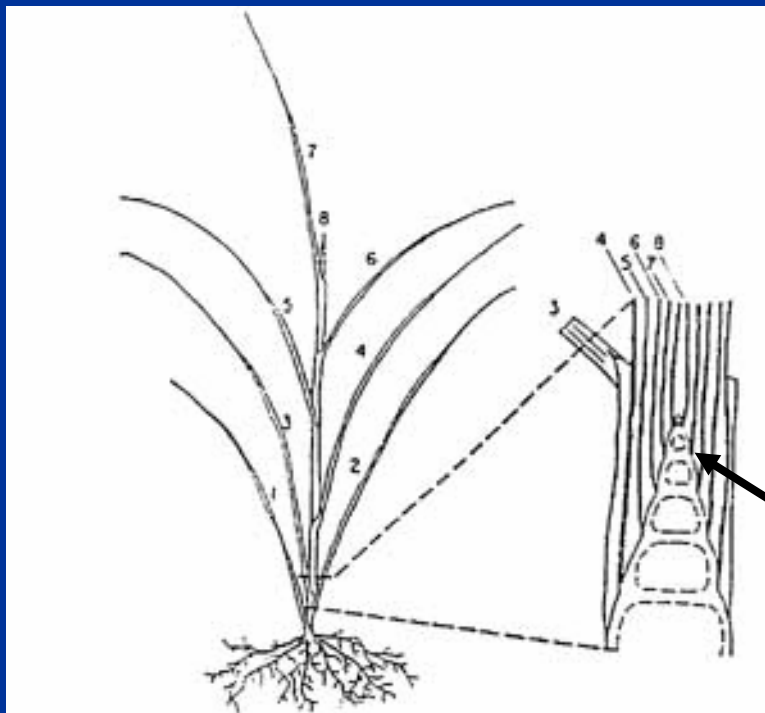
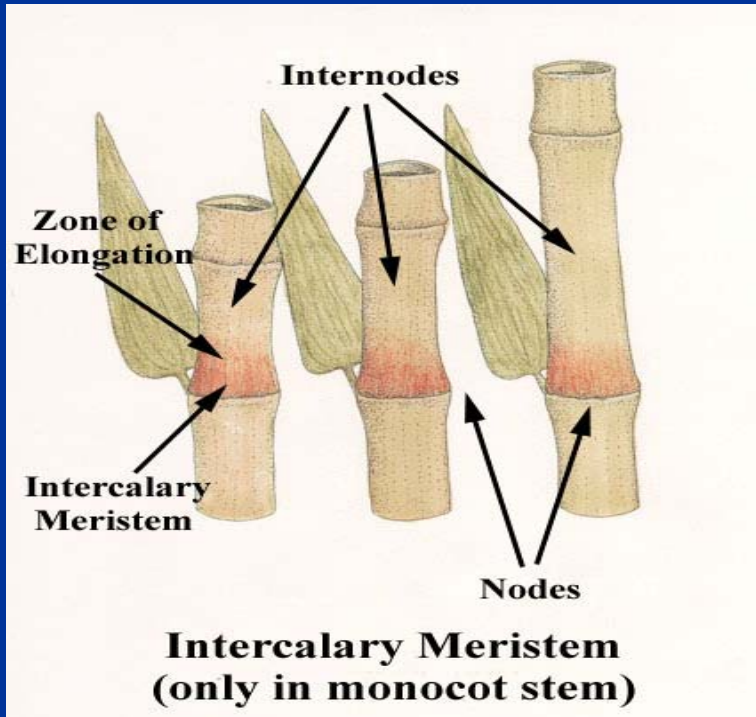
Flowering Plants

Monocots versus Dicots

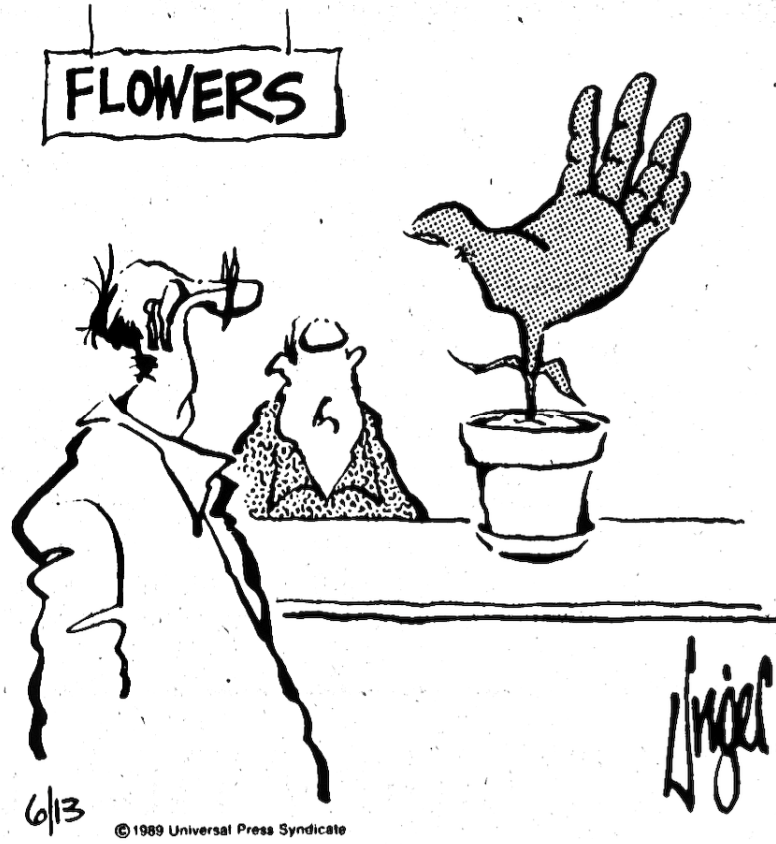


- **Monocots** are
 - grasses (grains), sedges, bamboos, ginger, onion family, and some woody plants such as palms and banana
 - Lilies, daffodils, irises, amaryllis, orchids, cannas, and tulips
- **Dicots** are just about everything else

Grass meristems



HERMAN By Unger



6/13

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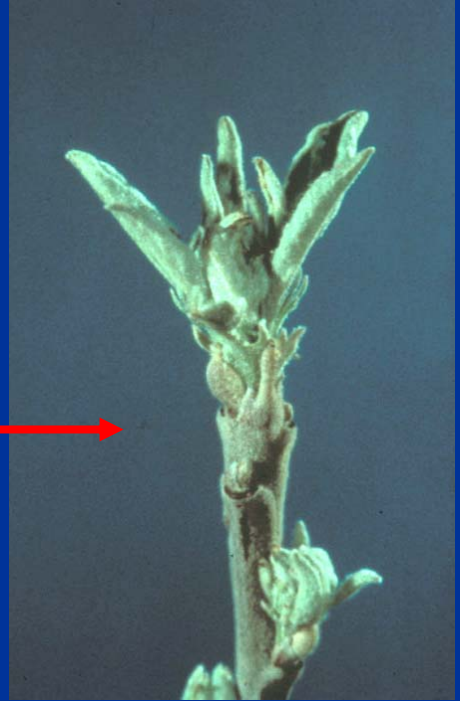
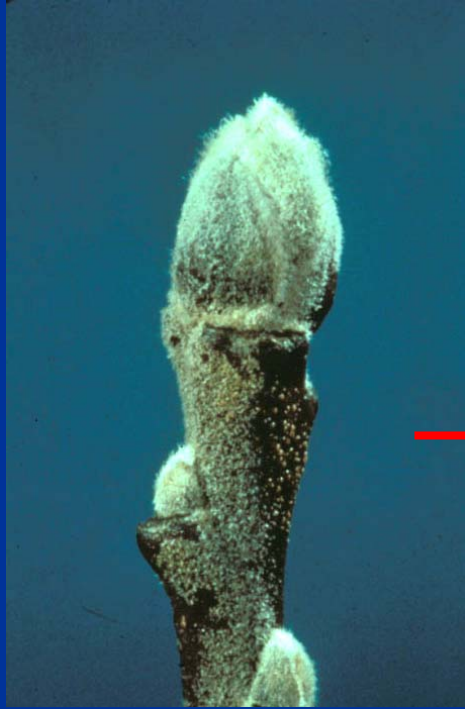
"It's a type of palm."

Vascular Cambium

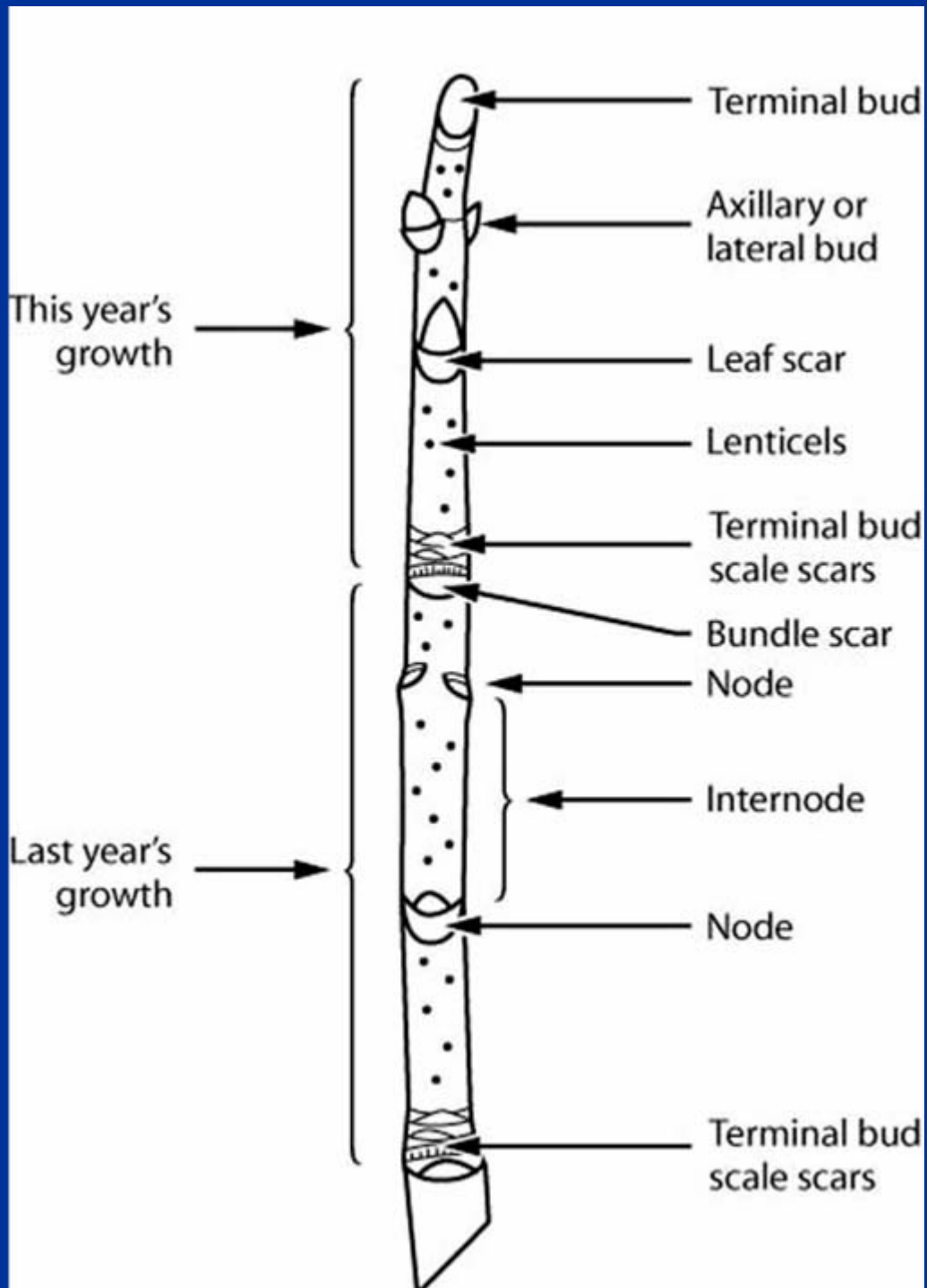


Apical Meristems

Flower and Vegetative Buds



Woody Stem Structure



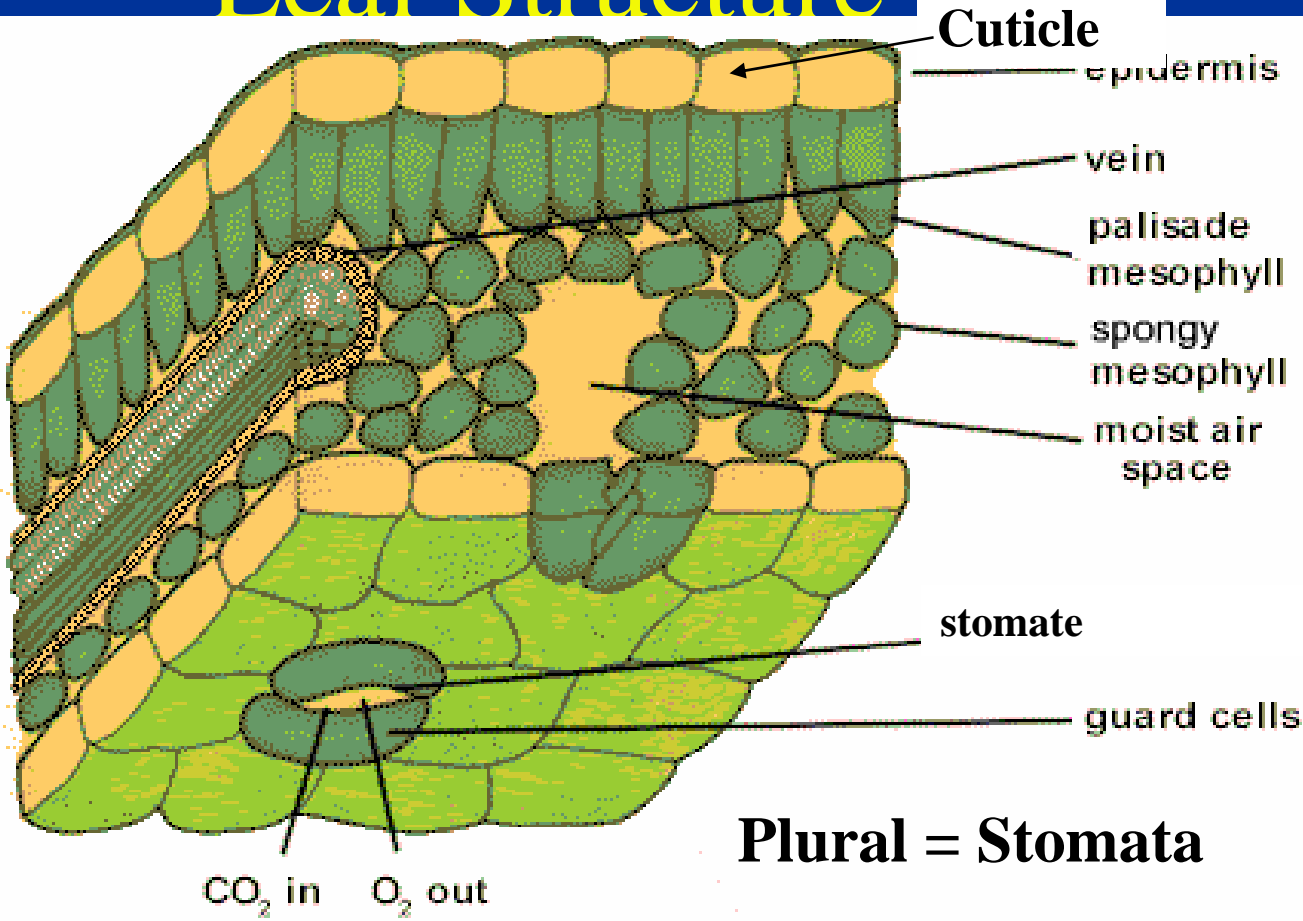
Homework

- Take a walk around your home landscape or garden and look at herbaceous and woody plants.
- Consider the plant's structure: What makes the plants and their parts so different ?
- Consider differences in the type of meristems and their location.

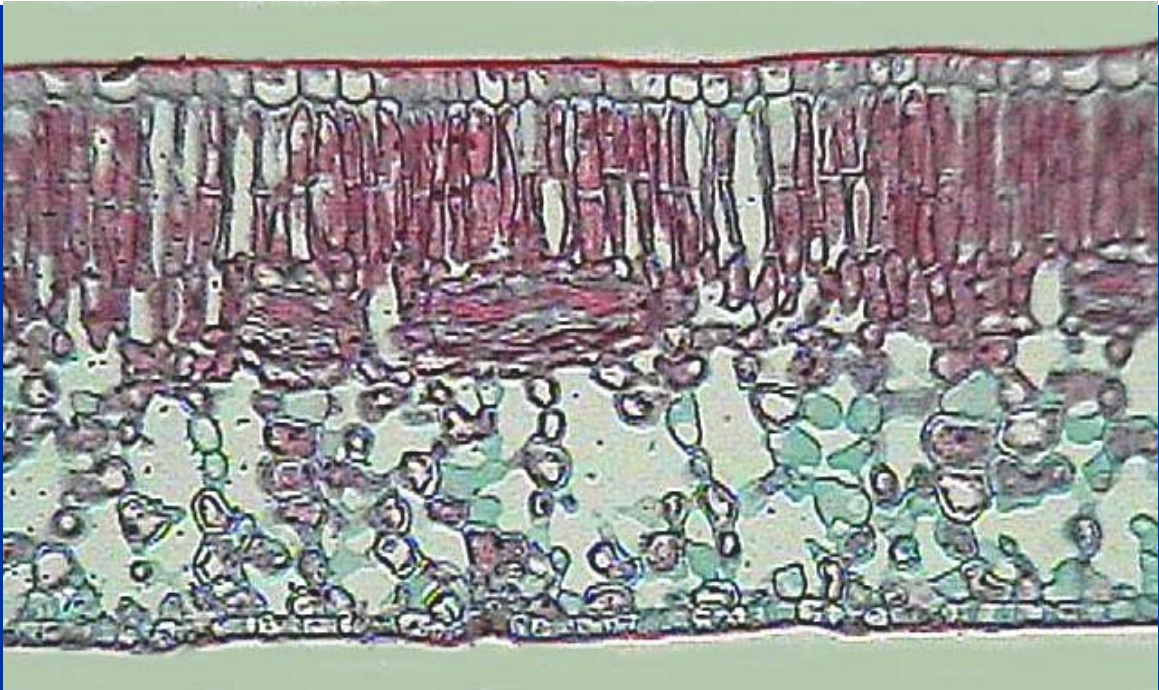


LEAVES

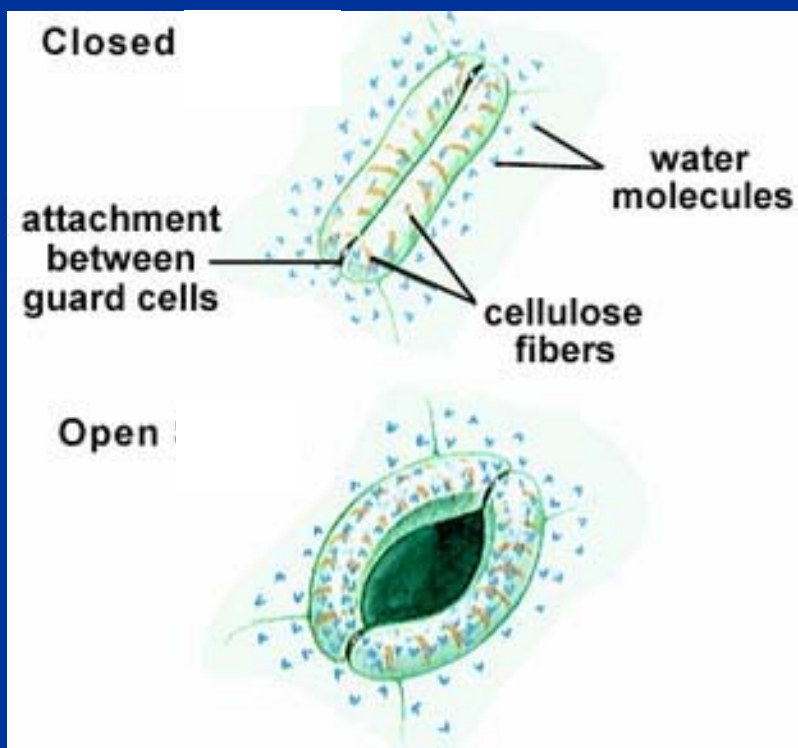
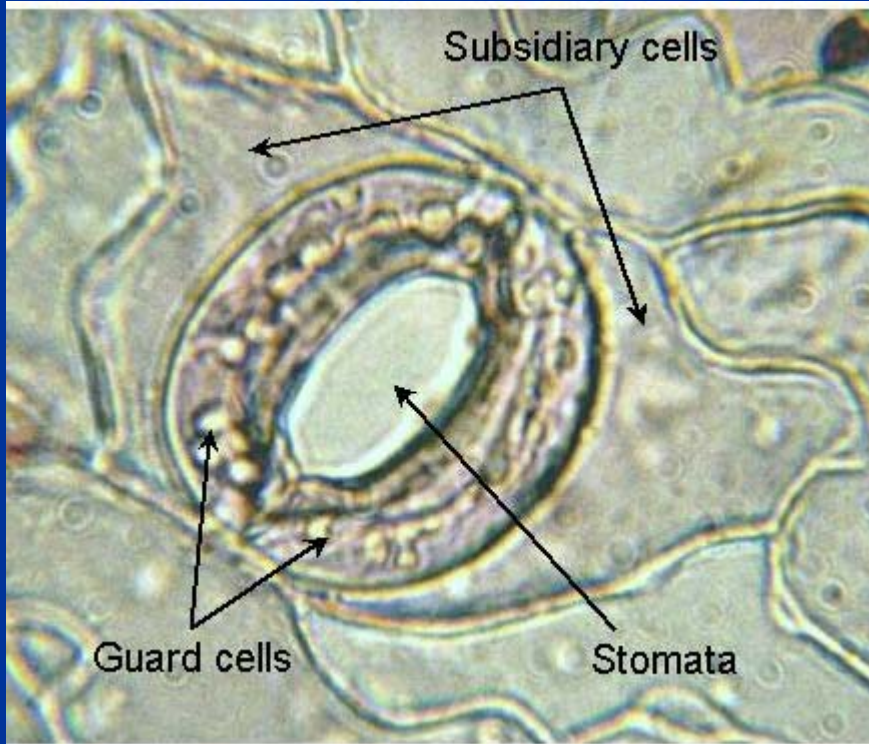
Leaf Structure



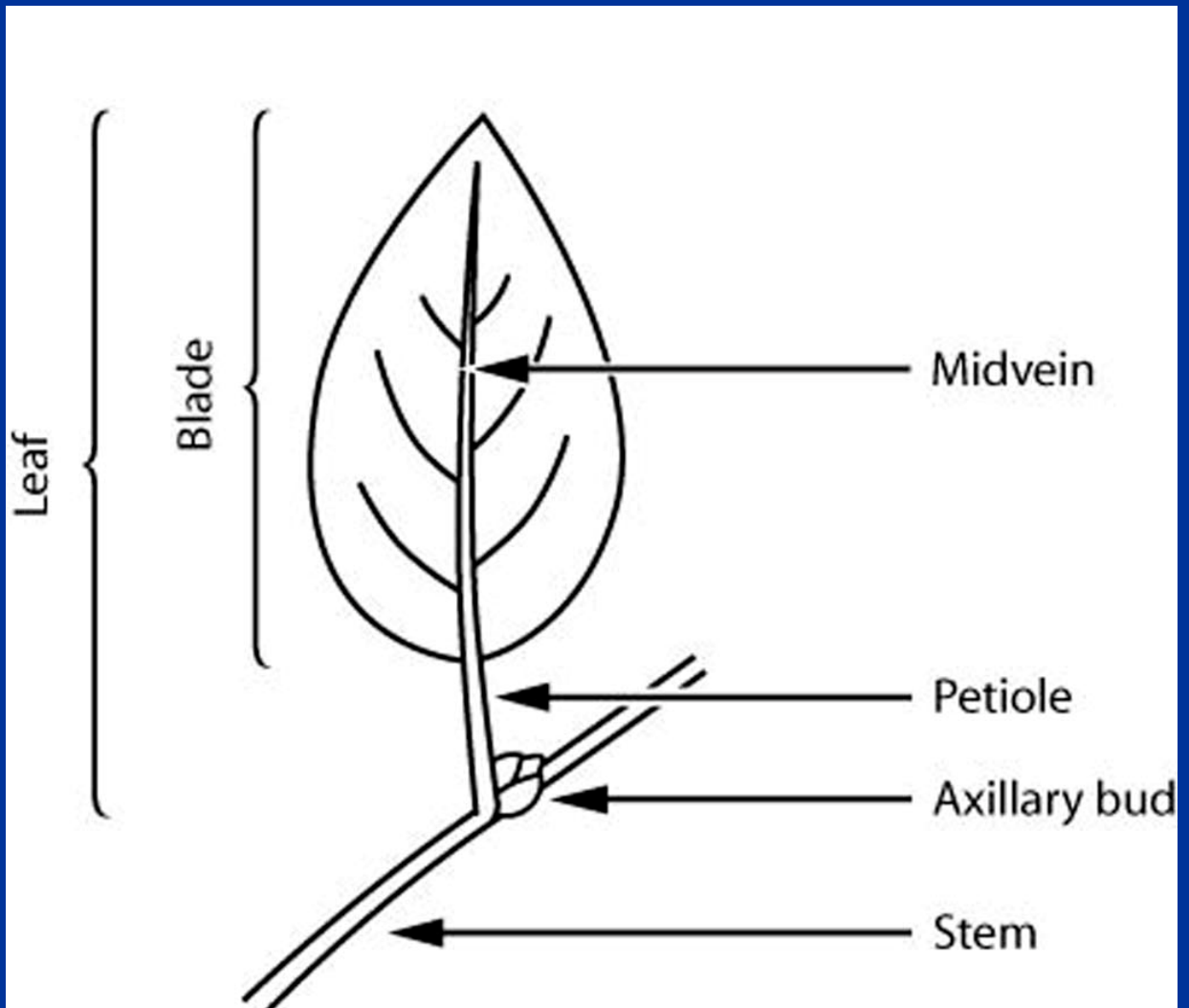
Plural = Stomata



Stomata

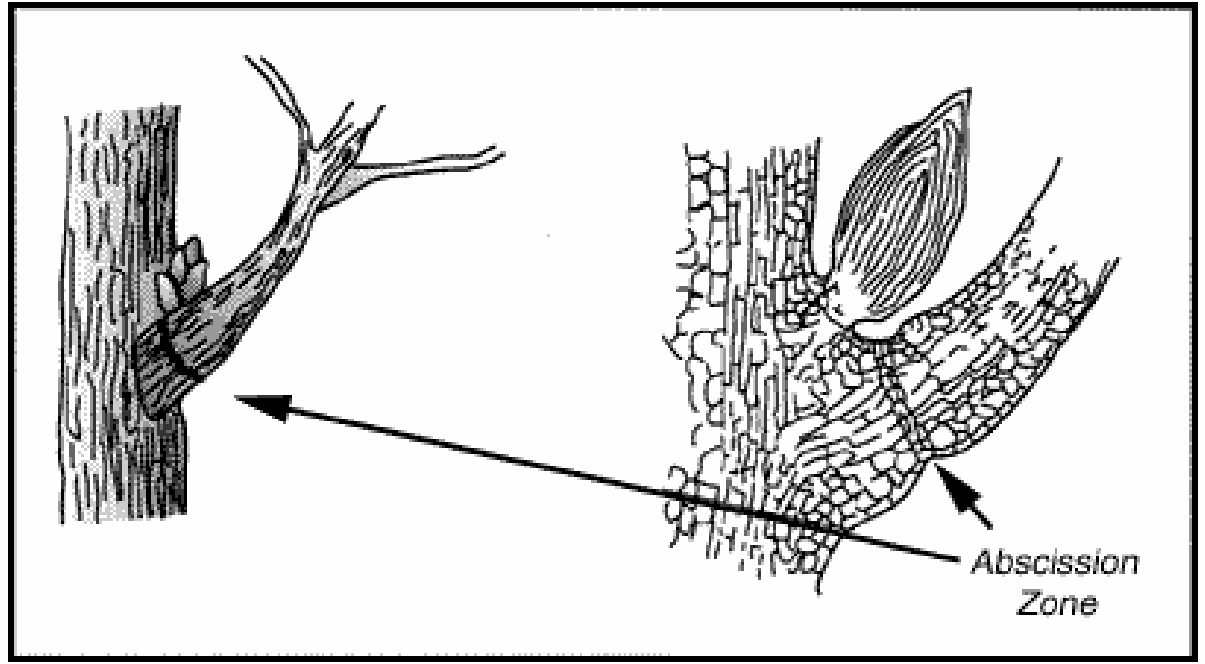


A Simple Leaf

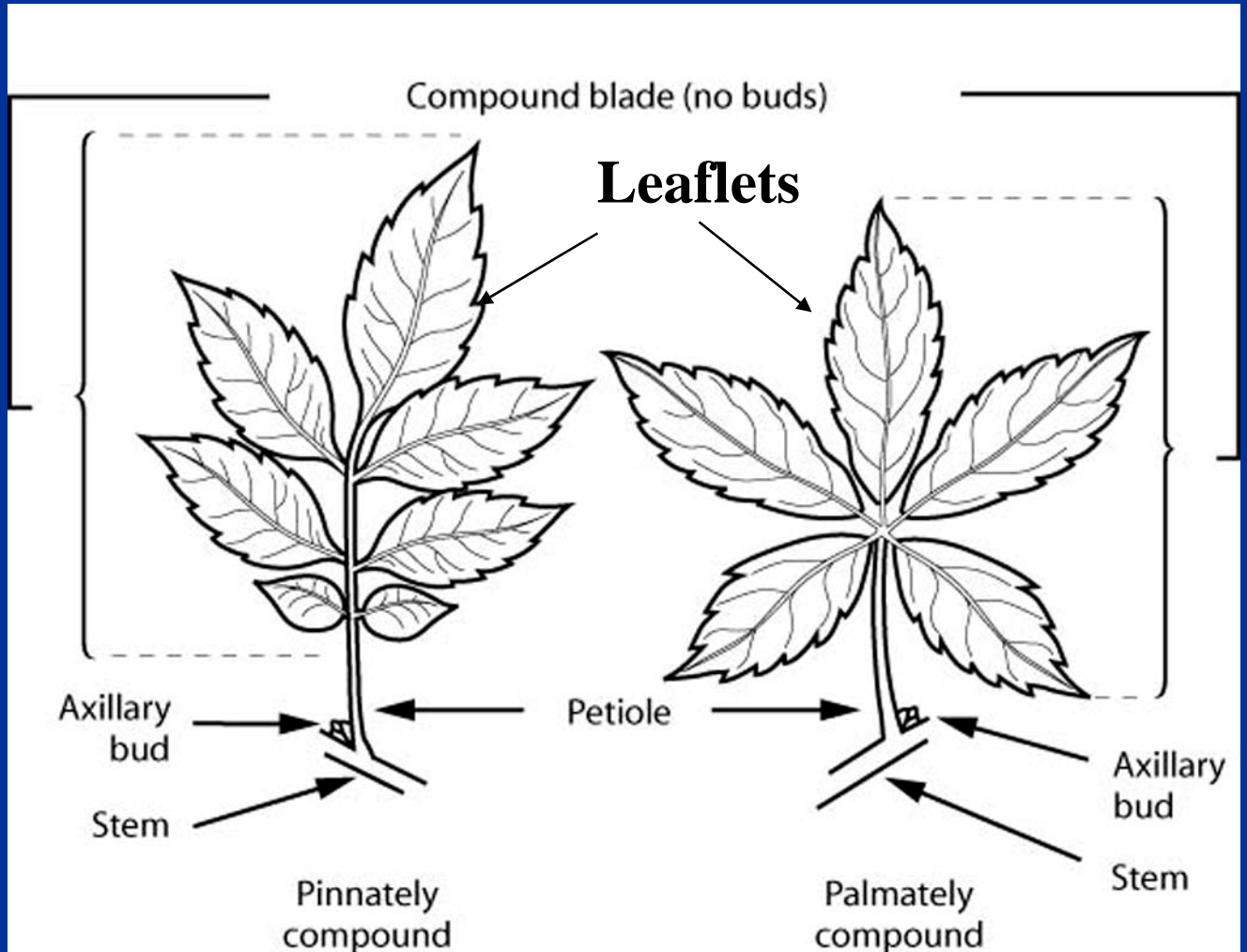


Leaf Abscission

Leaf with Abscission Layer



Compound Leaves



Homework

- Again, at your home landscape or garden
- Find simple leaves with the 3 venation types: pinnate, parallel, and palmate.
- Find a compound leaf. Is it pinnate or palmate?
- Look for all 3 leaf arrangement types: opposite, alternate, whorled.

Leaf Functions



Storage – of sugars



Photosynthesis - food production



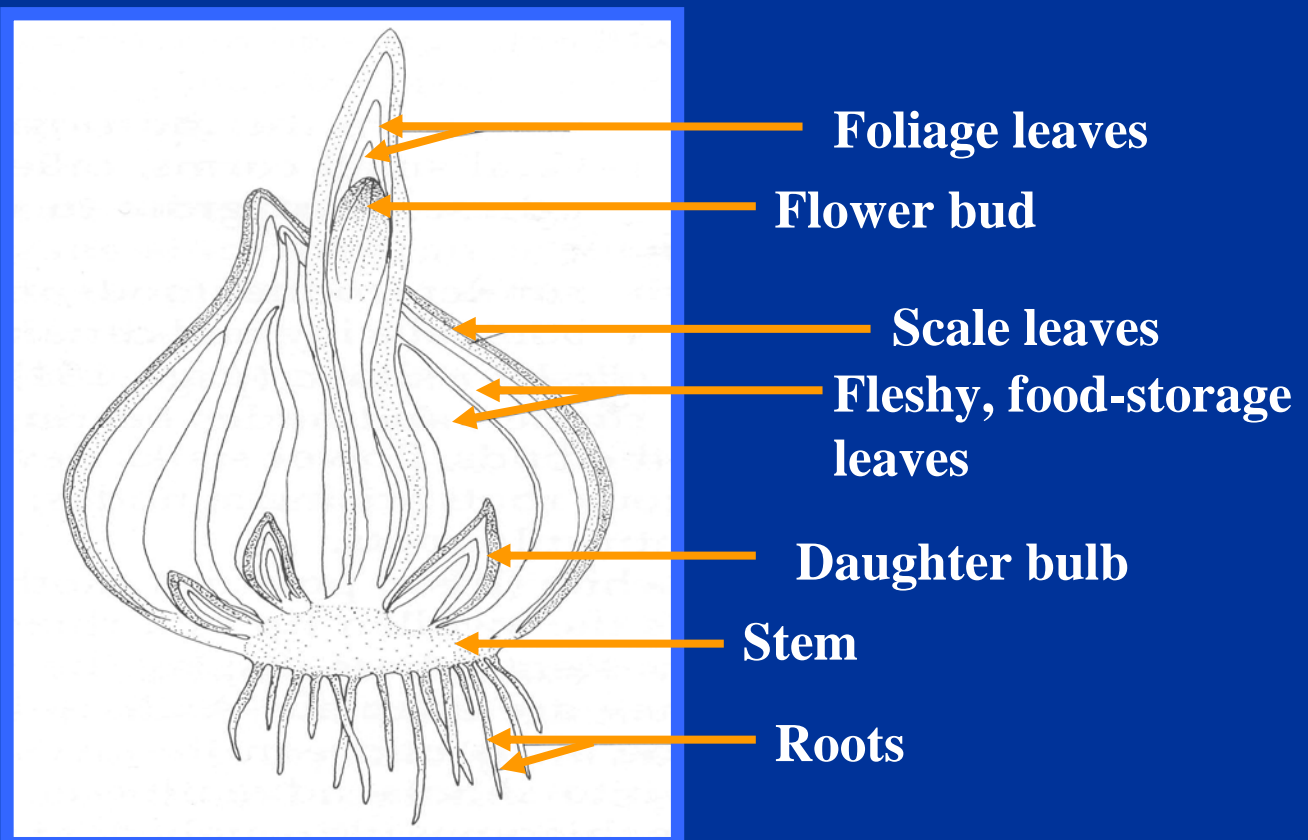
**Transpiration -
water evaporation
from the leaf surface**



Storage of sugars



Bulbs



A close-up photograph of a green leaf, showing a dense network of veins. The veins are a lighter green color, contrasting with the darker green of the leaf's surface. The central vein is particularly prominent, running vertically through the center. The overall texture is intricate and organic.

Photosynthesis

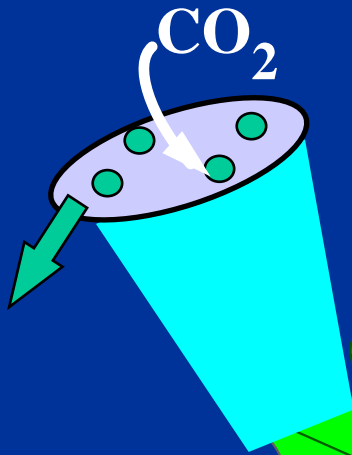
Photosynthesis



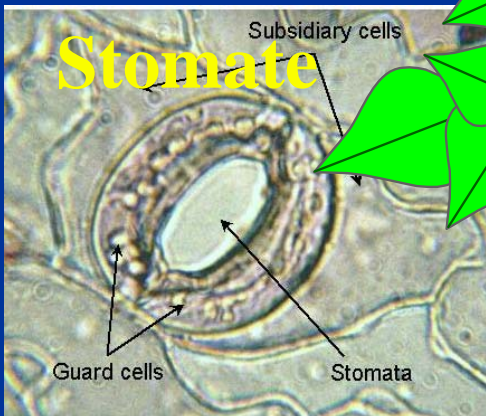
Energy - from sunlight



carbon dioxide -
from air



H₂O
water -
from roots



Transpiration

Water vapor



Stomate

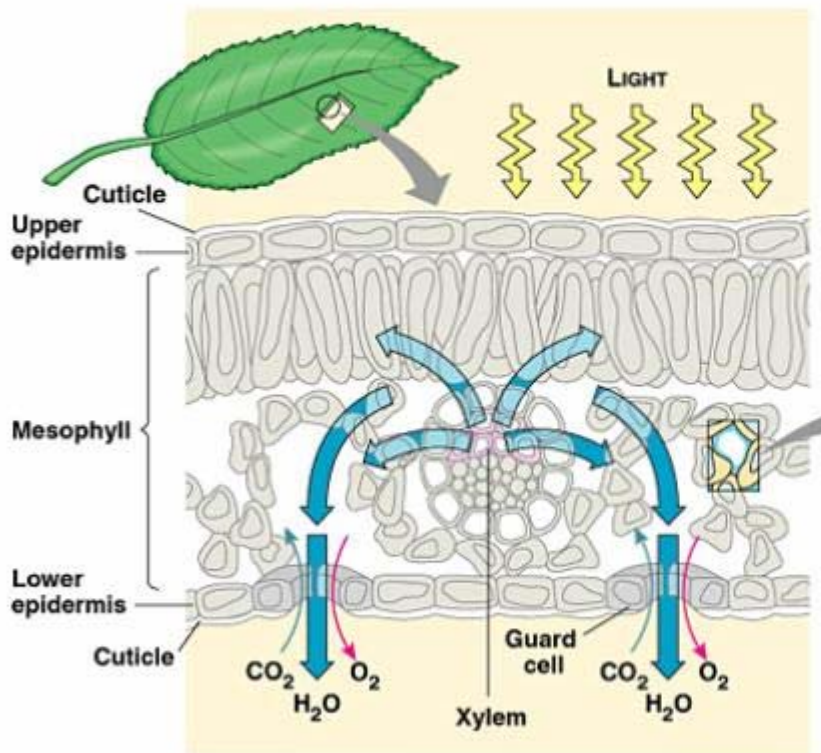


water -
from roots



Transpiration

Transpiration – Evaporation of Water from Leaf Surfaces



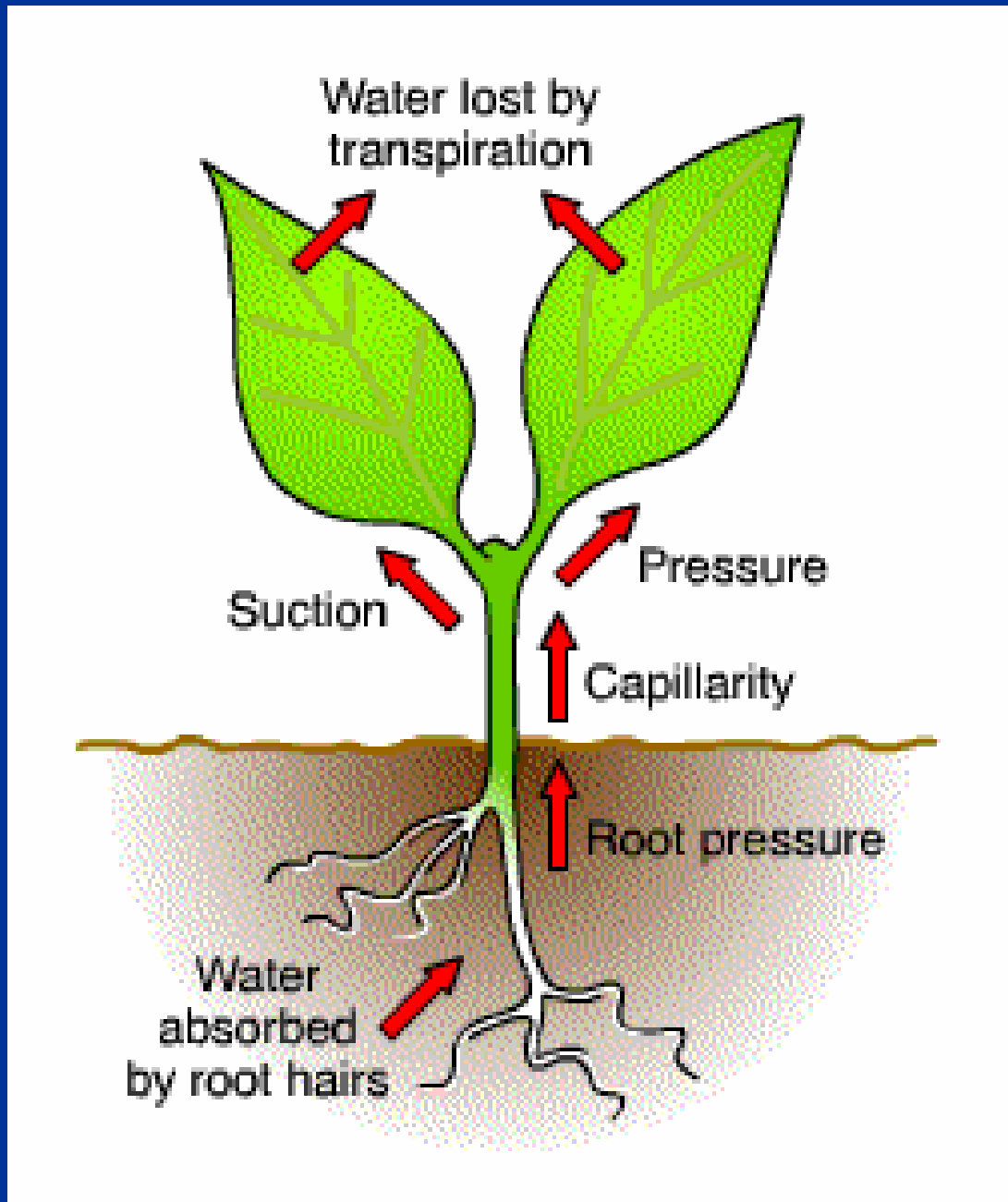
Water from xylem enters air spaces of the leaf and also diffuses into mesophyll cells.

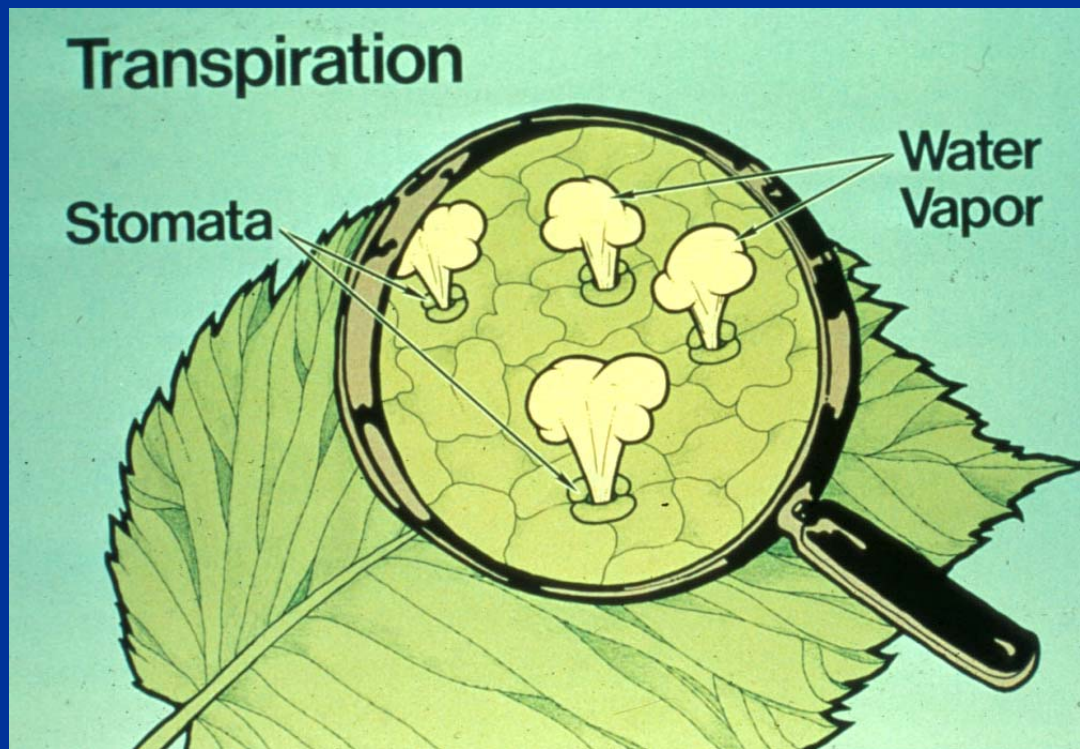
Water exits the leaf by **diffusion** mainly through **stomata**, which open and close in response to environmental and internal signals.

A small amount of water (<5%) can also diffuse through the epidermis.

Transpiration cools the leaf due to evaporative cooling.

Transpirational “Pull” with a little “Push”





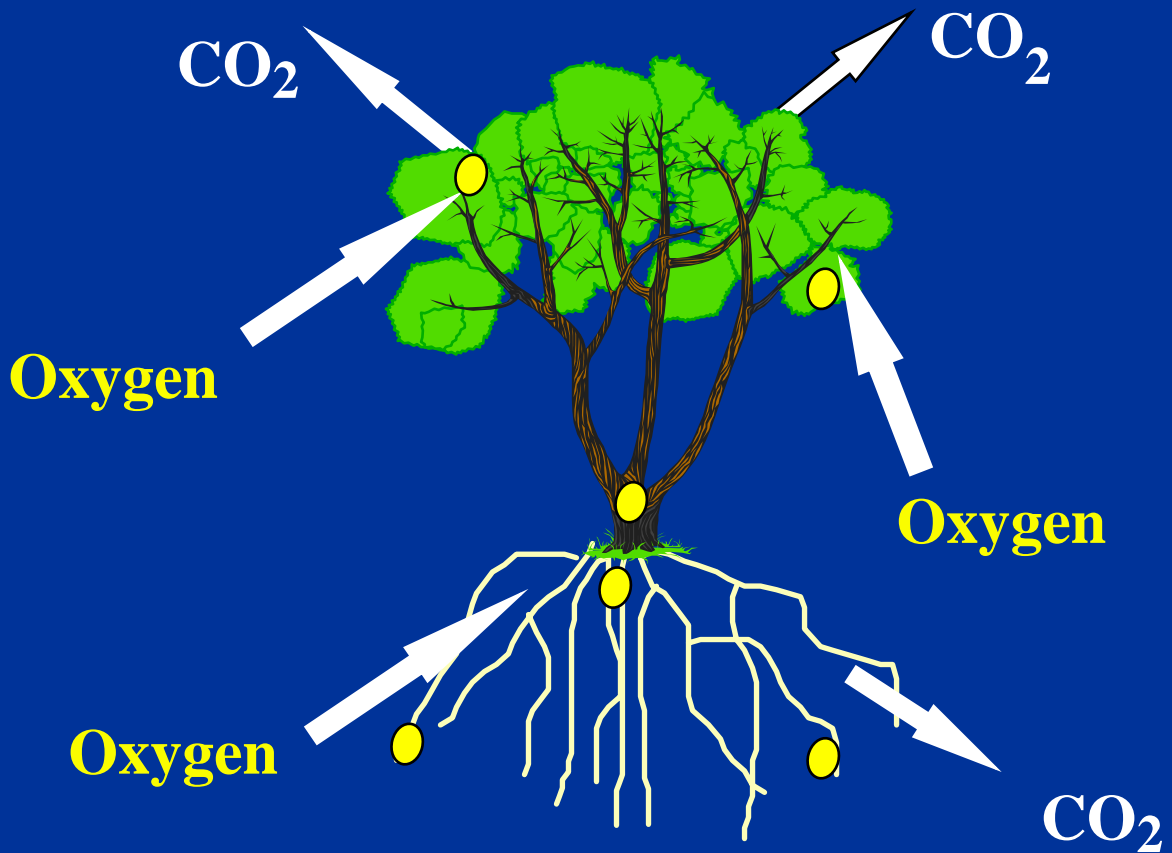
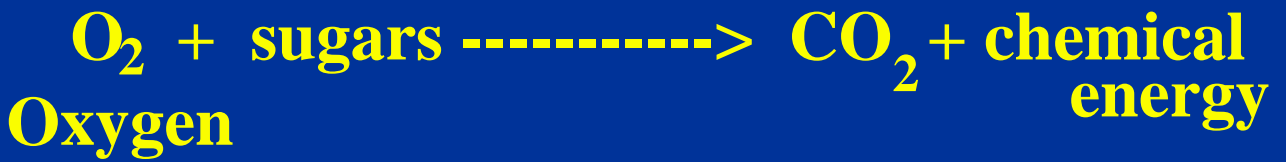
Factors Affecting Transpiration

- Light
- Temperature
- Humidity
- Wind Velocity
- Soil Moisture

Guttation



Respiration



Photosynthesis

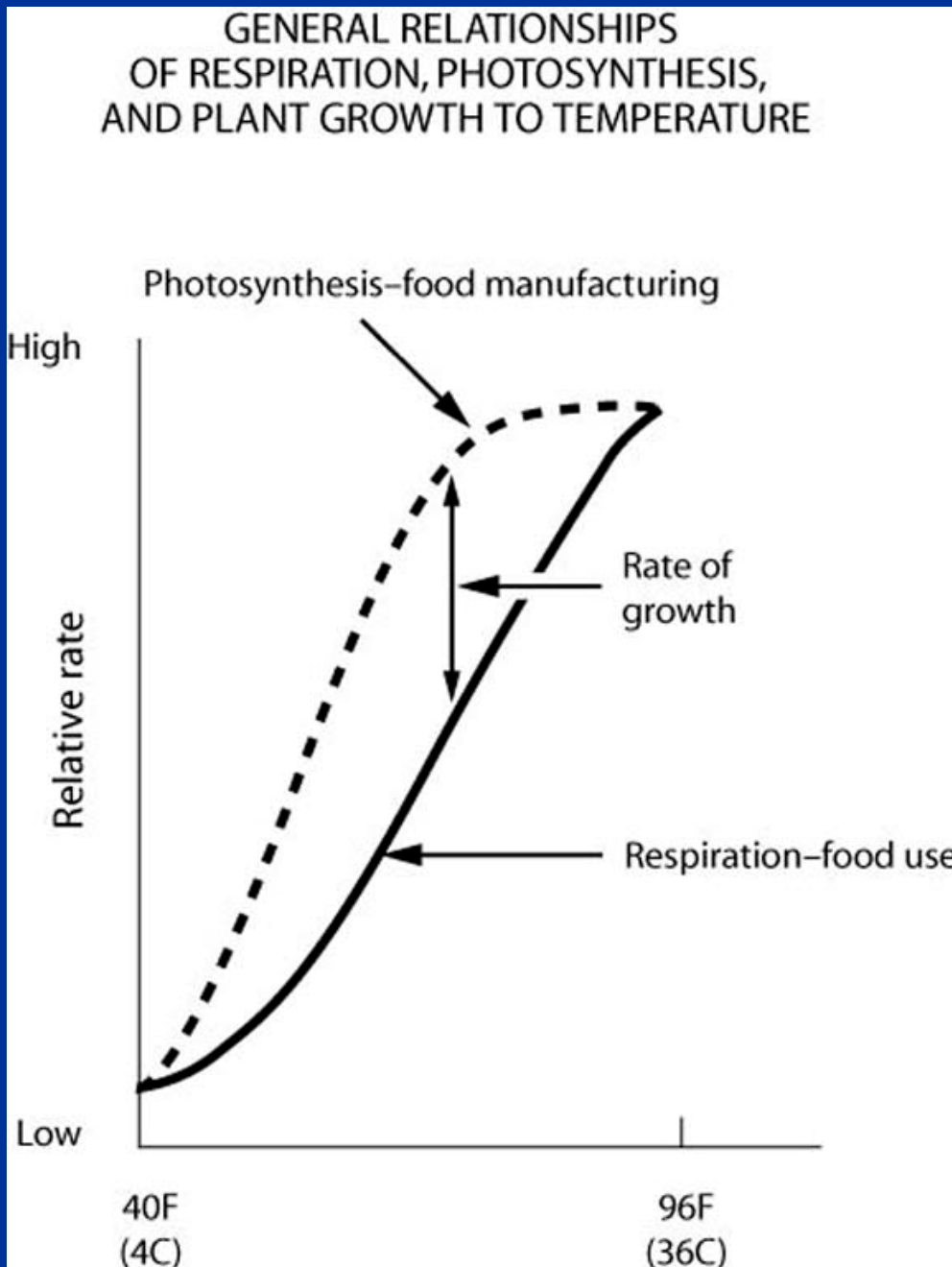
- * occurs only in light
- * occurs only in green tissue such as leaves and some stems

Respiration

- * occurs in the dark and light
- * occurs in all living tissue
- * rate increases during stress

Photosynthesis > Respiration = plant growth
(sugar prod.) (sugar usage)

Photosynthesis < Respiration = plant death



Effect of Environmental Factors on Plant Processes

Plant Condition

Heat stressed

Healthy

Photosynthesis

low

high

Respiration

high

low

Transpiration

high --> low

moderate

Nutrient uptake

low

moderate

Homework

- Consider this and explain in the context of photosynthesis and respiration balance.
- There is tenacious dandelion that keeps popping up in a container of bedding plants. You keep picking the shoots off, and again it comes up, you pick off the shoots, and again.....
- If you are tenacious in your picking, why do you eventually win?



FLOWERS

FLOWER FUNCTIONS

 **Attract pollinators**

 **Attract humans**



Attract pollinators





Attract people



Juvenility (Vegetative)



Maturity (Flowering)



Flower initiation

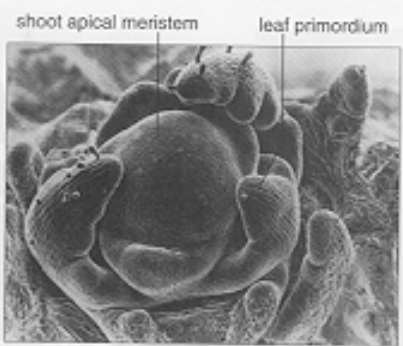


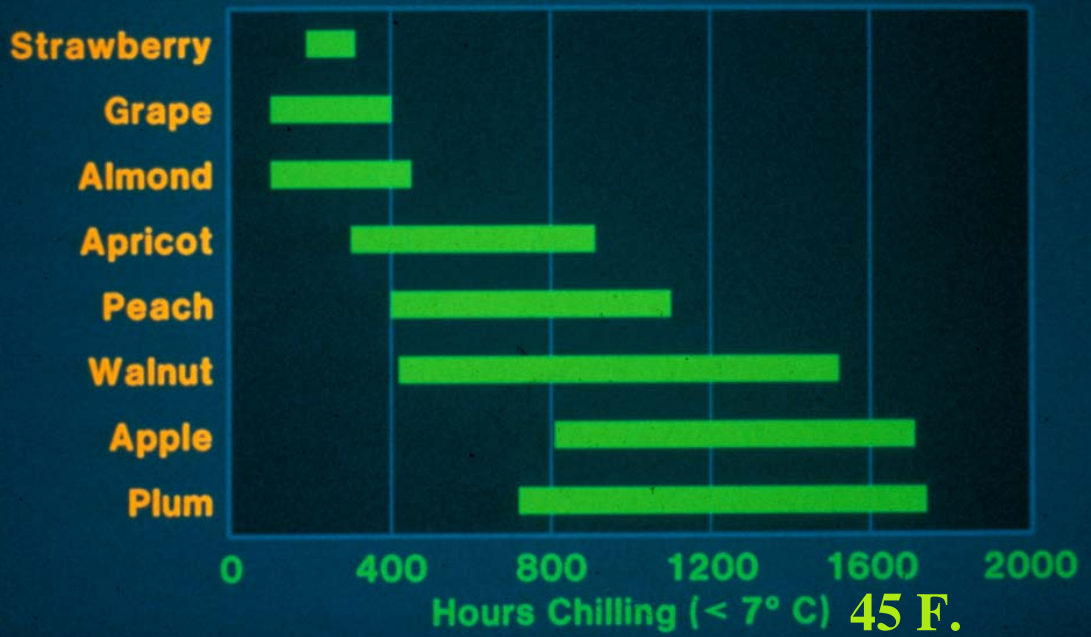
Figure 13.9 Development of a flower from the floral apex. **(a)** Flower of pheasant-eye (*Adonis aestivalis*), a member of the buttercup family. **(b)** Early phase floral apex, $\times 35$. **(c)** Late floral apex showing stamens and then carpels near the apex tip, $\times 52$. **(d)** Nearly formed flower. The meristem has now completely formed all the flower parts. The carpels are in the middle, surrounded by stamens, $\times 54$. **(e)** Mature carpels with feathery stigmas, $\times 17$.

Often flowers occur in clusters.

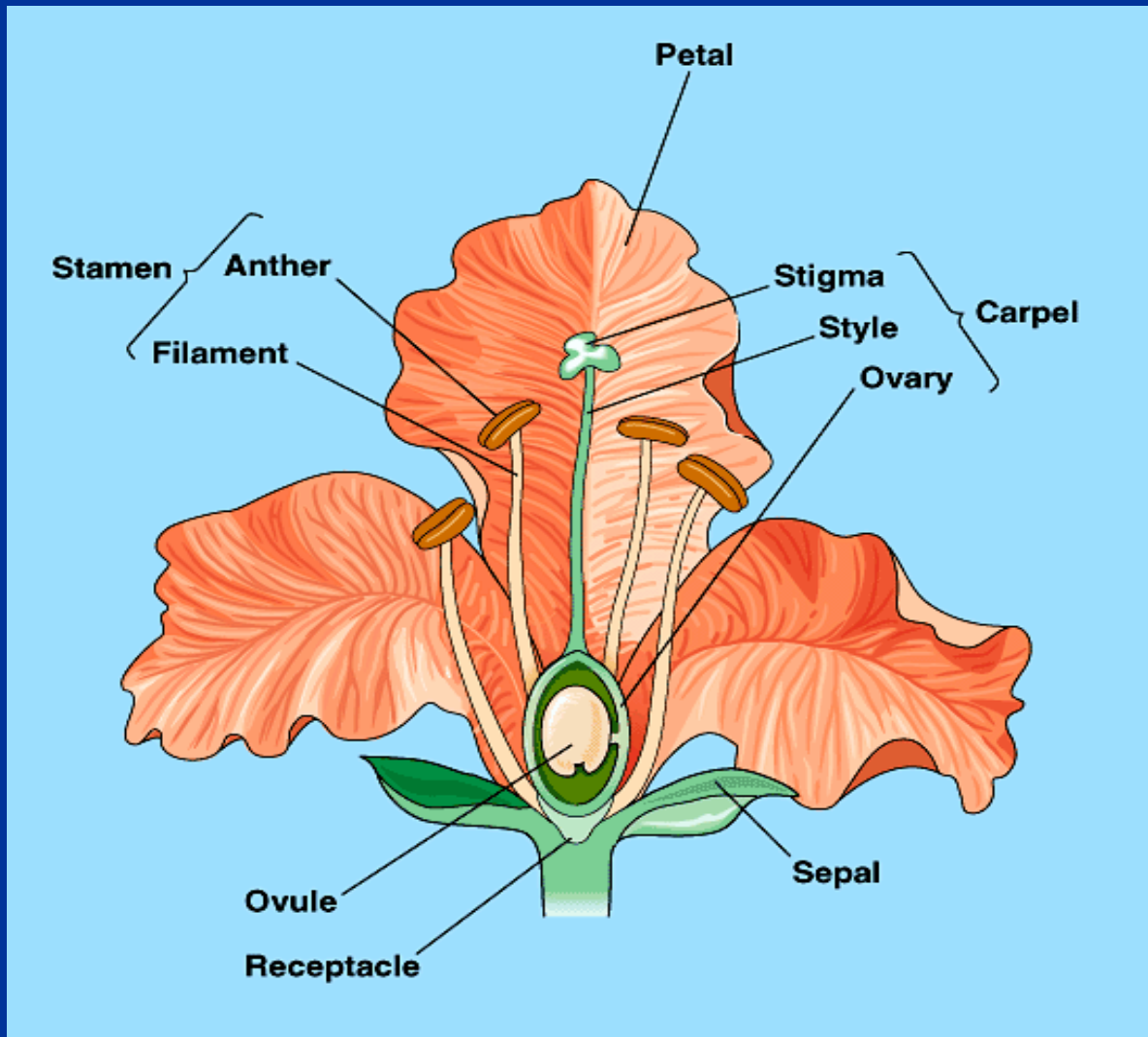
Flower initiation

- Juvenile development needed which establishes a level of nutrition and carbohydrate levels
- Environmental factor initiates changes
 - Temperature, ie chilling hours below 40 F.
 - Photoperiod, short or long days

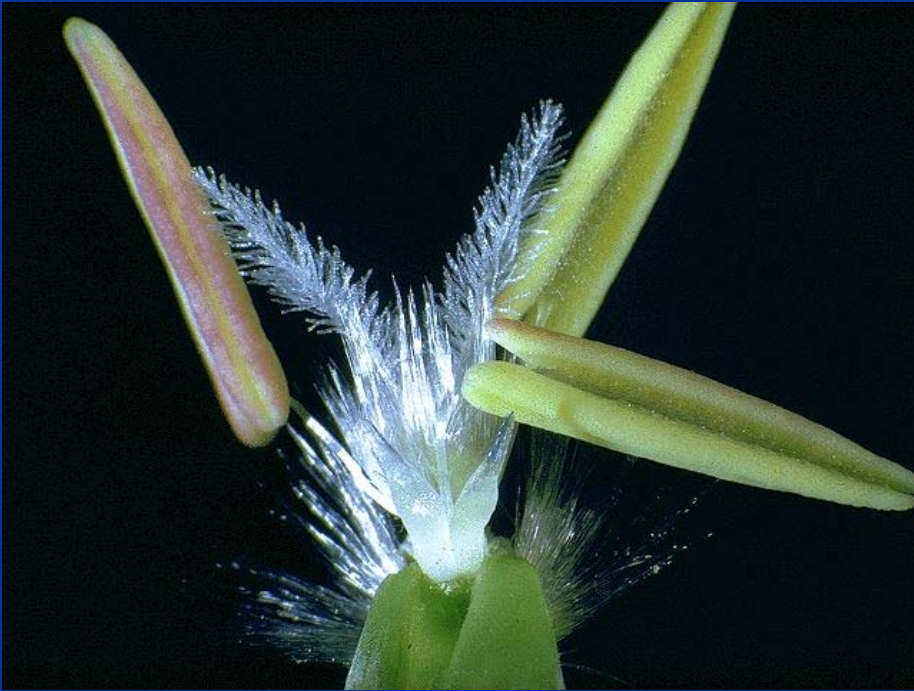
Chilling Requirements to Break Winter Rest



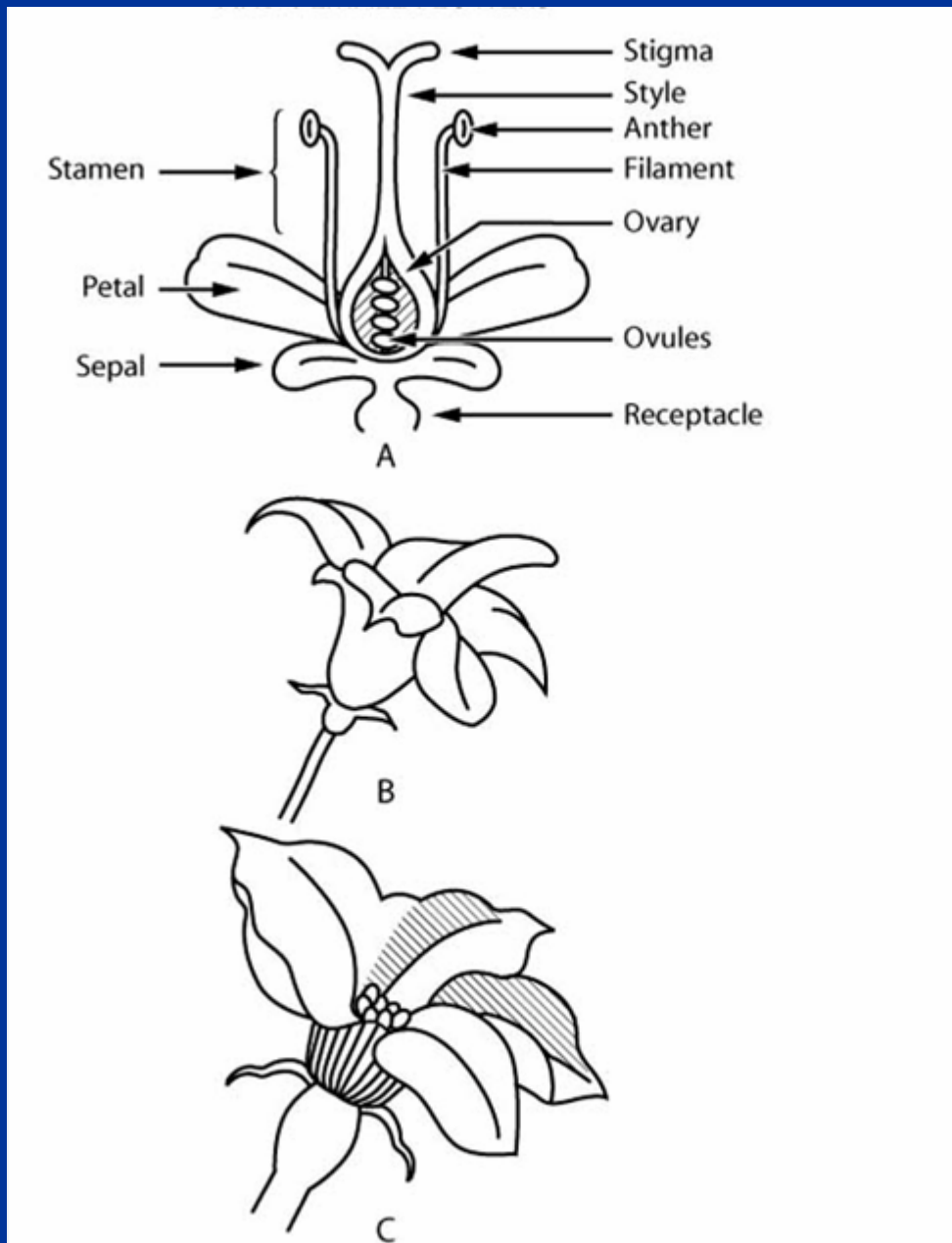
Flower structure



Flower structure: grasses

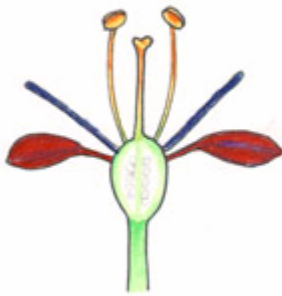


Perfect and Imperfect Flowers

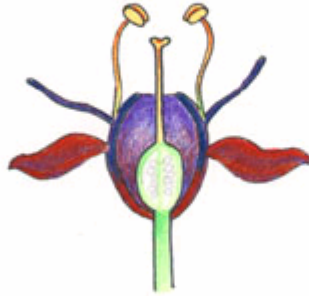


Flower structure

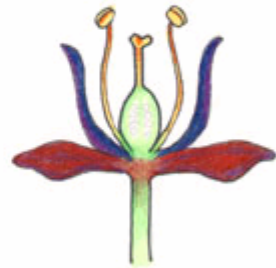
Ovary Position



Epigynous



Perigynous



Hypogynous

Flower Arrangement



solitary



raceme



spike



corymb



umbel



capitulum



panicle

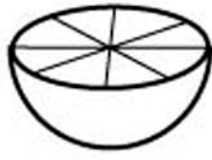


cyme

Example of simple fruits (modified ovary and seed)



Tomato



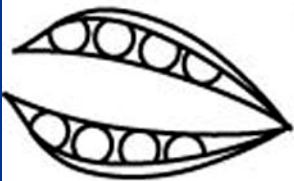
Orange



Peach



Apple



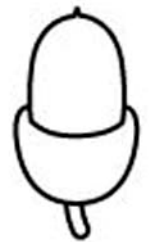
Pea pod



Maple samara

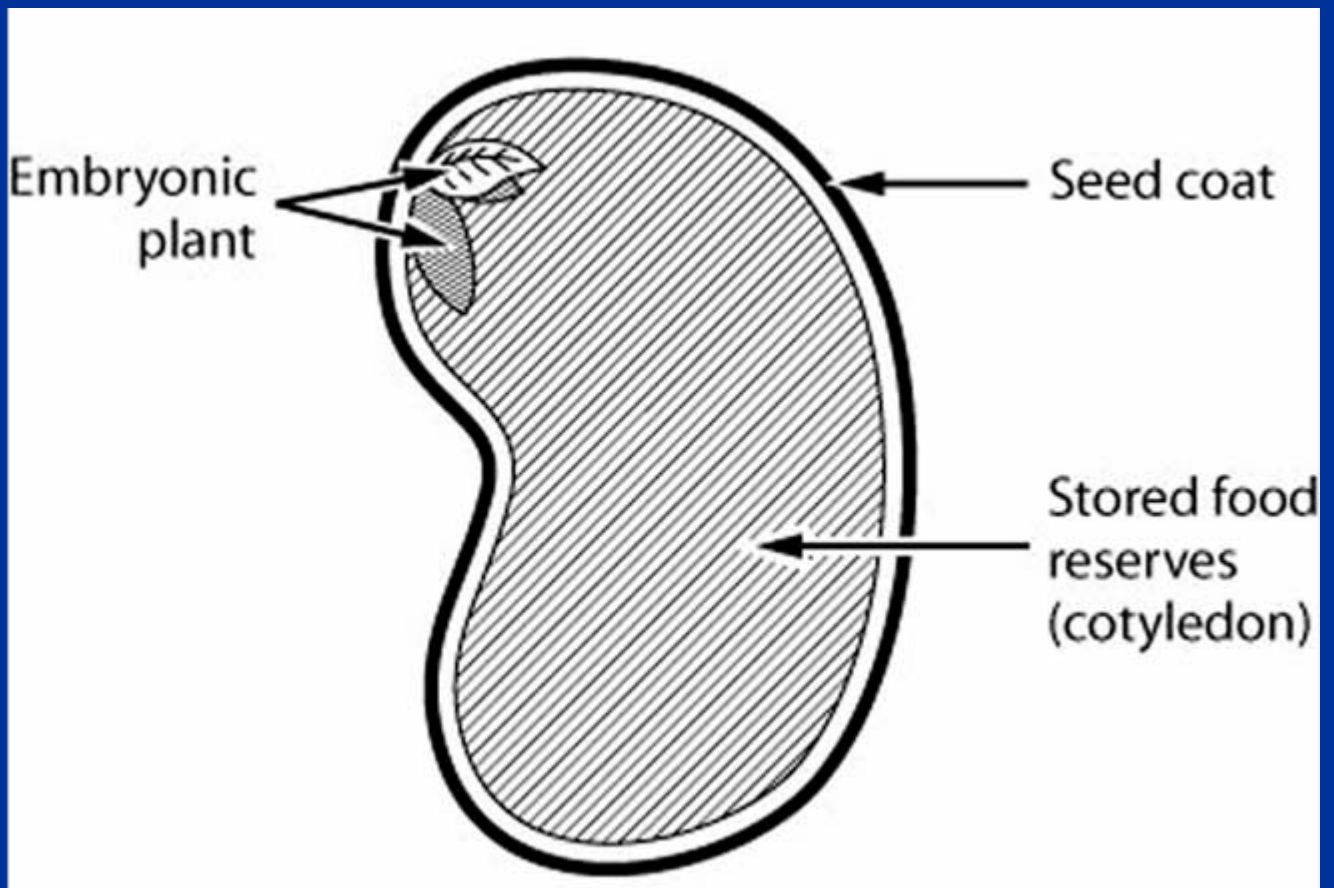


Corn kernel

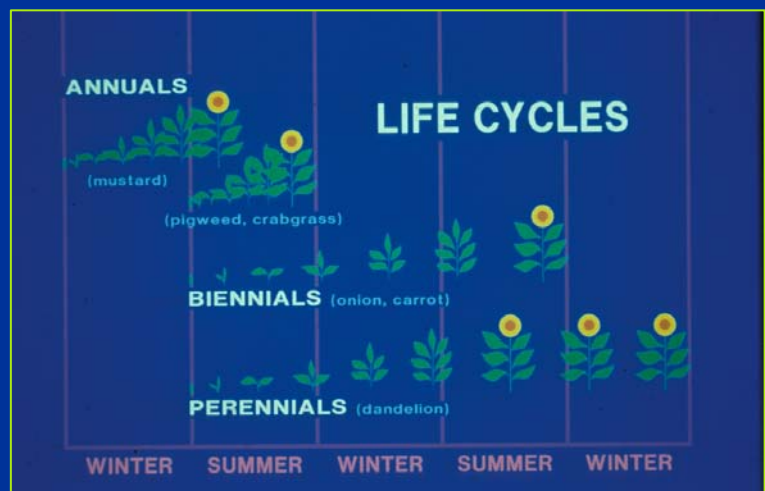
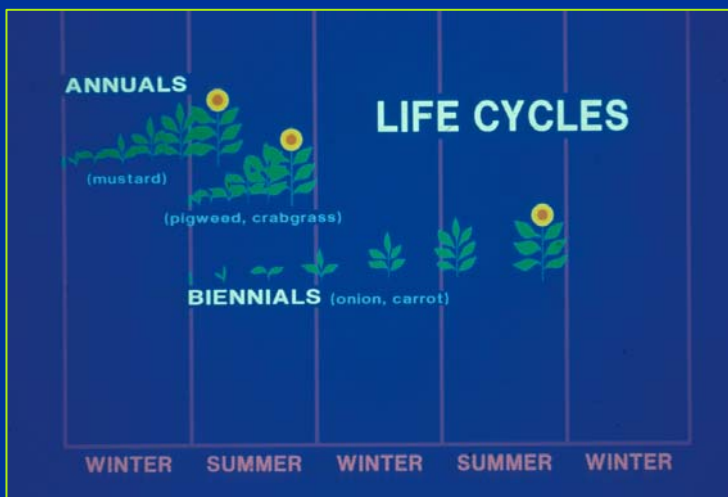


Oak acorn

Seed Structure (Bean)



Plant classification related to flowering



Homework

- Look at flowers, close up, and pick them apart.
- Identify as many parts as you can.
- Are the flowers botanically perfect or not perfect?

CONCLUSIONS

Roots:



Anchorage



Storage of food



Regeneration of new plants



Absorption of water and nutrients

CONCLUSIONS

Stems:



Supports leaf canopy and flowers

Produces and stores sugars

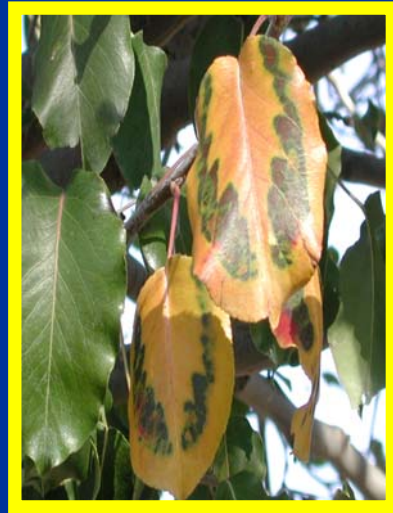
Shoot regeneration

Pathway for water/nutrient transport

Pathway for food transport

CONCLUSIONS

Leaves:



 **Photosynthesis -**
food production

 **Transpiration -**
water evaporation
from the leaf surface

CONCLUSIONS

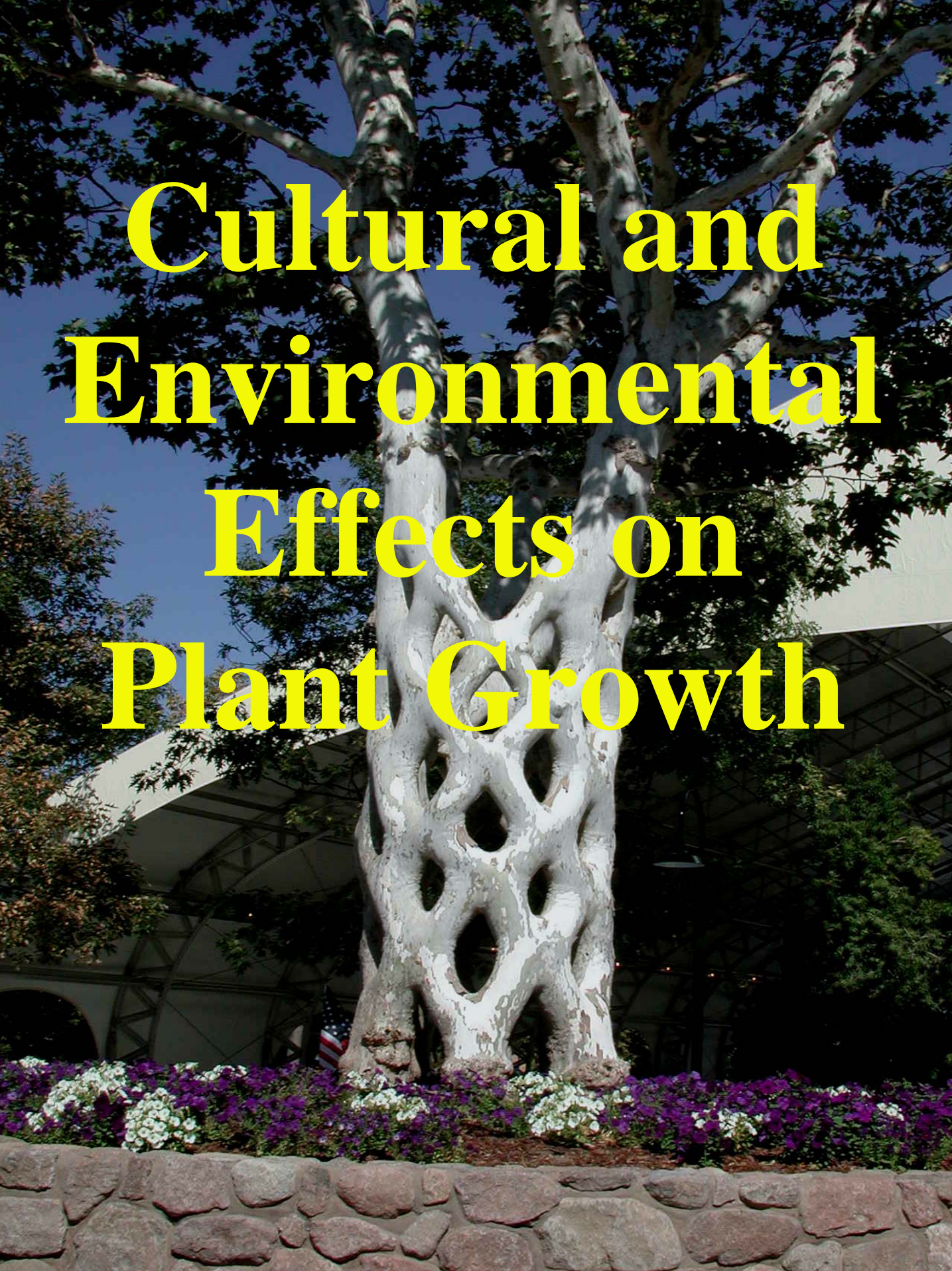
Flowers:



**Attract bees and
other insects**



Attract people



Cultural and Environmental Effects on Plant Growth

Overview



Temperature



Light



**Environmental
Stress**



**Plant
hormones**



TEMPERATURE

Temperature

 **Low vs. high**

 **Daily fluctuations**

 **Seasonal fluctuations**

 **Media vs. Air**

Temperature Effects on Plant Development

 **Rate of plant growth**

 **Flower bud initiation**

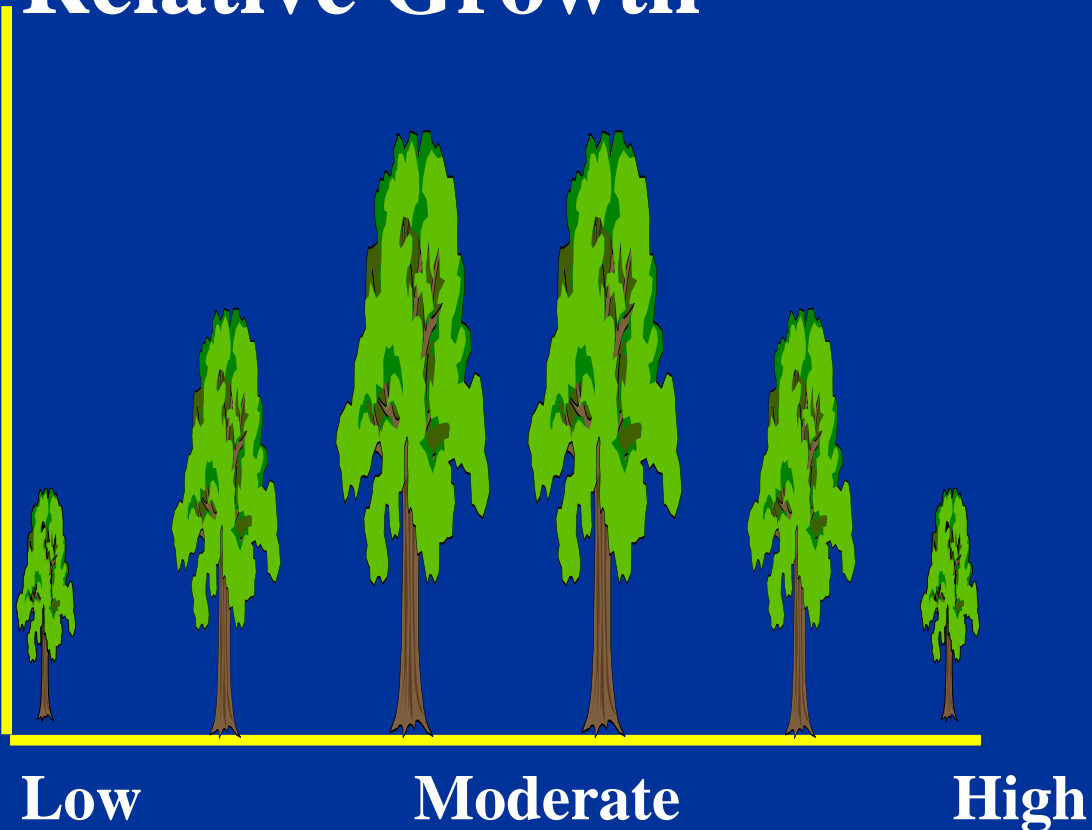
 **Flower quality**

 **Plant height**

 **Plant branching**

Low vs. high temperatures

Relative Growth



Example

Cool and warm vegetables
(cabbage vs. tomato)

Cool and warm flowering annuals
(pansy, primroses vs. zinnia, marigold)

Daily temperature fluctuations

(DIF) Day – Night Temperature

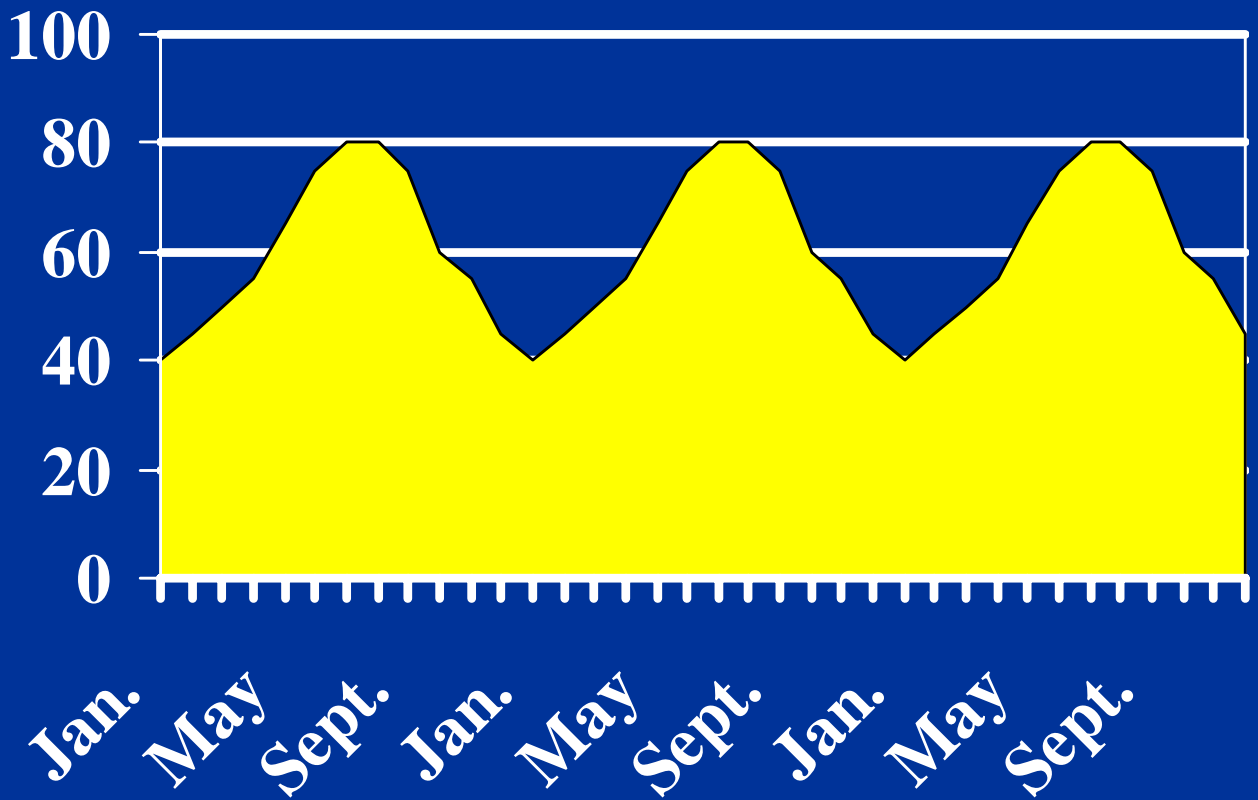
	Temperature Regime		
	A	B	C
	F (C)	F (C)	F (C)
Day temperature	60 (15.5)	55 (13)	50 (10)
Night temperature	50 (10)	55 (13)	60 (15.5)
DIF	+10 (5.5)	0	-10 (-5.5)
Plant height	tall	medium	short
Average daily temperature	55 (13)	55 (13)	55 (13)

*Dole, J.M. and H.F. Wilkins. Floriculture Principles and species. 1999.
ISBN: 0-13-374703-4



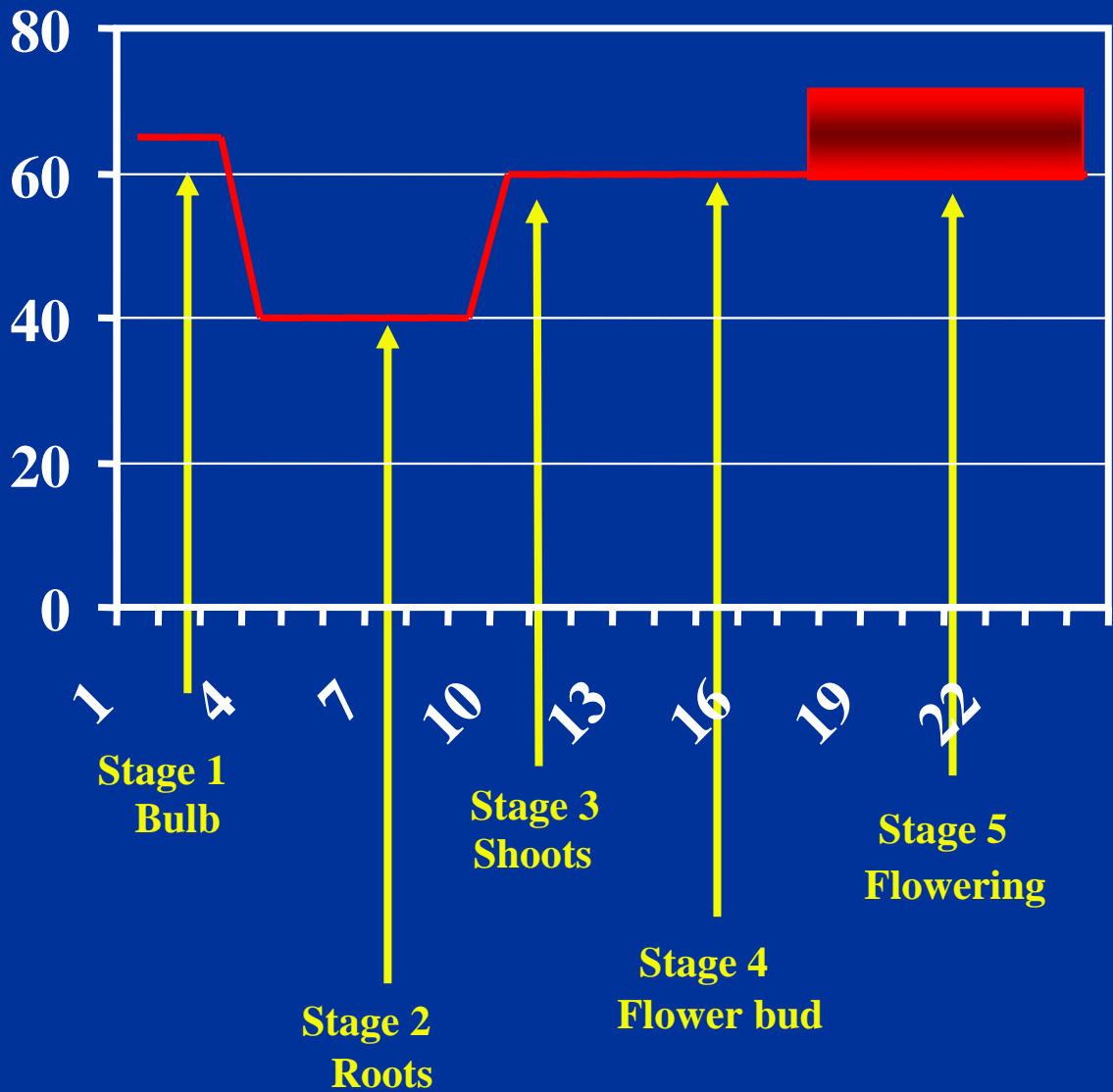
Seasonal fluctuations

Air and Soil Temperature (F)



Lily Temperature Model


Temperature (F)





LIGHT

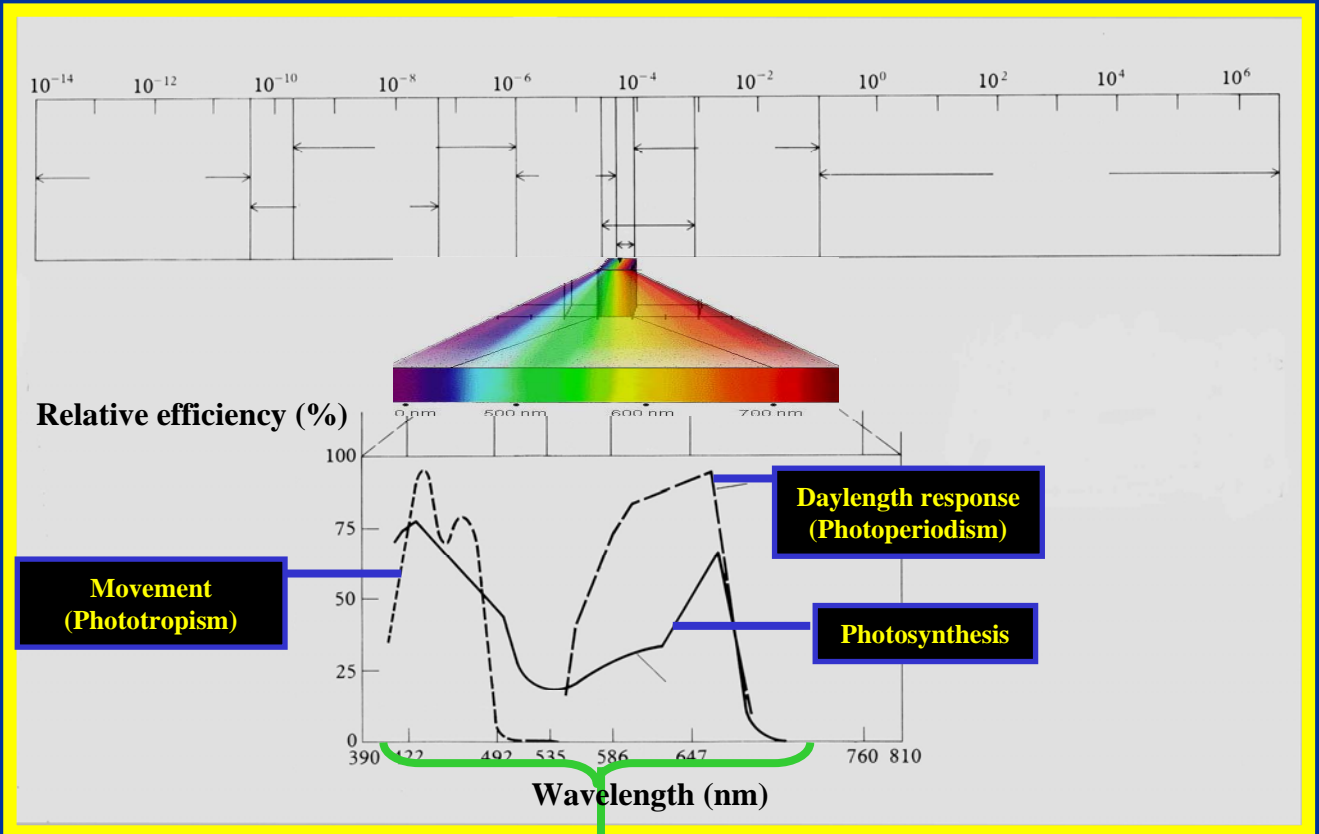
Light

 **Quality = Wavelength**

 **Quantity = intensity**

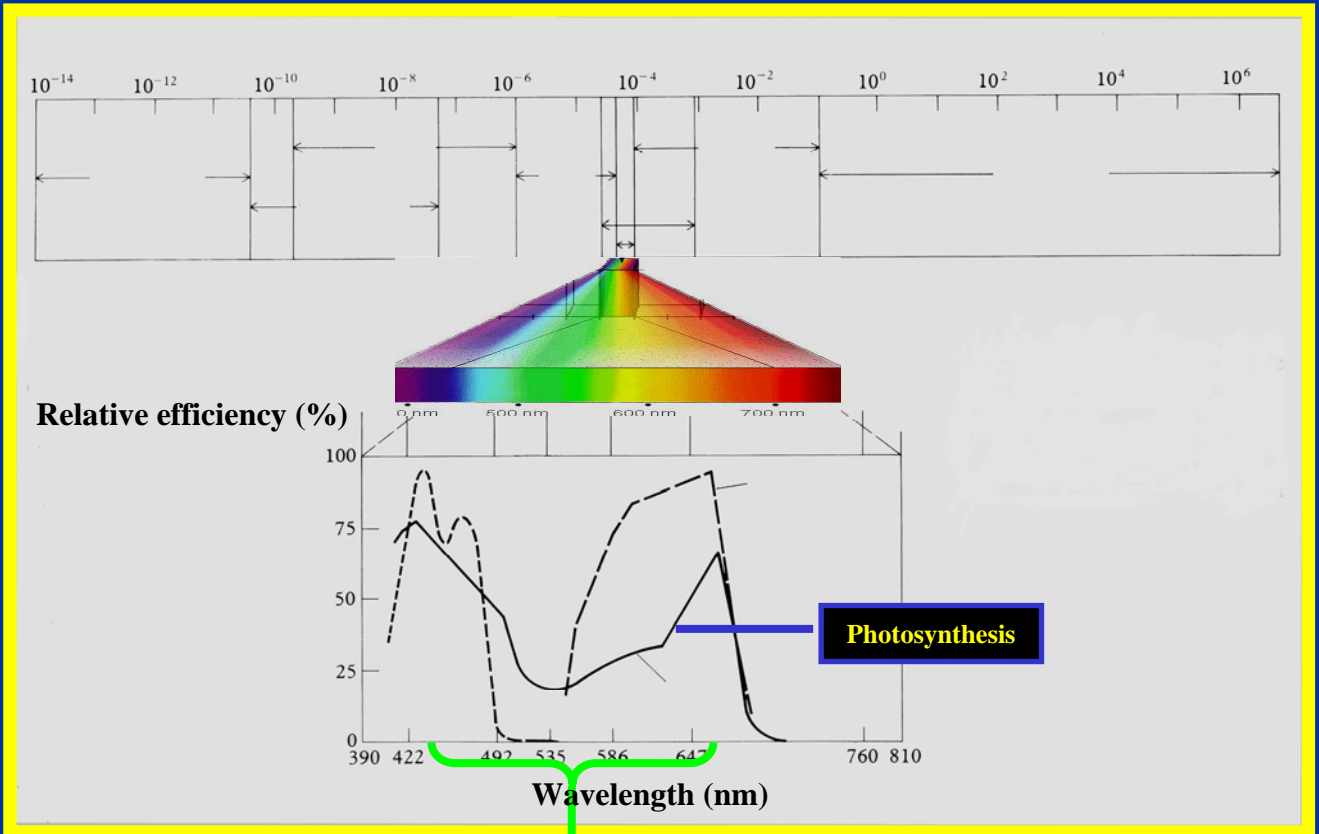
 **Duration = Time**

Light Quality



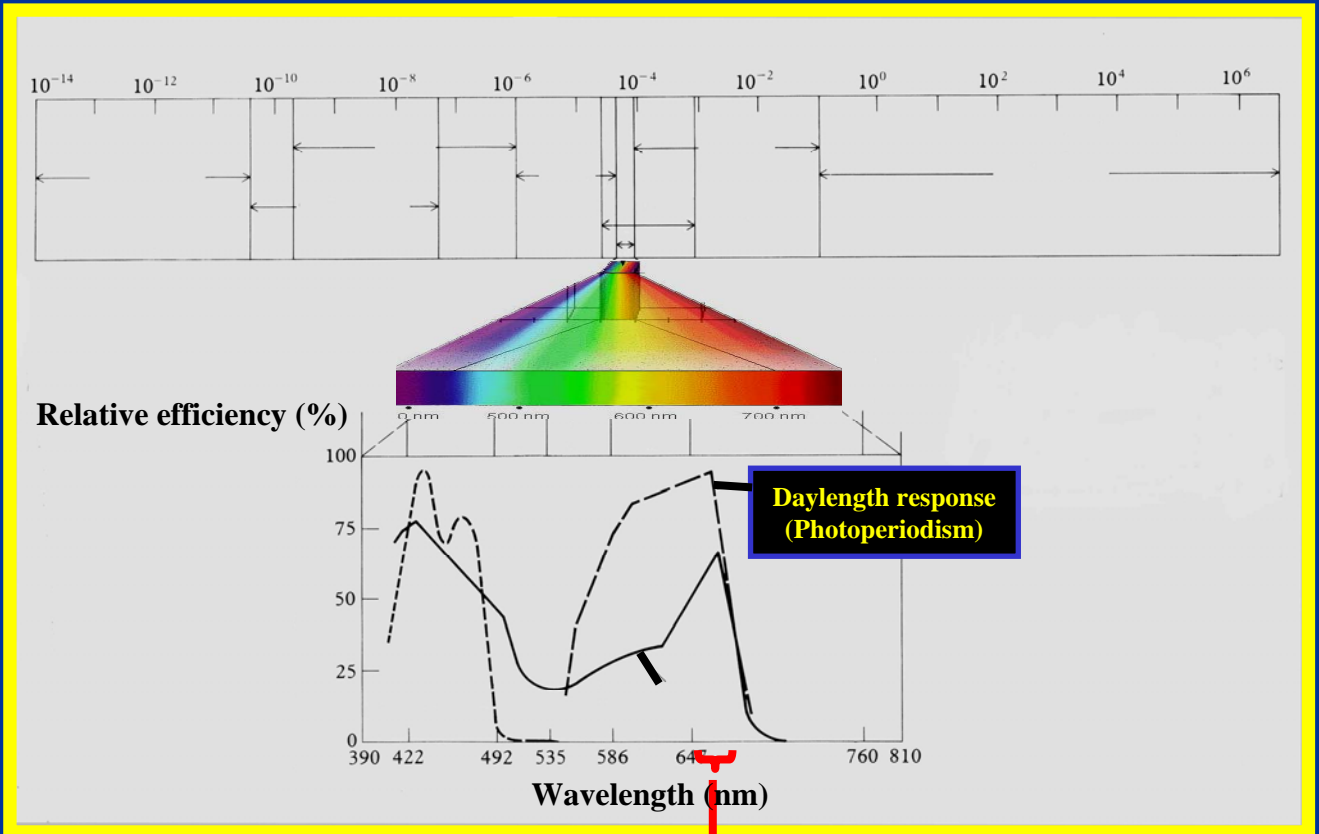
Plant Receptive Range
***400-730 nm.**

Light Quality



Photosynthesis –
***435-650 nm.**

Light Quality



Red light –

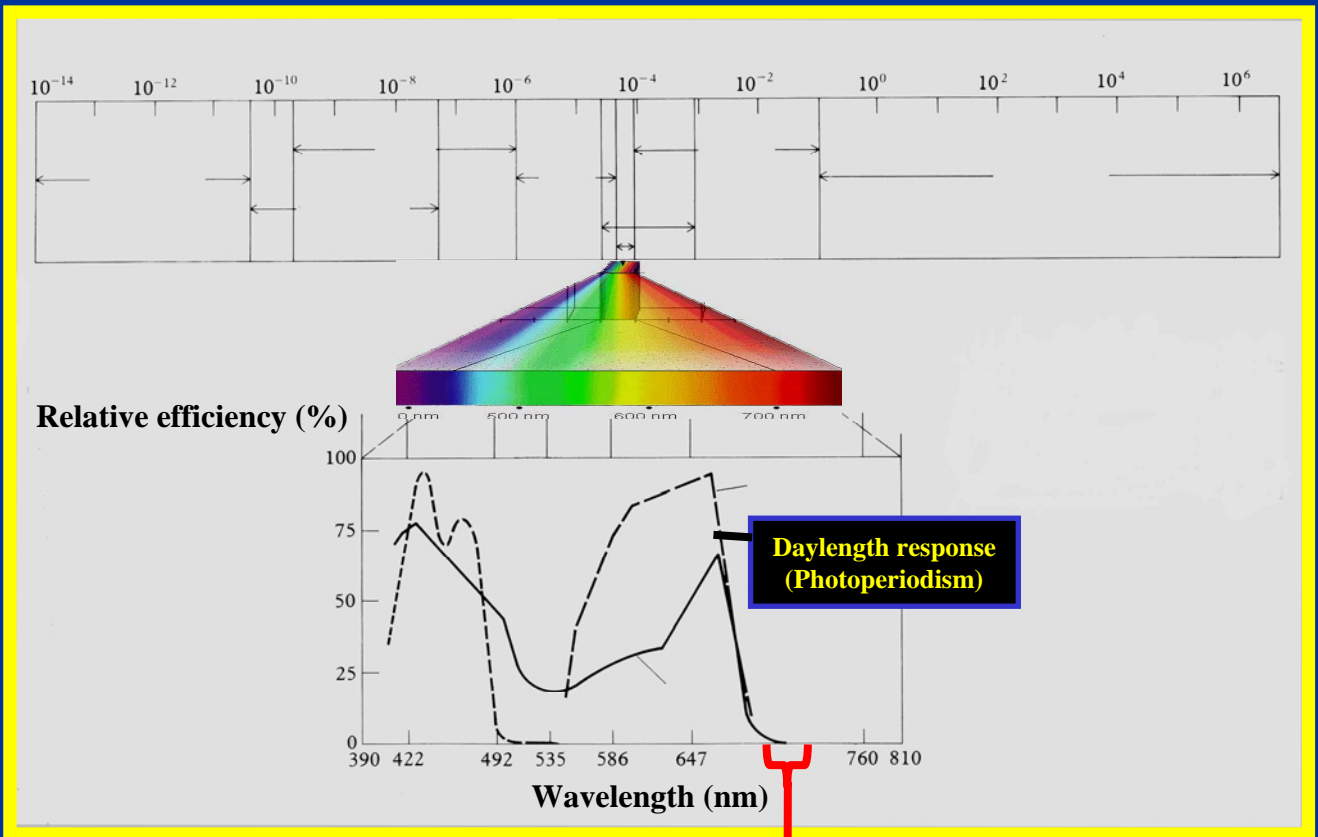
*660 nm

*short stems

*dark green foliage

*increased branching

Light Quality

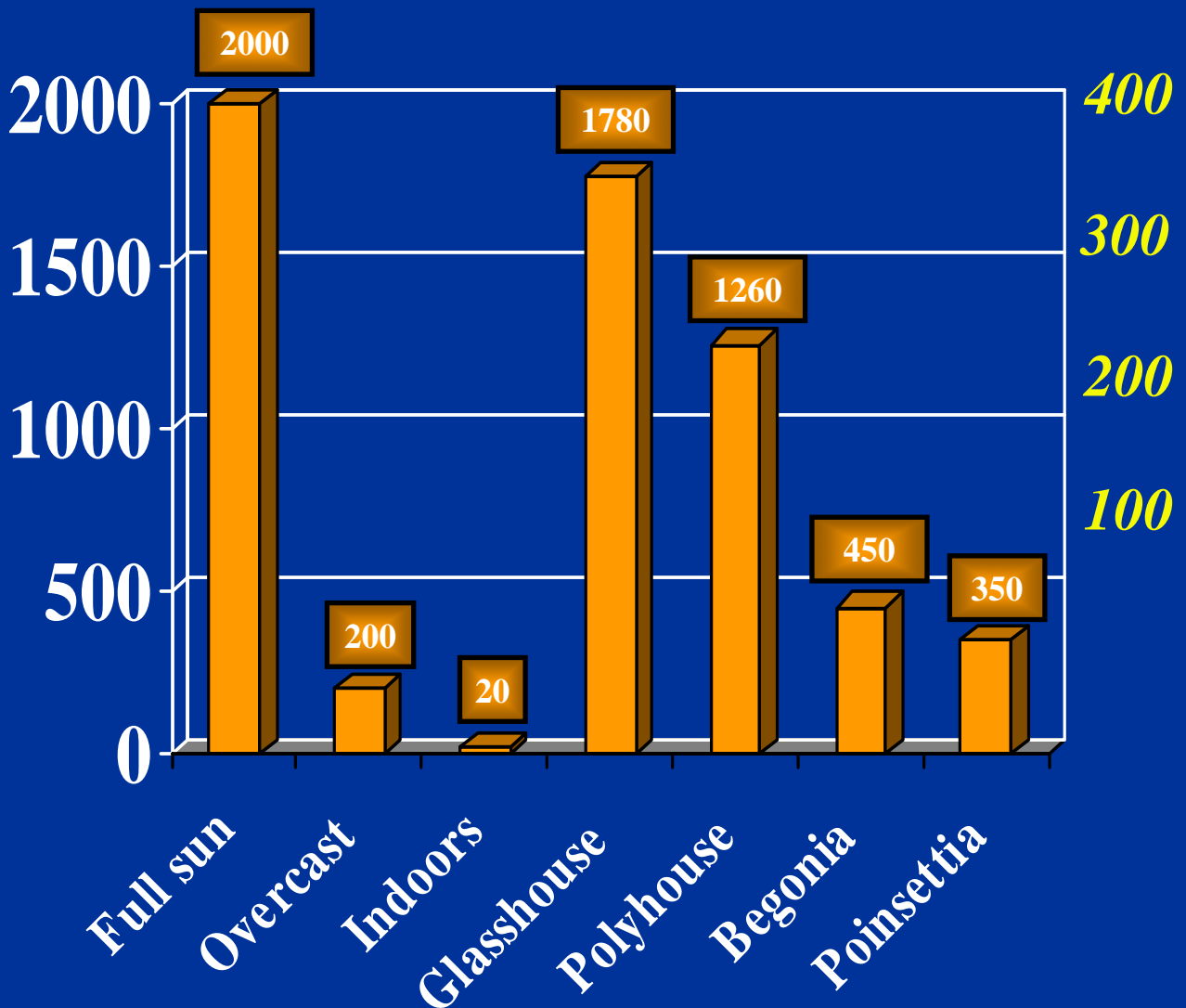


Far-red light –

- *730 nm
- *elongated plants
- *larger leaves
- *decreased branching
- *reduced color intensity.

Light Quantity

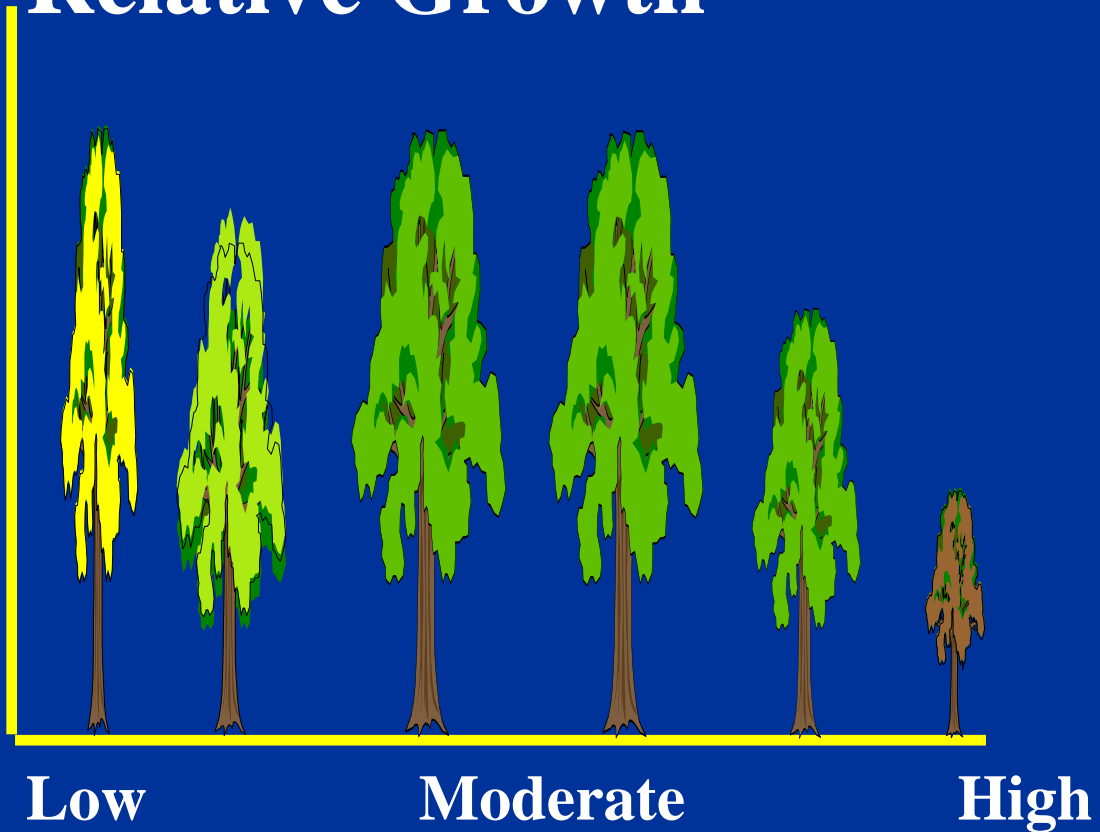
*Light Intensity (mol/s/m²)
[*foot candles*]



*Light intensity is for wavelengths of 400-700 nm.

Light Quantity

Relative Growth



Light (Quantity) Intensity

Light Duration (Photoperiodic Response)

***Long Day Plants (LD)**

(short nights)

-flowering induced by long days.
> 12 hours of light or interruption
of darkness during the night
(short nights).

-Petunia, Phlox, Ageratum

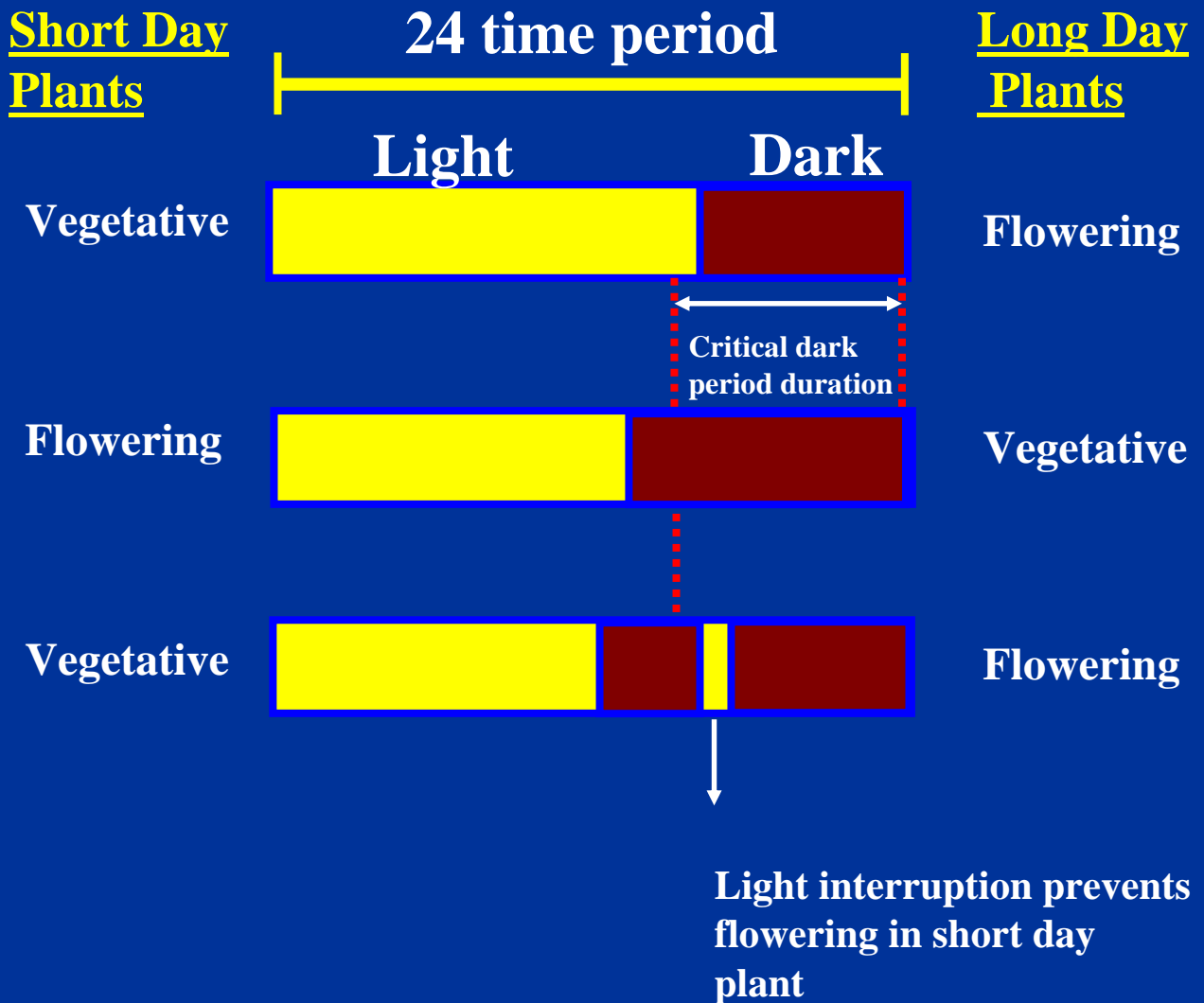
***Short Day Plants (SD)**

(long nights)

-flowering induced by short days.
< 12 hours of light.

-Euphorbia, Cosmos, Dahlia

Light Duration (Photoperiodism)





ENVIRONMENTAL STRESS

Environmental Stress

 **Temperature stress**

 **Water stress**

 **Mechanical stress**

 **Light stress**

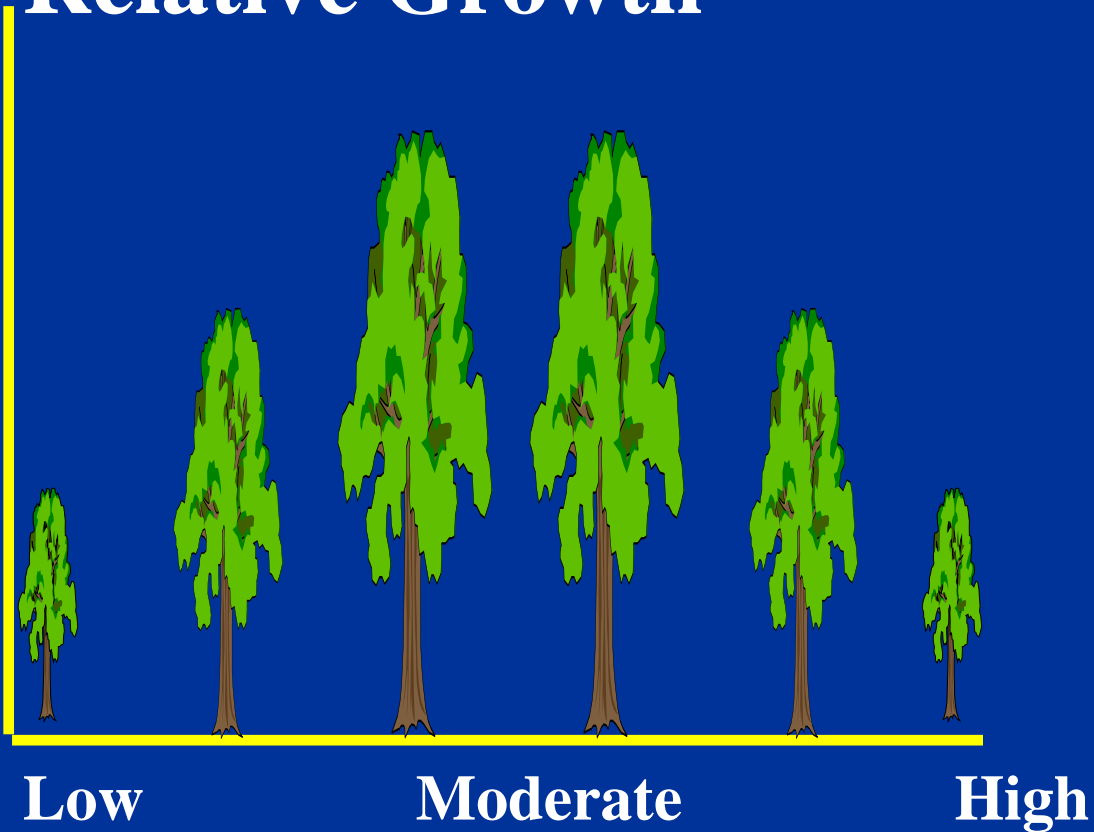
 **Nutritional stress**

Effect of Temperature on Plant Processes

	<u>Heat stressed</u>	<u>Healthy</u>
Photosynthesis	low	high
Respiration	high	low
Transpiration	high --> low	moderate
Nutrient uptake	low	moderate

Temperature, Water or Nutrient Stress

Relative Growth



*Light Intensity

*Fertilizer

*Temperature









Bullheads

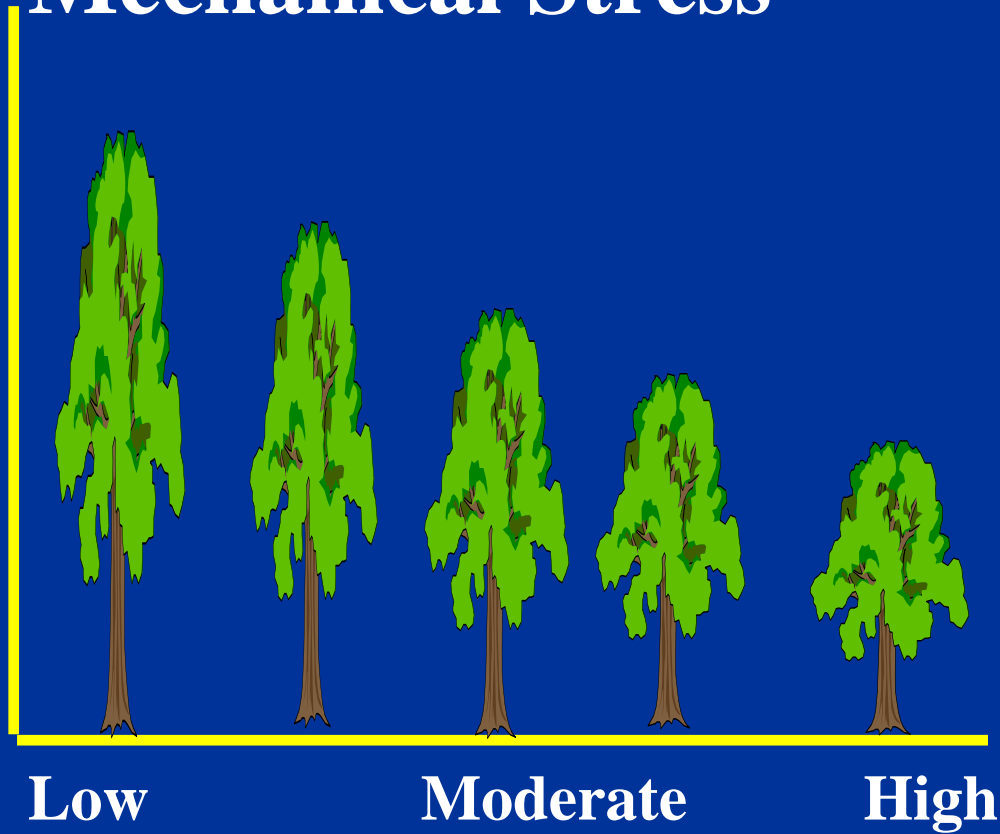




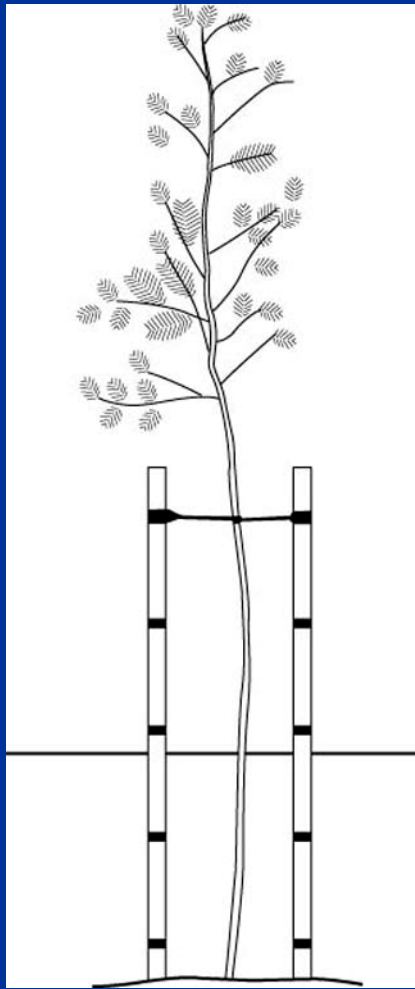


Mechanical Stress

Mechanical Stress



Proper staking provides movement of trunk and benefits



Homework

- Again, in your home landscape or garden.
- Find a plant that has not been doing well for a long time.
- Consider how excessive or deficient *light, heat, or other environmental factors* might be adversely affecting the plant.

GROWTH HORMONES



Growth Hormones (Growth Regulators) -

+ a substance produced by the plant in small quantities which is transported to different sites of the plant to control growth and development.

+ Concentration specific

+ Stage of development

Growth Hormones (Growth Regulators)

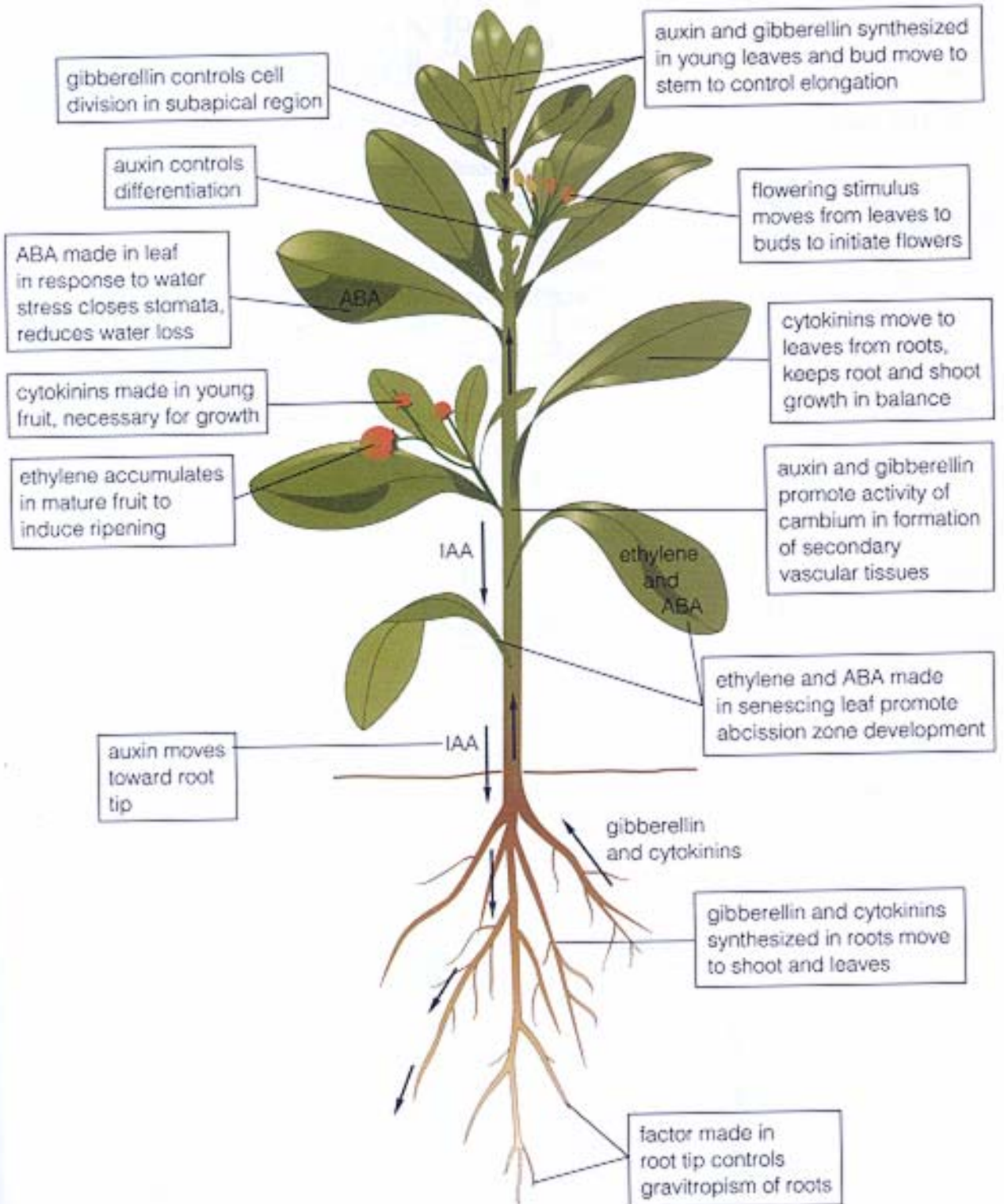
 **Auxins**

 **Abscissic Acid**

 **Cytokinins**

 **Ethylene**

 **Gibberellins**



Growth Hormones (Growth Regulators)

Auxins

- **Rooting Powders**
- **2,4 D**

Ethylene

- **Ripening, branching,
flower/fruit drop**
- **Increase flower life**

Gibberellins

- **ProGibb**
- **Growth Retardants**



Homework

- Time to go home.....