

## 2. E3 Plant Biology Basics



# Plant Biology Basics, Plant Classification

**Gymnosperms Non-flowering plants including conifers.**

**Needle-leaved or scale-leaved, mainly evergreen, cone-bearing trees and shrubs including pines, spruces, junipers and firs.**



# Plant Biology Basics, Plant Classification

**Angiosperms  
flowering  
plants**

*Monocots*

**monocotyledons,  
one seed leaf**

*Dicots*

**dicotyledons, two  
seed leaves**



# **Plant Biology Basics, Plant Classification**

**Woody plants have basic stem structures that are perennial with annual growth rings.**

**Include**

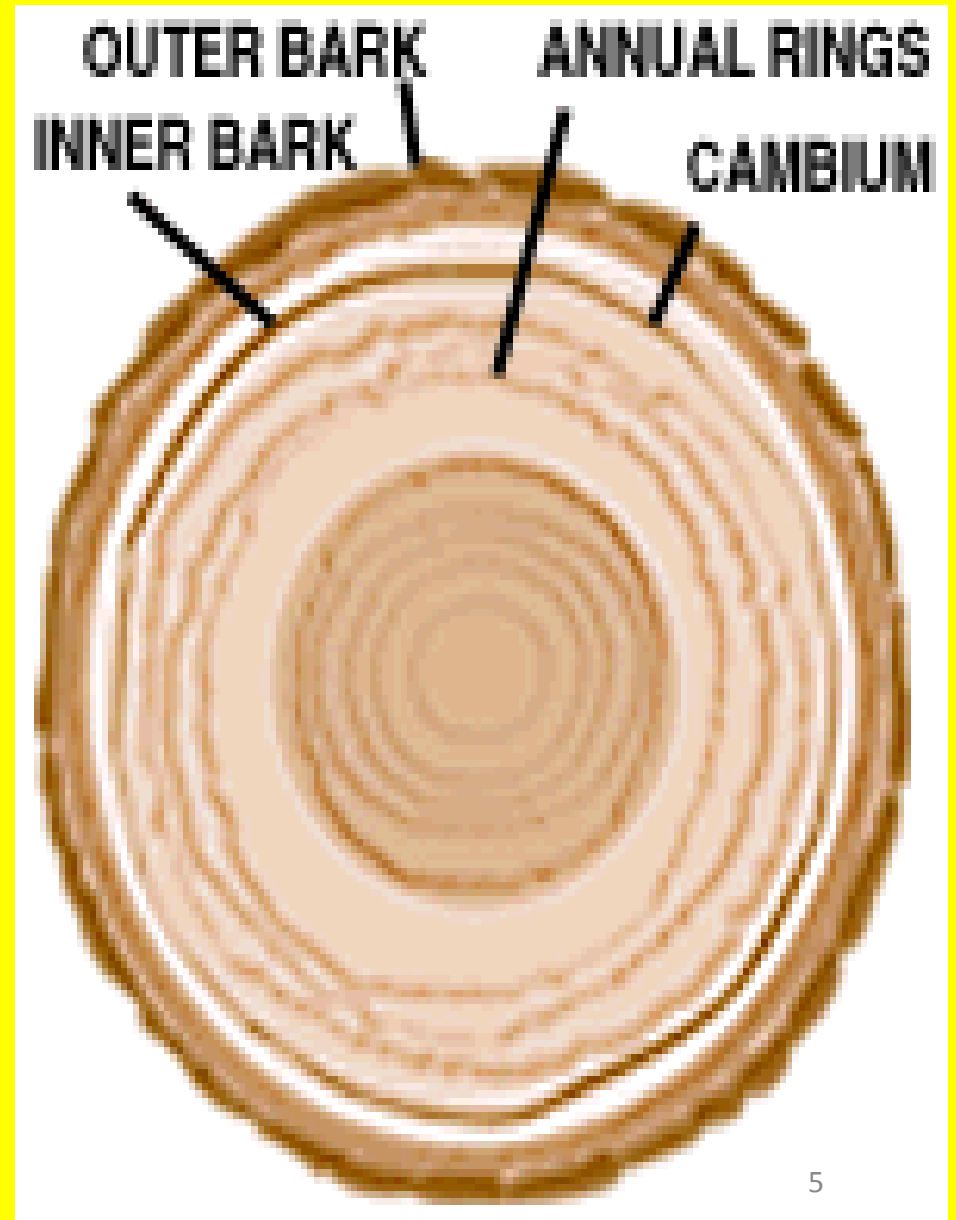
**Trees are defined as single stem plants greater than 20 feet tall.**

**Shrubs are defined as multi-stem plants less than 20 feet tall.**

# Plant Biology Basics, Plant Classification

**Woody plants have basic stem structures that are perennial with annual growth rings visible in a cross section of the stem. Include**

**Produce new xylem layers each year**



# Plant Biology Basics, Plant Classification

## Herbaceous plants.

Any plant with a non-woody stem that dies back to the roots in winter, hostas, begonias, daylilies.



# Short Summary

Flowering plants are angiosperms.

Gymnosperms are non-flowering plants including conifers.

The two types of angiosperms are monocots and dicots.

Woody plants have basic stem structures that are perennial with annual growth rings.

# Quick Questions

**What is the basic definition of a tree?**

*A single stem plant more than 20 feet tall.*

**What is the basic definition of a shrub?**

*A multistem plant less than 20 feet tall.*

**A woody plant produces a new xylem layer?**

*Every year*



# Plant Biology Basics, Plant Classification

## Scientific and common names

Specific plants can have several common names but only **one** scientific name in Latin

In scientific classification the scientific name is a binomial, two parts, consisting of:

**Genus**, a capitalized Latin name. In taxonomy, a unit above species and below family

**species**, a non-capitalized Latin name,

In print, the Latin Genus and species names are *italicized*, such as *Homo sapiens*.

# Plant Biology Basics, Plant Classification

Genus	Species	Common Name
<i>Acer</i>	<i>rubrum</i>	Red maple
<i>Viburnum</i>	<i>trilobum</i>	American Highbush Cranberry

# Plant Biology Basics, Plant Classification

## Cultivars, varieties, and hybrids

Cultivar is a contraction of 'cultivated variety'

Always capitalized, set off with single quotes or the abbreviation cv. Produced by human selection.

Variety is a naturally occurring variation of a plant. Preceded by var. and *italicized*.

Hybrid is a cross of two or more species or cultivars. Hybrids can occur naturally, as shown in *Acer* x *Freemanii*, or through plant breeding.

# Plant Biology Basics, Plant Classification

Genus	Species	Cultivar	Variety	Common Name
<i>Gleditsia</i>	<i>triacanthos</i>		var. <i>inermis</i>	
<i>Tilia</i>	<i>americana</i>	'Boulevard'		'Boulevard' linden
<i>Acer</i>	X (the X denotes a hybrid cross)	'freemanii'		Freeman maple
<i>Malus</i>	X	'Prariefire		Prariefire crabapple

# Plant Biology Basics, Plant Parts

The **cell** is the basic building block for plants. Site of all physiological processes that are associated with growth.

**Tissues** are groups of cells related in structure or by function.

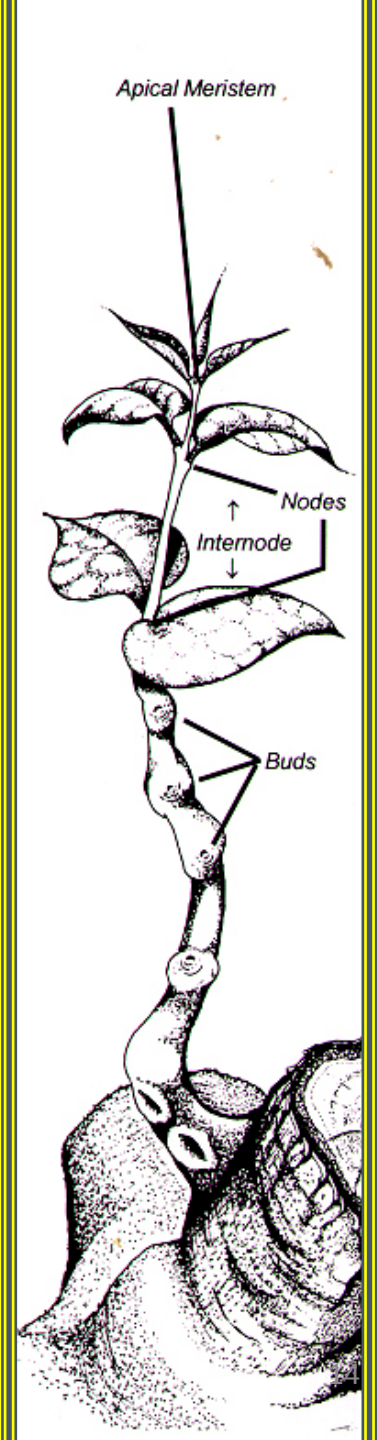
**Plant organs** include: stems, leaves, roots, and reproduction. Each organ has a characteristic form and performs a major function in the plant.

# Plant Biology Basics, Plant Parts

## The stem

Attachment point for leaves, flowers, and fruit.

Path, containing the xylem and phloem conductive tissues, for transport of carbohydrates, water, minerals and for applied pesticides.



# Plant Biology Basics, Plant Parts

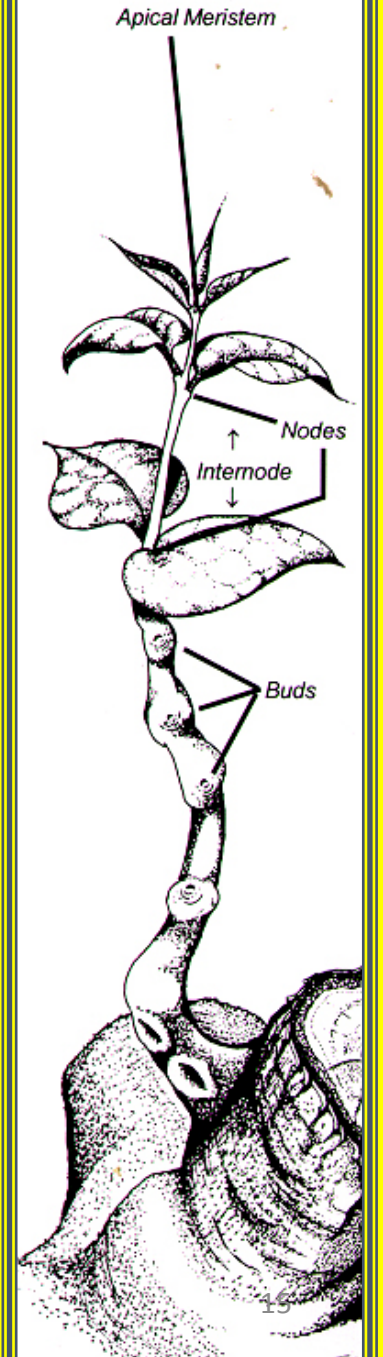
## The stem

### Nodes and internodes

The point of attachment for the leaf is called the **node**.

The space between two nodes is the **internode**.

**Buds** embryonic stems enclosed in scale-like leaves called bud scales.



# Plant Biology Basics, Plant Parts

**Bud scale scars.** Scales form protective coverings over immature leaves and sensitive growing tips (buds) at the outer most points of branches.

Scars are left behind when the scales from last year's terminal bud dropped off as new leaves expanded in the spring and the twig grew throughout the season."



# Short Summary

In MN turf grass is classed a cool-season species.

In scientific classification the scientific name is a binomial, consisting of Genus and species.

Cultivar is a contraction for cultivated variety.

Cultivar names are set off with single quotes and the first letter is capitalized.

# Quick Questions

How many scientific names are there for single species?

*One*

Name some plant organs

*Stems, leaves, roots, and reproductive*

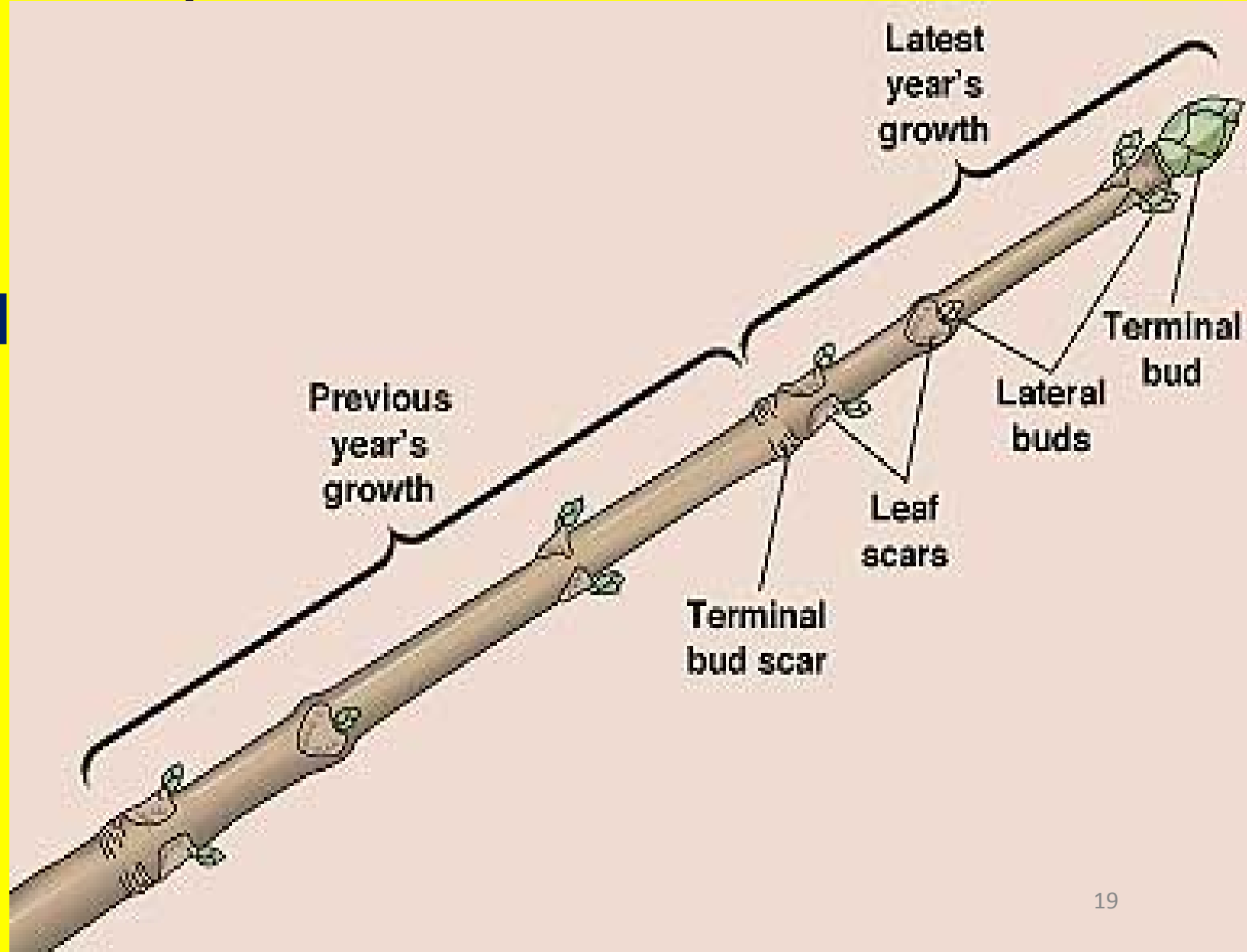
What is the attachment point for a leaf on a stem?

*A node*

# Plant Biology Basics, Plant Parts

The current year's growth is the distance from the terminal bud to and the first set of bud scale scars.

Buds along the stem are called lateral or axillary buds.



# Plant Biology Basics, Plant Parts

**Meristems** are rapidly growing plant tissue.

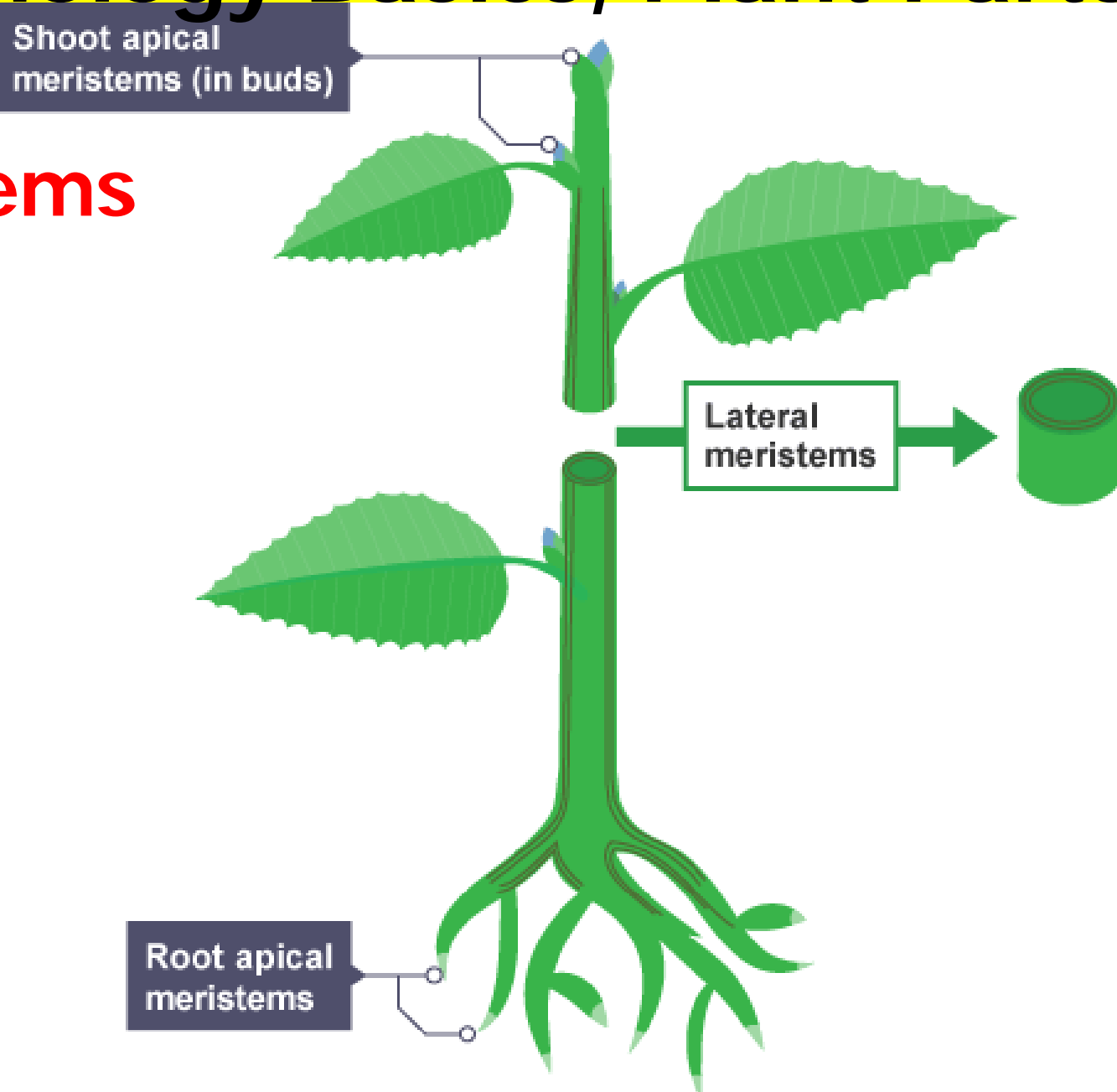
**Apical meristems** at the growing tip of the shoot.

**Secondary meristems** also called **lateral meristems**, increase diameter.

**Marginal meristems** are located near nodes and areas of leaf attachment. They are common in monocots like grasses and regenerate the grass leaf blade after cutting.

# Plant Biology Basics, Plant Parts

## Meristems



# Plant Biology Basics, Plant Parts

**Xylem and phloem** are the two types of plant conductive tissue.

Xylem conducts water and dissolved minerals from the roots upward only.

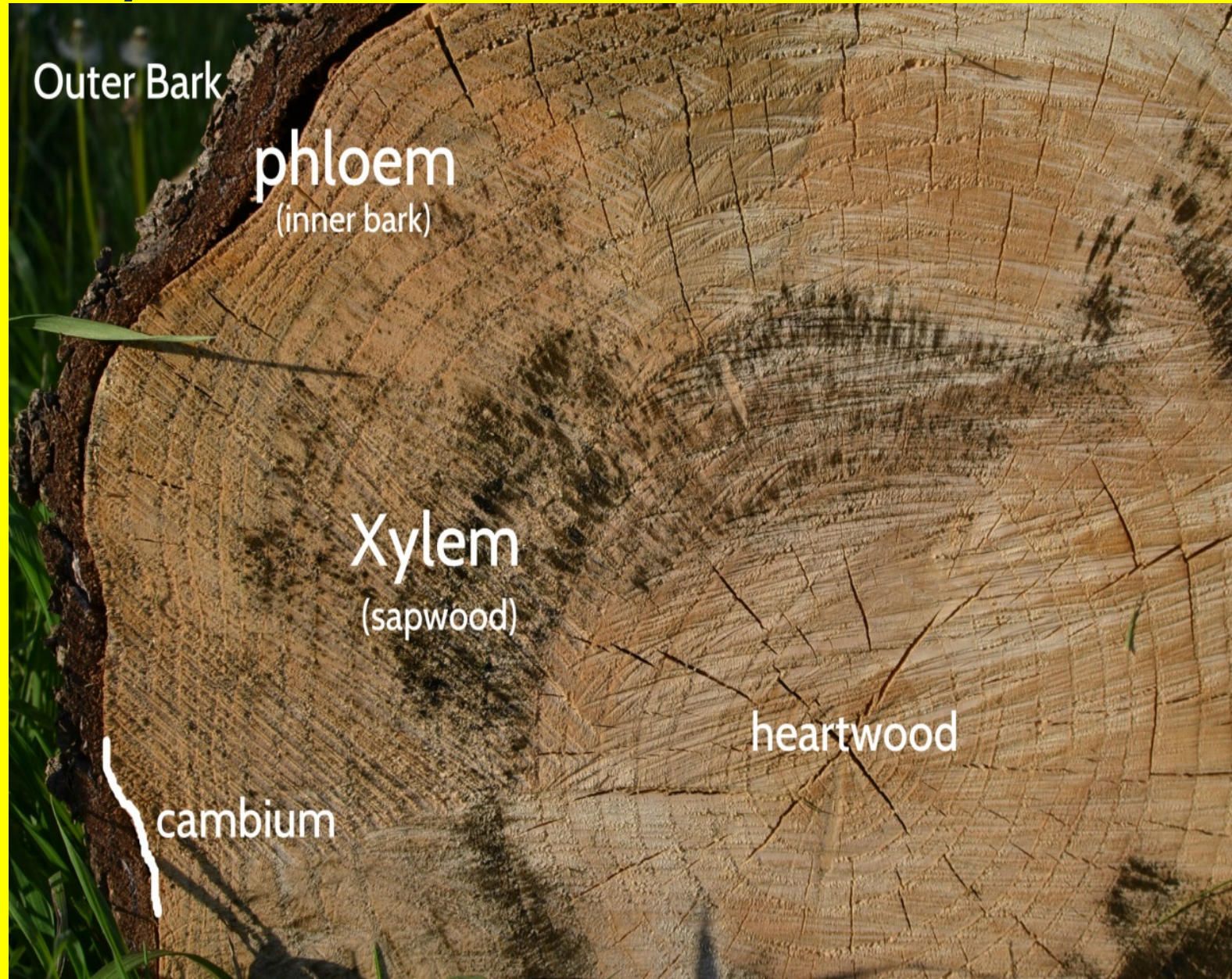
Xylem is also referred to as sapwood.

**Translocation** is the movement of water and nutrients through the organs of the plant.

# Plant Biology Basics, Plant Parts

## Phloem

Phloem conducts sugars and other metabolic products from the leaves. Movement is upward and downward



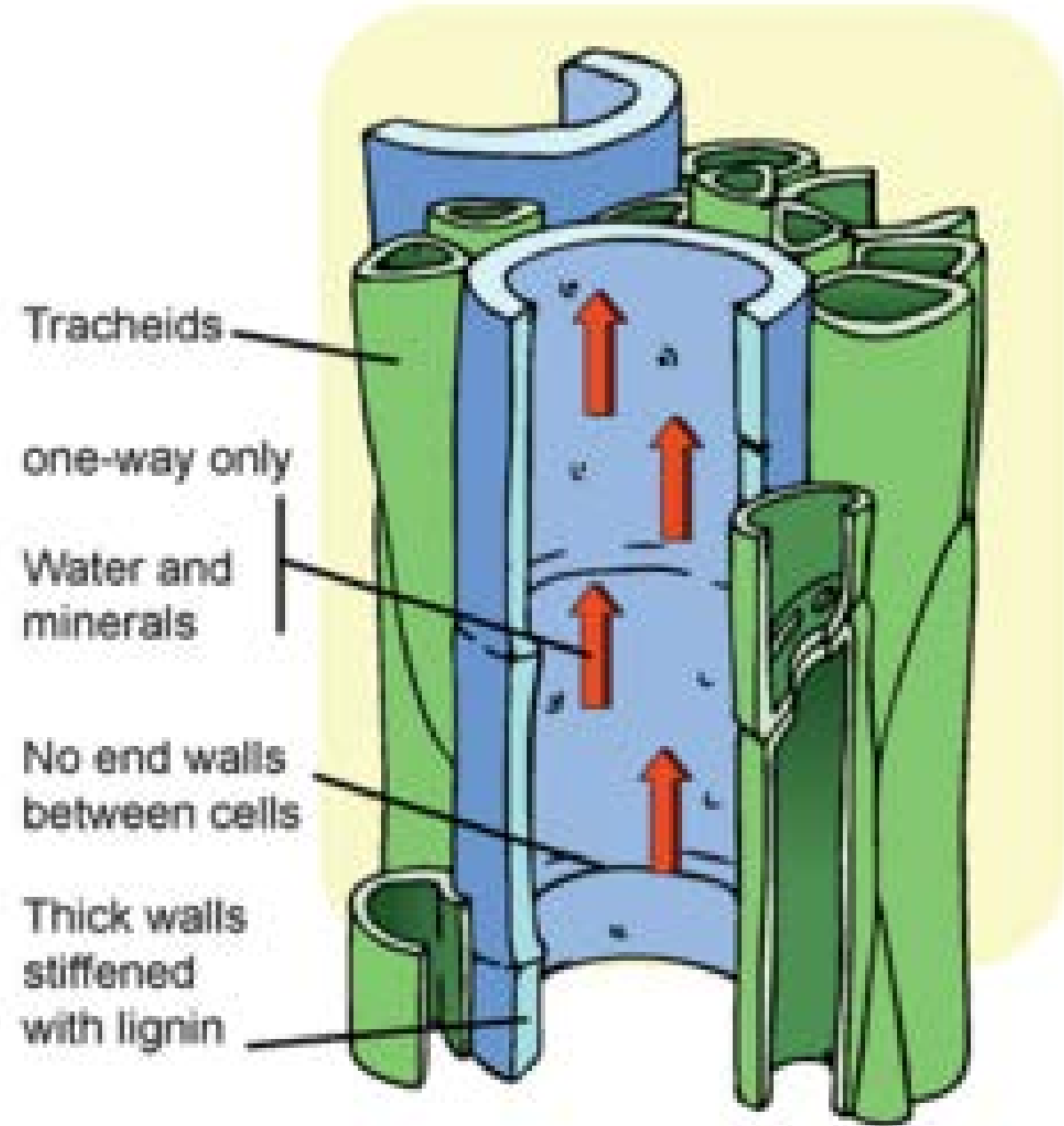
# Plant Biology Basics, Plant Parts

## Xylem

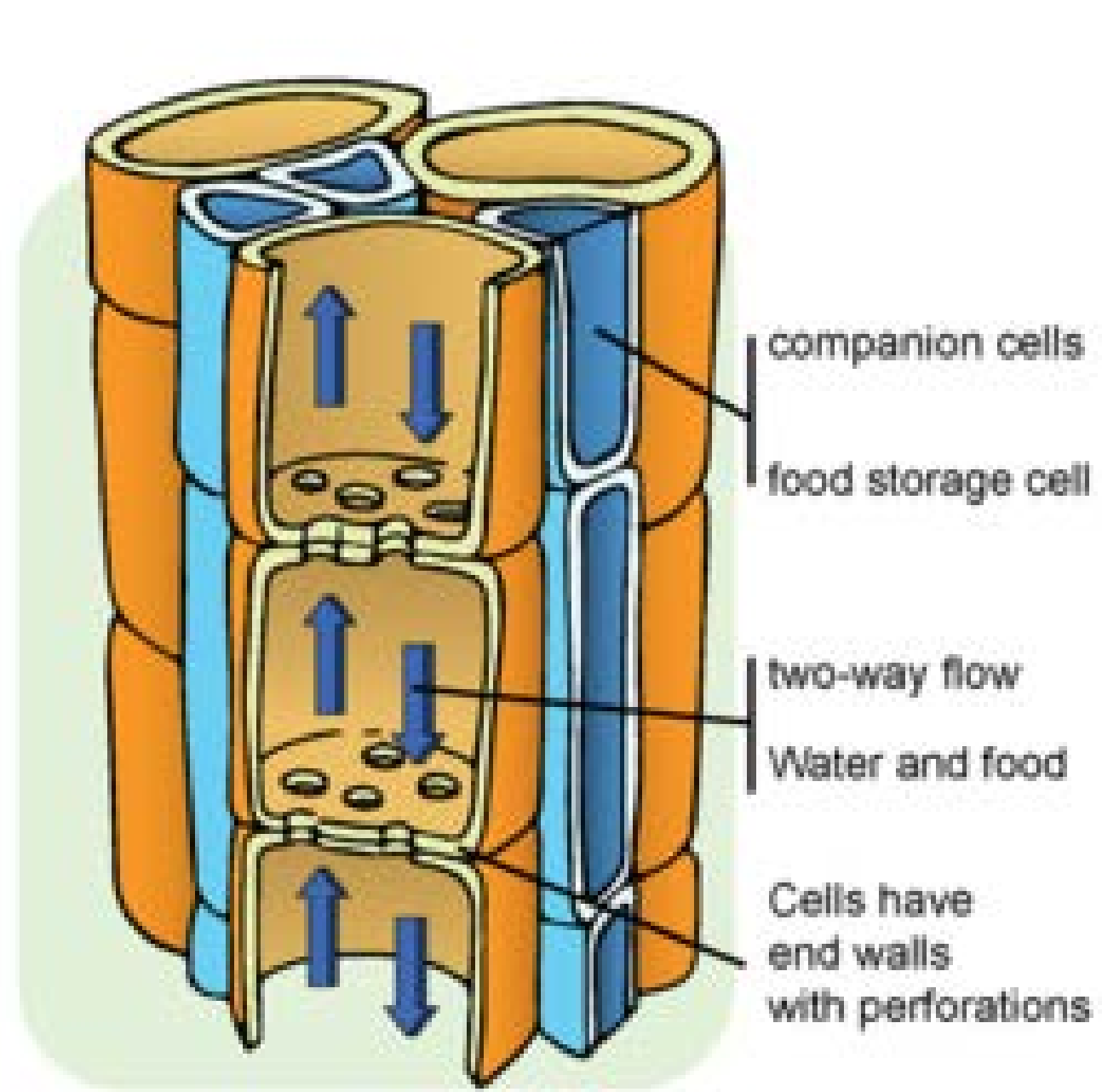
**Girdling** is removal of a strip of bark including phloem, cambium , and sometimes part of the xylem.







**Xylem vessel**



**Phloem vessel**

# Plant Biology Basics, Plant Parts

## Cambium

- The **cambium** is a layer or zone of cells, one cell thick, inside the inner bark.
- The cambium produces both the xylem and phloem cells.
- This is where diameter growth occurs and where rings and inner bark are formed.

# Short Summary

**Xylem conducts water and minerals upward.**

**Phloem conducts sugars upwards and downwards.**

**The cambium produces xylem and phloem cells.**

# Quick Questions

What are the two plant conducting tissues

*Xylem and phloem*

What occurs in regions of Meristems?

*Rapidly growing plant tissue*

Where does diameter growth occur?

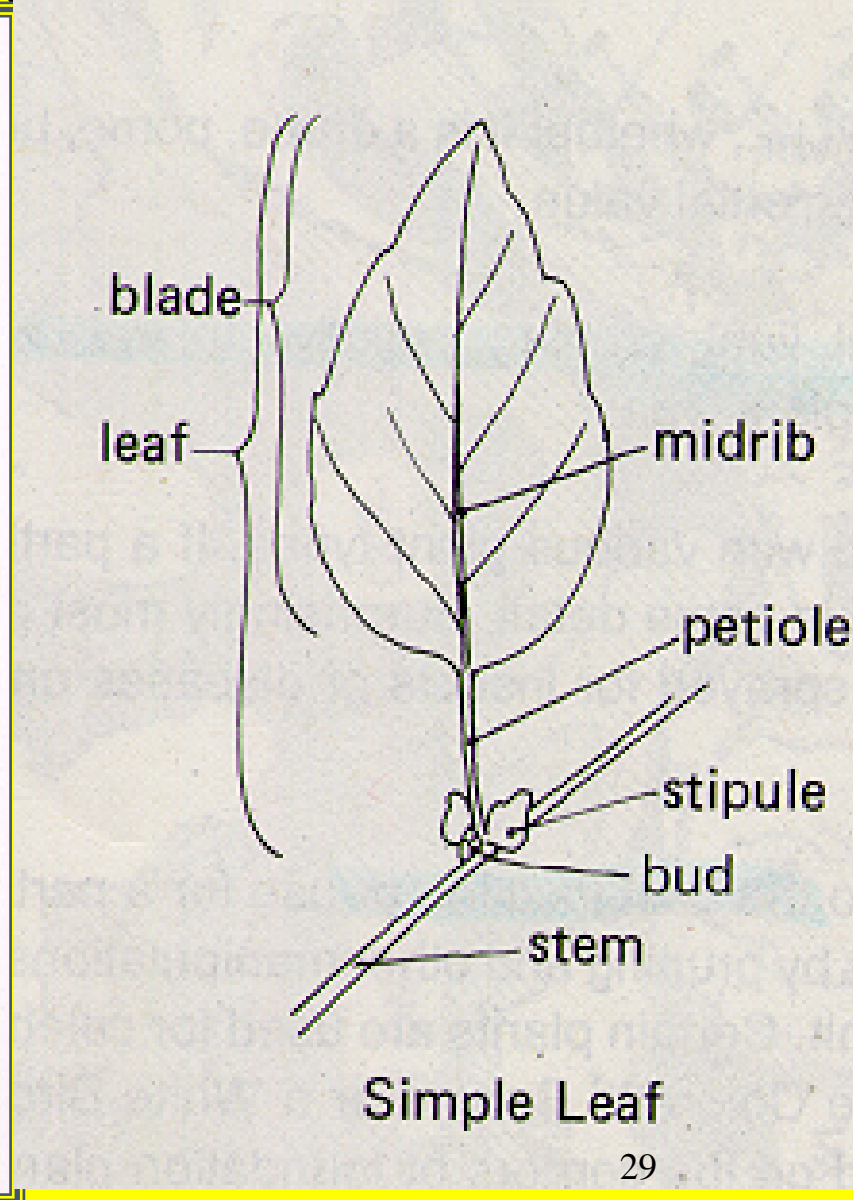
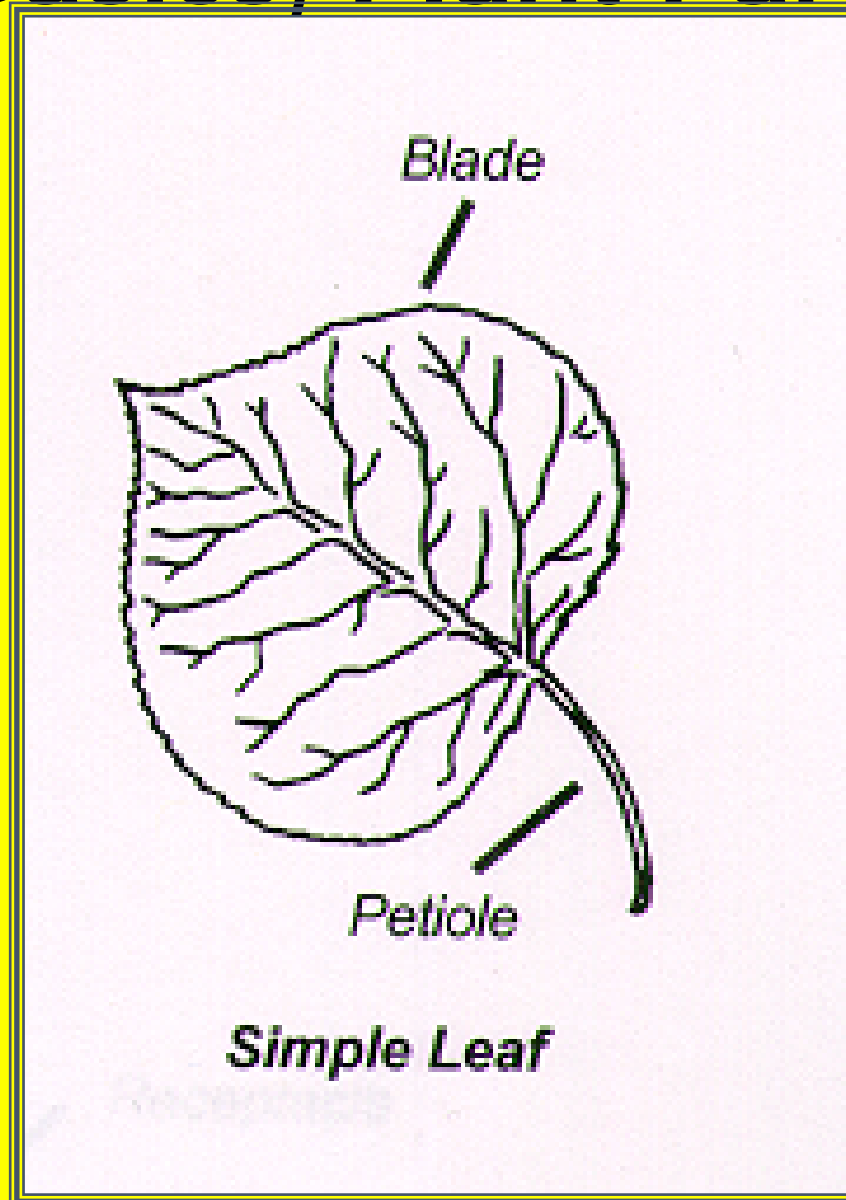
*In the cambium*

# Plant Biology Basics, Plant Parts

## Leaves

A simple leaf

- Blade
- Petiole
- Stipule

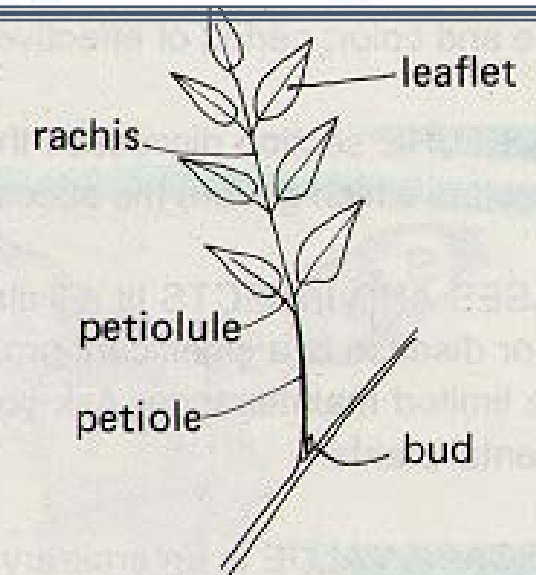
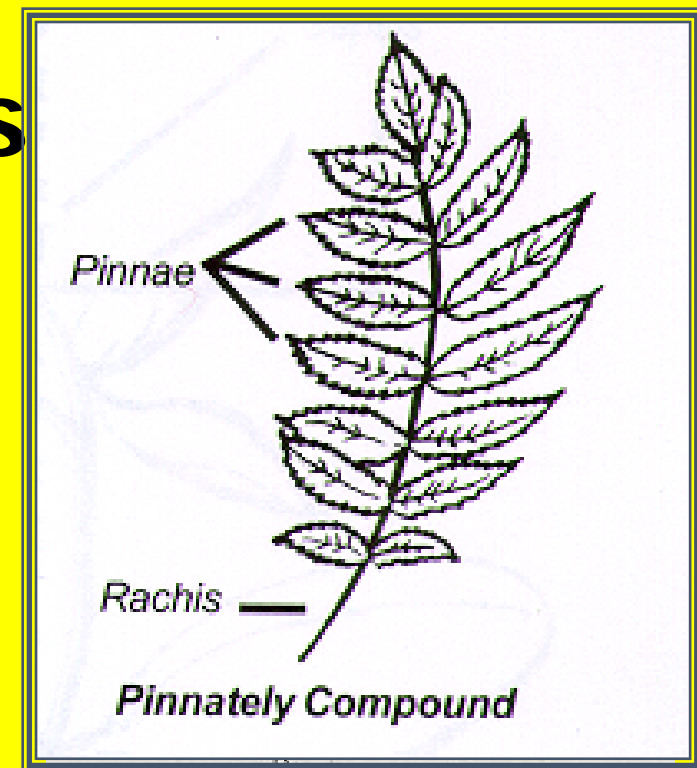


# Plant Biology Basics, Plant Parts

## Leaves

### Leaf types:

1. *A simple leaf* has one attach point to the stem.
2. *Compound leaves* have two or more leaflets arising from the attachment point to the stem.



Pinnately Compound Leaf

# Plant Biology Basics, Plant Parts

## Leaf arrangements



**Opposite**



**Whorled**



**Alternate**

# Plant Biology Basics

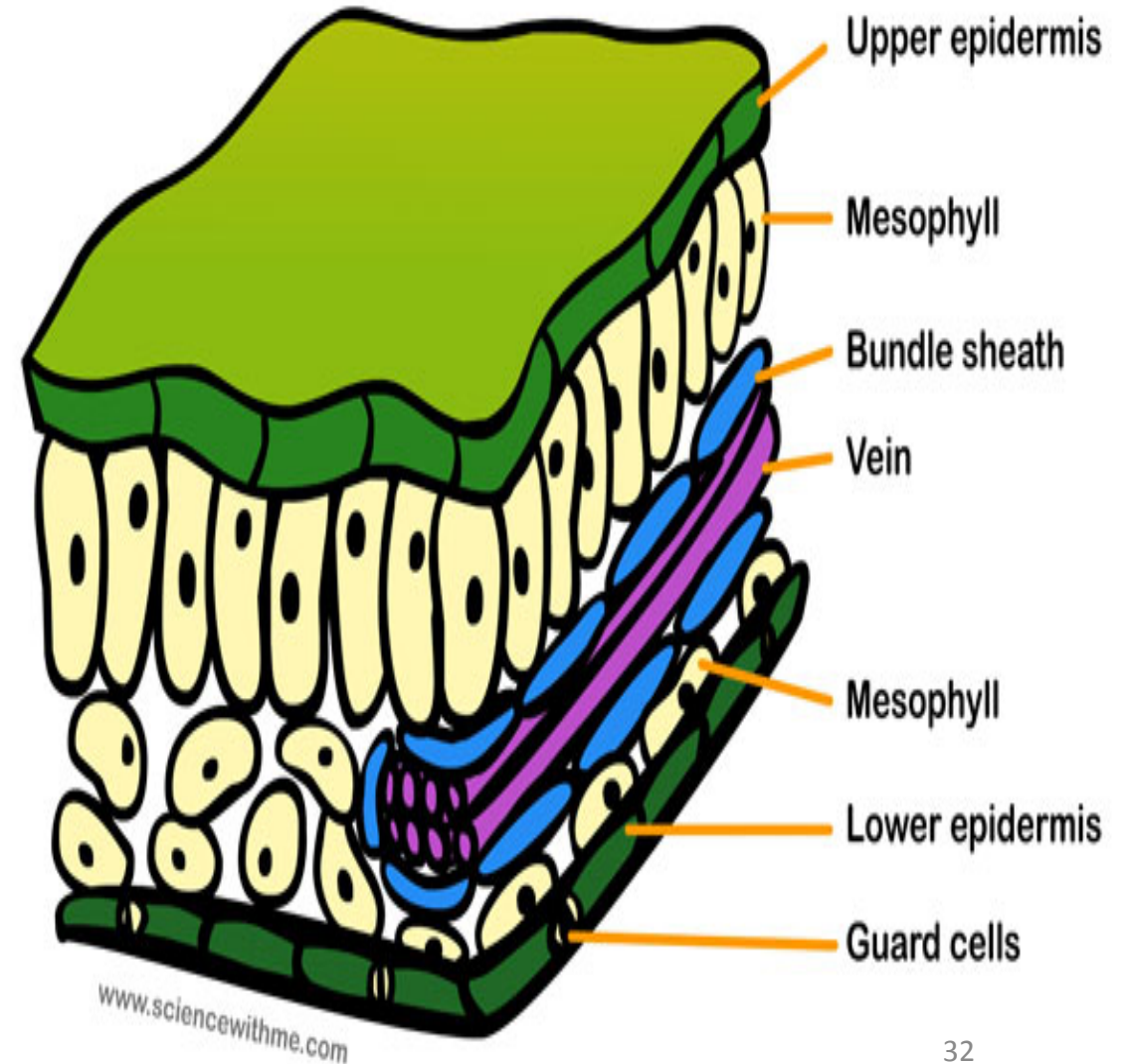
## Leaves

The **epidermis** the outer part of the leaf covered by a waxy cuticle.

The area between the upper and lower epidermis is the **mesophyll**.

The mesophyll has veins that contain xylem and phloem, chloroplasts for photosynthesis and air spaces for gas exchange.

## CROSS SECTION OF A LEAF





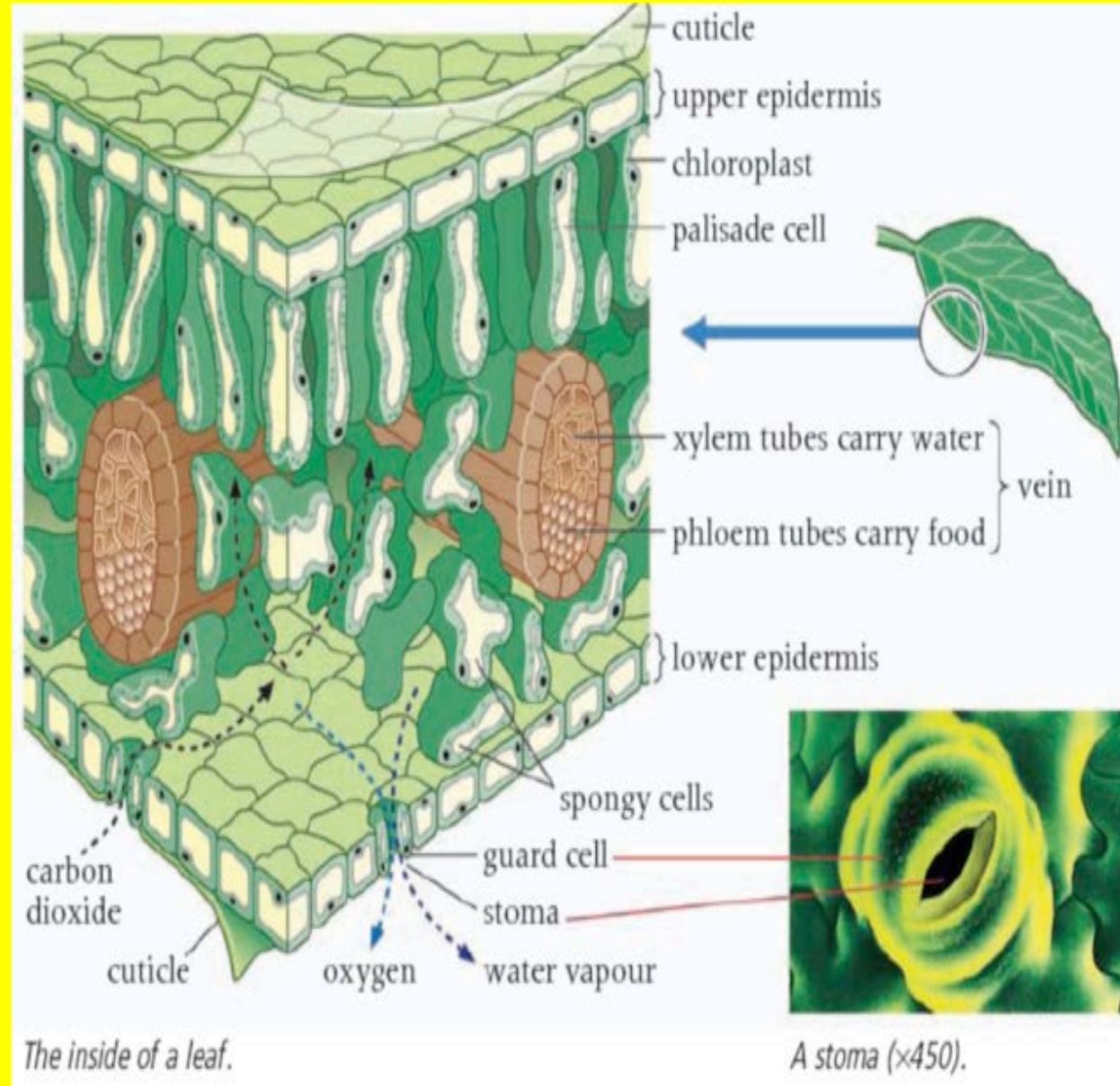
# Plant Biology Basics, Plant Parts

## Leaves

The **stomata** provide points for gas exchange and permit the movement of water vapor.

**Guard cells** regulate the function of the **stomata**, opening and closing for gas exchange.

**Cuticle** the outermost layer of the upper and lower epidermis.



# Plant Biology Basics, Plant Parts

## Leaves

When applying contact herbicides the leaves are the primary target.

**Epidermis** an outer protective layer or layers of cells in the leaves covered with waxy layers called the **cuticle**

The cuticle can affect the ability of pesticides to penetrate the plant.

# **Plant Biology Basics, Plant Parts**

## **Roots**

**The root is an organ.**

**Roots anchor and support the plant.**

**Stores carbohydrates from the leaves to be translocated through the plant for spring growth.**

# Plant Biology Basics, Plant Parts

## Roots

**Translocation** is the movement of water and nutrients through the organs of the plant.

**Plant organs include**

Roots

Stems

Leaves

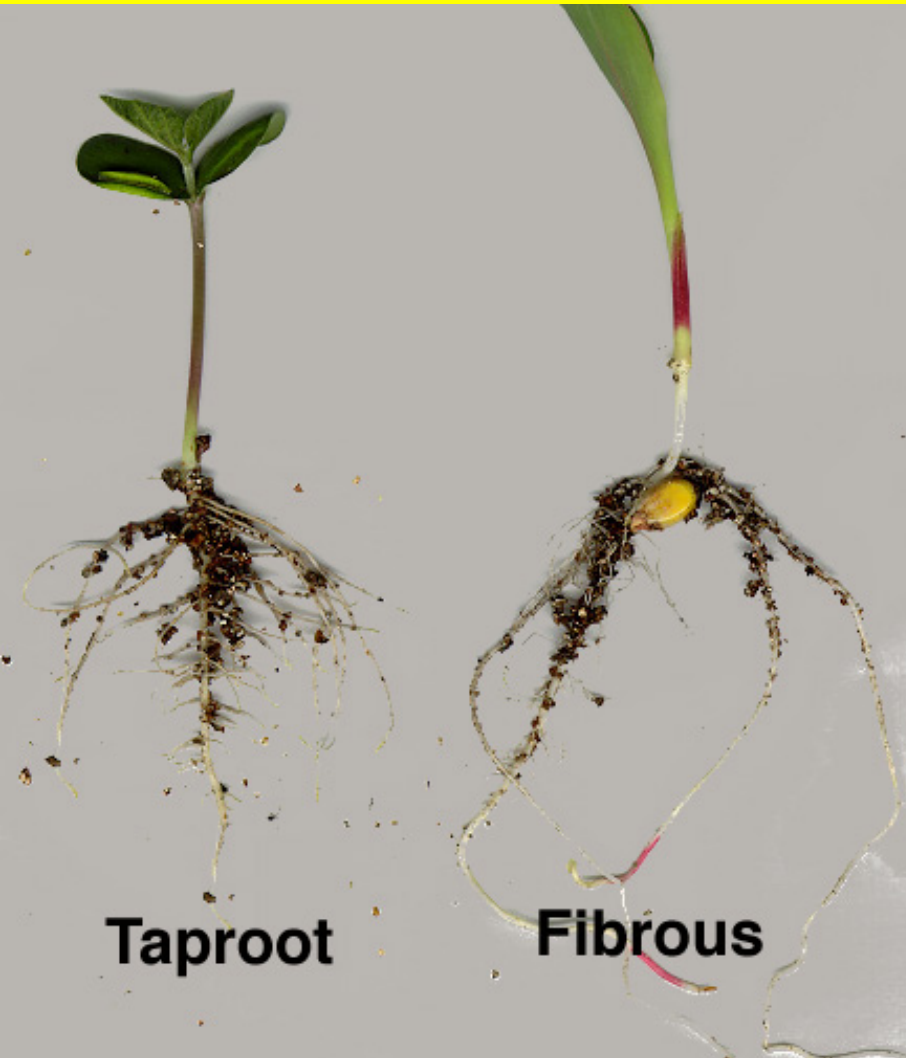
# Plant Biology Basics, Plant Parts

## Root systems

Root systems most turfgrasses and common nursery plants have a fibrous root system as opposed to a taproot

**Taproot**, one main root from which branch roots extend. Tap roots penetrate deeper into the soil the fibrous roots.

**Fibrous roots**, many branching roots.



# Plant Biology Basics, Plant Parts

## Rhizome

An underground stem that spreads to produce new aboveground shoots.

Many invasive plants have rhizomes.

Some rhizomes have thickened areas for storage e.g. potato. The potato tuber is technically a modified underground stem produced at the tip of a rhizome.

# Plant Biology Basics, Plant Parts

## Rhizomes

Examples of  
rhizomatous plants

a. Lily of the valley

b. Quackgrass



# Plant Biology Basics, Parts

The function of the flowers is to attract pollinators.

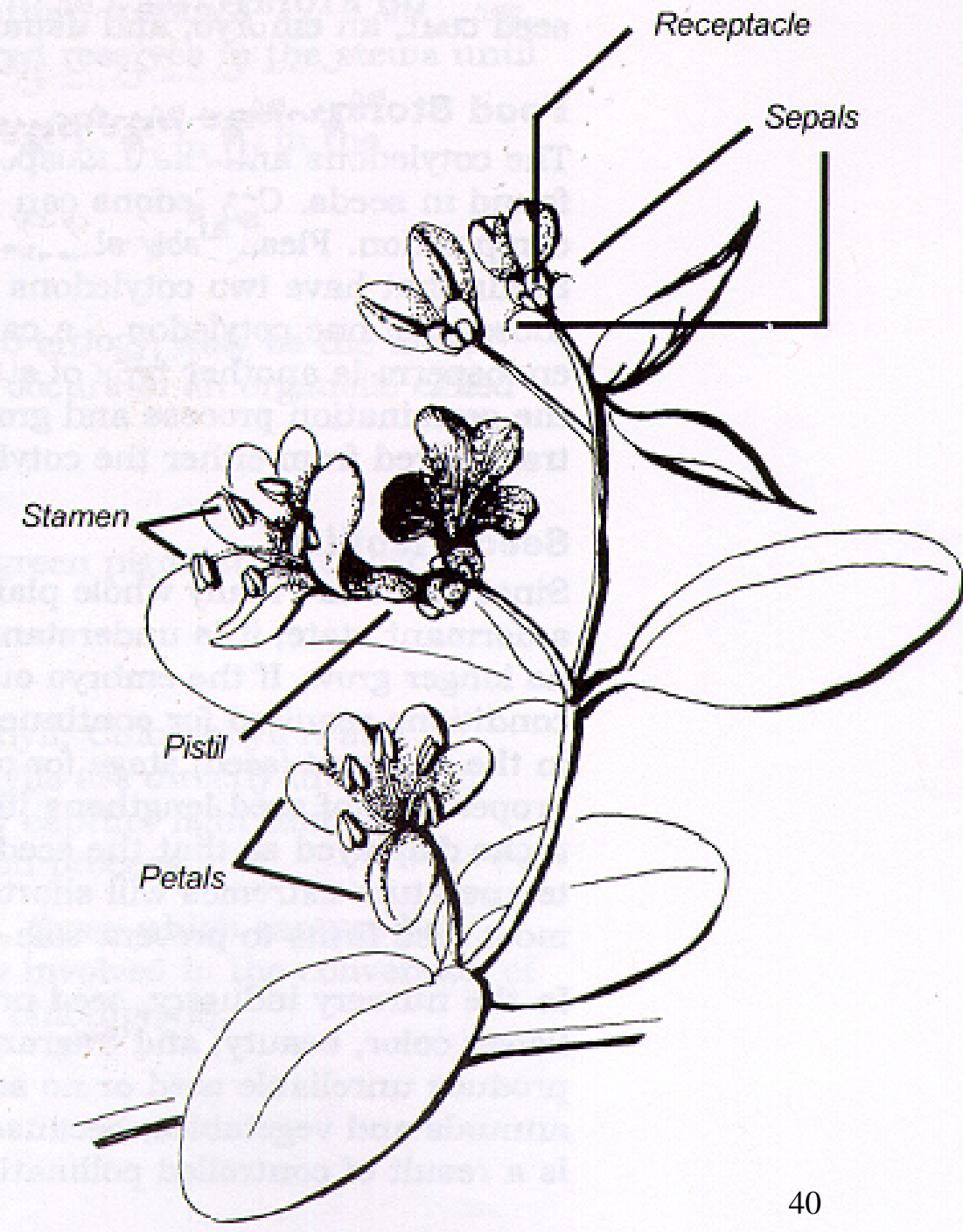
**Flower** the reproductive organ of angiosperms

Typical flower parts

**Pistil** is the female part of the flower.

**Stamens** are the male parts of flowers.

There are perfect, monoecious, dioecous plants.





# **Short Summary**

**The epidermis is a protective layer of cells covered by the cuticle.**

**The cuticle can affect the ability of pesticides to penetrate the plant.**

**The mesophyll is a layer between the upper and lower epidermis containing chlorophyll.**

**The rhizome is an underground stem.**

# Quick Questions

What are the two types of root systems?

*Taproot and fibrous*

What is translocation?

*The movement of water and nutrients through the organs of the plant*

What are the two leaf types?

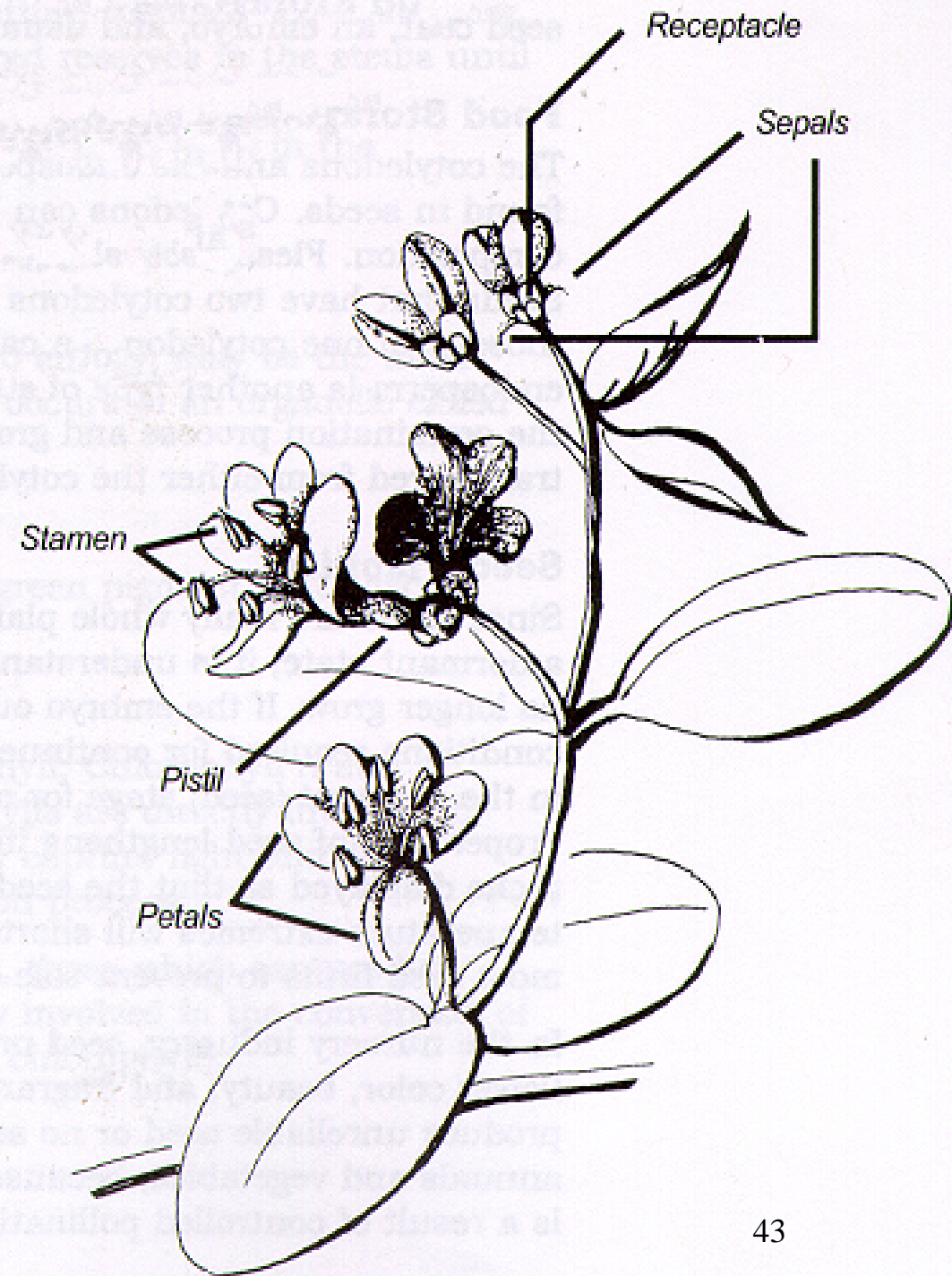
*Simple and compound*

# Plant Biology Basics, Parts

## Typical flower parts

**Sepals** are modified leaves, usually green, that surround the petals.

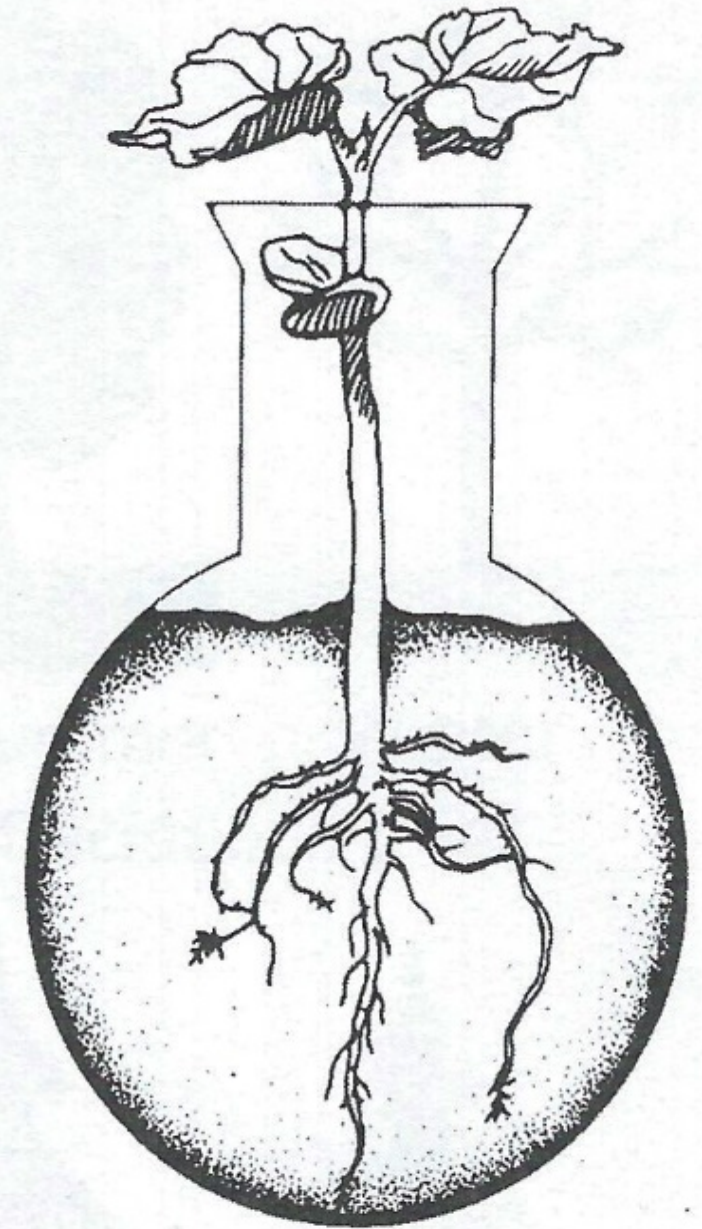
**Petals** are showy, white or colored to attract pollinators.



# Plant Biology Basics, Plant Parts

## Adventitious roots

**Adventitious roots** arise from certain stem tissue if separated from the plant or if injury occurs



Adventitious Root

# Plant Biology Basics, Plant Parts

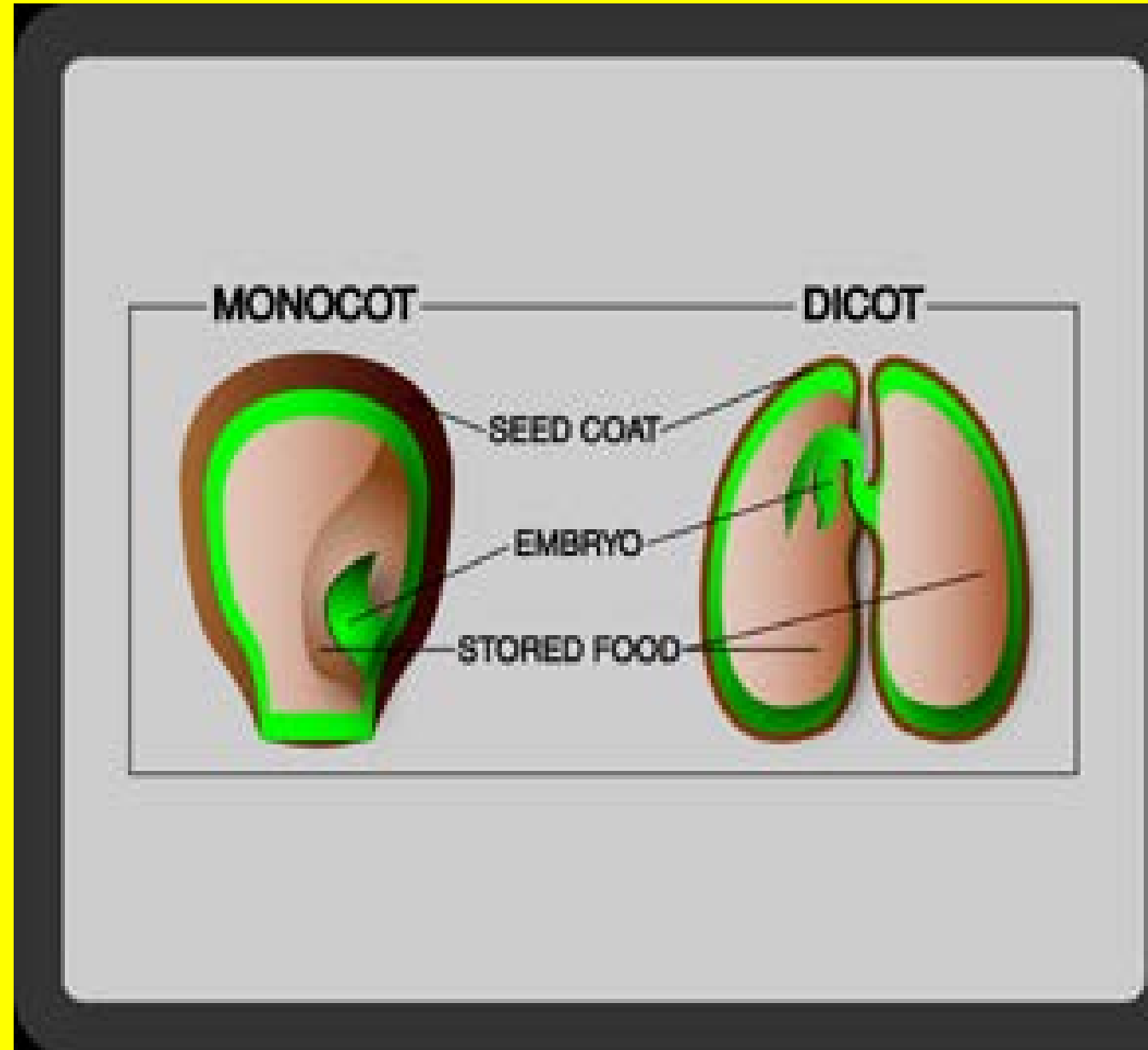
## Fruit and seed

In botany *fruit* means a ripened ovary.

*Seed* consists of  
Seed coat

dormant embryo

Stored food called  
endosperm.



# Plant Biology Basics, Growth Cycles

## Growth Cycles

Plants are classified by their life cycles and growth habits.

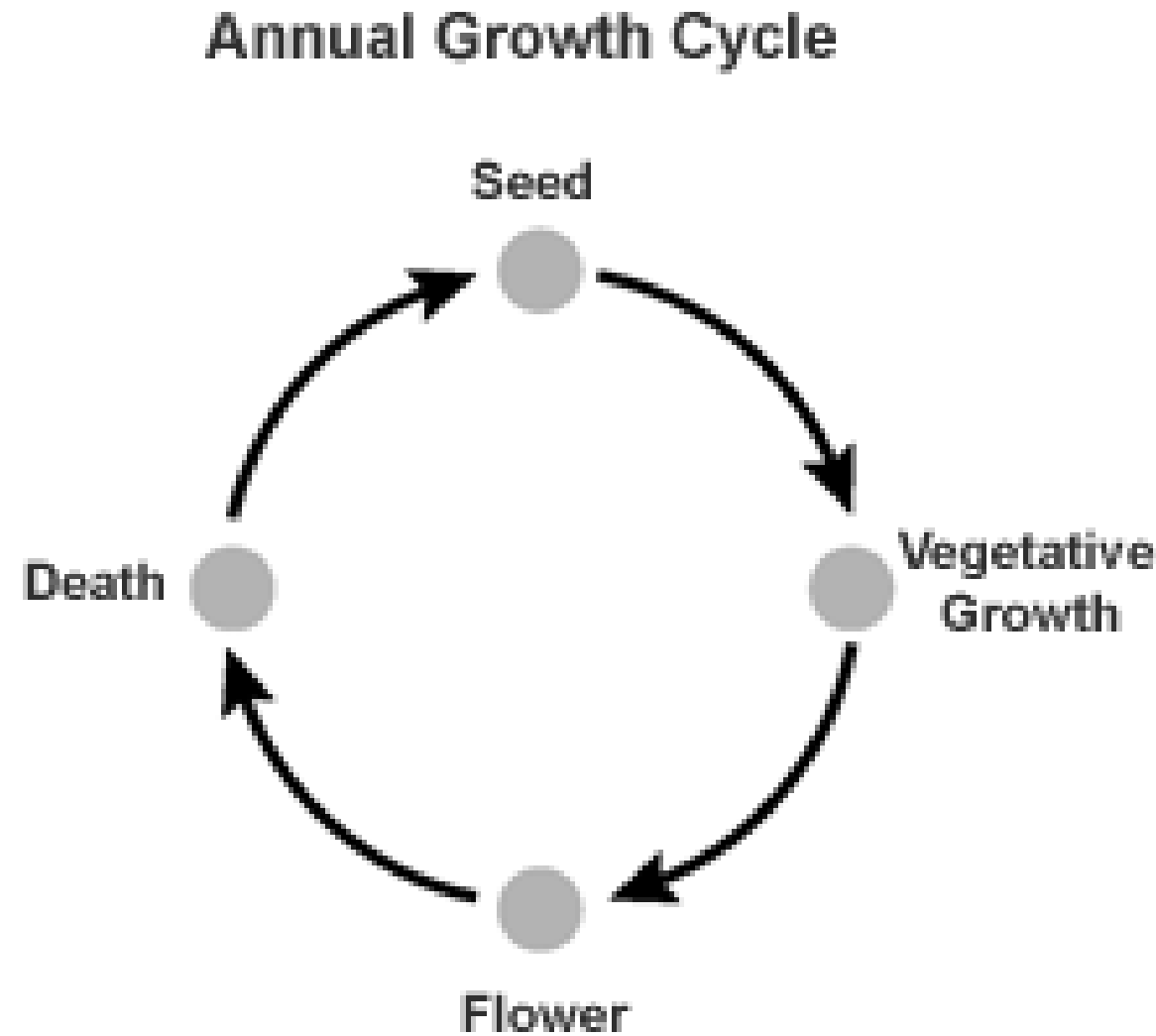
Plant Type	Growth Cycle
Annual	< 1 year
Biennial	> 1 and $\leq$ 2 years
Perennial	> 2 years

# Plant Biology Basics, Growth Cycles

## Growth cycles

**Annual.** A plant that completes its lifecycle in one year. e.g., cereal grains, marigolds, petunias, etc.

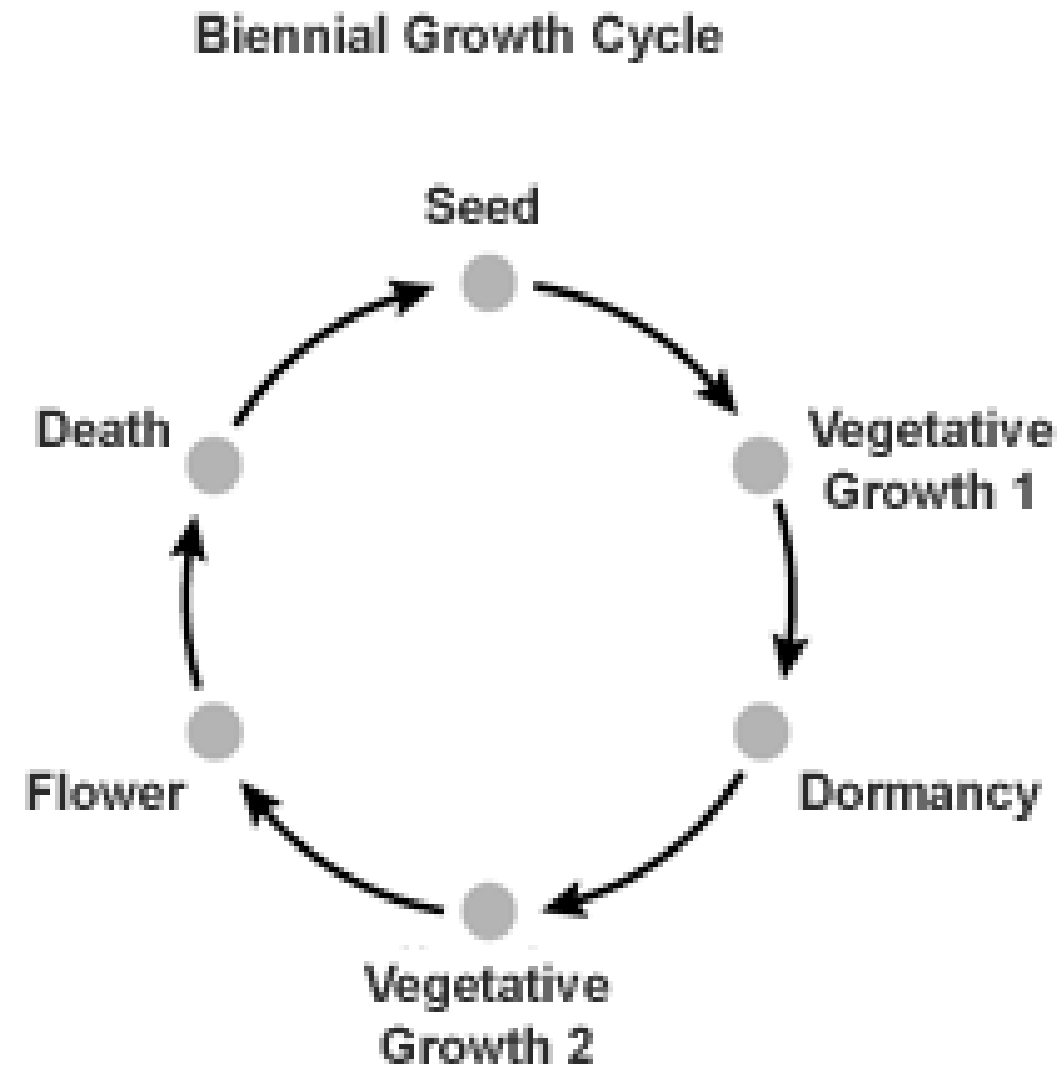
**Winter annuals** germinate in early winter and bloom in late winter or spring



# Plant Biology Basics, Growth Cycles

**Biennial.** A plant are plant that requires two growing seasons to complete its life cycle.

During the first year the plants undergo vegetative growth and often produce a rosette. e.g., foxgloves, hollyhocks, and garlic mustard.





# Plant Biology Basics, Growth Cycles

## Growth cycles

**Perennial** A plant that survives from year to year. Perennials can be herbaceous e.g., hostas or woody e.g., maple, pines, rhododendrons. Woody perennials are categorized based on height and growth habit.

**Deciduous** plants lose their leaves at the end of each growing season.

**Conifers** lose their old needles every 3 years.

# **Short Summary**

**The pistil is the female part of the flower.**

**The stamen is the male part of the flower.**

**Adventitious roots arise from stem tissue.**

**In botany, fruit means ripened ovary.**

# Quick Questions

**What is the growth cycle of an annual?**

*An annual completes its life cycle in one year*

**What is the growth cycle of a biennial?**

*A biennial goes through two growing seasons.*

**What is the growth cycle of a perennial?**

*A perennial live through more than two growing seasons.*

# Plant Biology Basics, Reproduction

## Sexual Reproduction

Hybrid vigor the tendency of a crossbred individual to show characteristics superior to both parents

Plant growth and development involves many chemical and physiological processes, which are controlled by **environmental factors** such as: light water, temperature, oxygen, and carbon dioxide.

# Plant Biology Basics, How Plants Grow

## Seed germination

The embryo utilizes food stored in the cotyledons and endosperm, water, oxygen, a required temperature range, and sometimes light to germinate. If the conditions are met the seedling is now self-sustaining.



# Plant Biology Basics, Reproduction

## Sexual Reproduction

**Pollination.** The sexual propagation of a plant, resulting when pollen (sperm) enters the pistil (ovary) of a flower.

Sexual propagation combines the characteristics of the parents resulting in an hybrid offspring different from each parent.

Sexual reproduction is an integral part of the process of evolution.

# Plant Biology Basics, Reproduction

## Asexual Reproduction

New plants can be started from adventitious root or shoot pieces cuttings.

*Stolons* are stems on the top of the ground that form adventitious roots at nodes and are called runners, strawberries

*Rhizomes* are underground stems that form adventitious roots at nodes and are called pips, lily of the valley, iris.

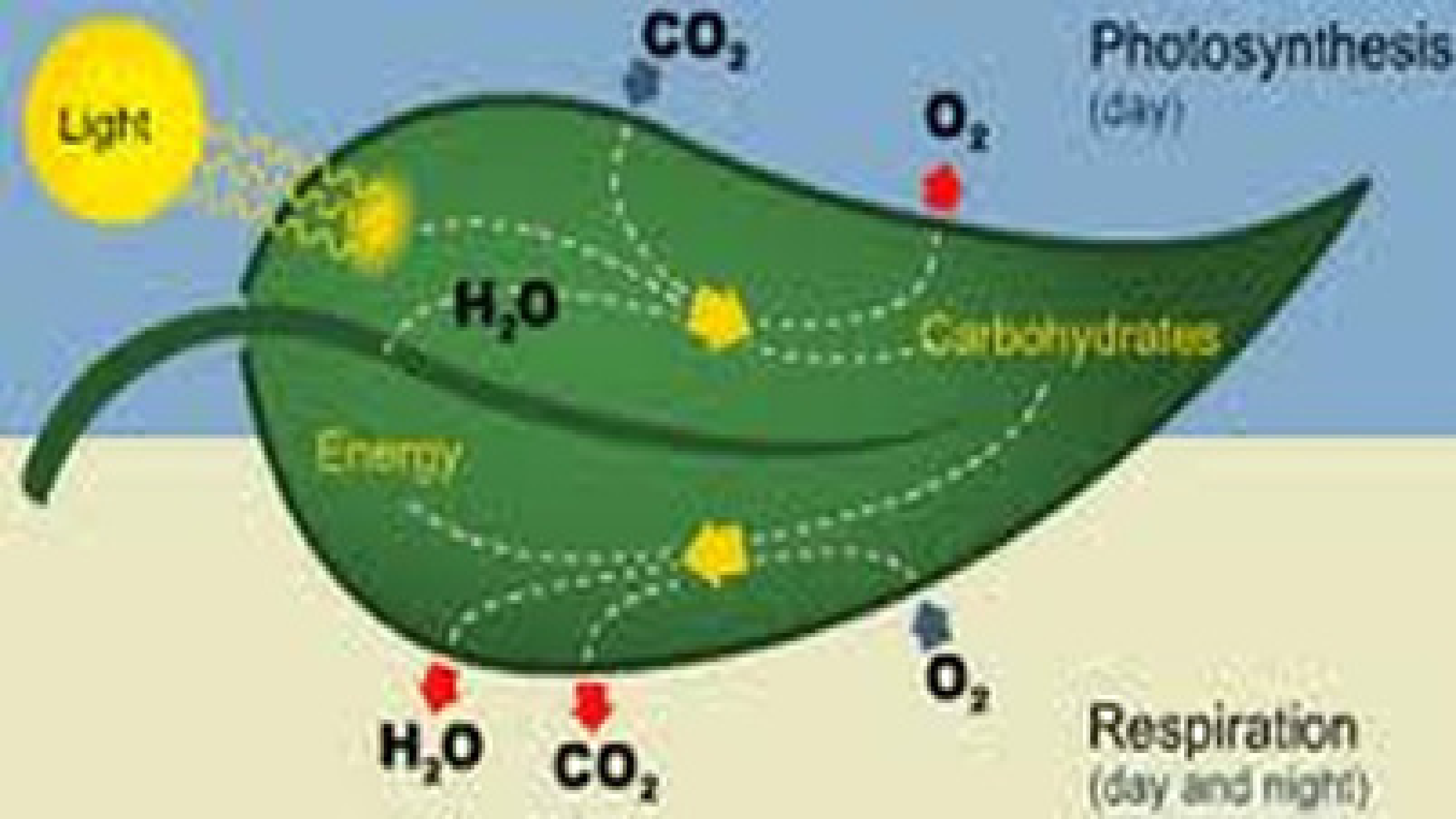


# Plant Biology Basics, How Plants Grow

## Photosynthesis

The process by which green plants use sunlight to synthesize food from carbon dioxide and water.





Light

$CO_2$

Photosynthesis  
(day)

$O_2$

$H_2O$

Carbohydrates

Energy

$H_2O$

$CO_2$

$O_2$

Respiration  
(day and night)

# Plant Biology Basics, How Plants Grow

**Aerobic Respiration** is the process by which the plant releases energy from stored sugars and starch.

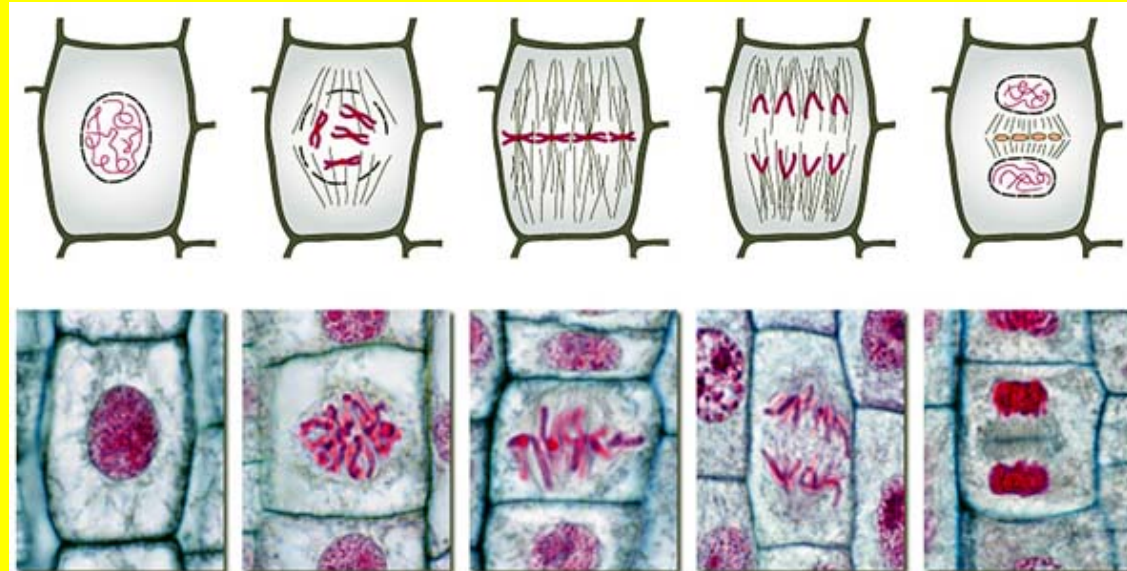
It is called aerobic because oxygen from the air is required.

Plants constantly undergo aerobic respiration.

# Plant Biology Basics, How Plants Grow

**Growth** occurs through cell division, cell enlargement, and cell differentiation.

**Cell division** occurs in the root and shoot meristems increasing above ground height and the root system.



# Plant Biology Basics, How Plants Grow

## Meristems

**Apical meristems** found in growing tips produce elongation

**Secondary or lateral meristems** found in stems produce increase in diameter

**Marginal meristems** forming leaf blades—  
regenerate plant parts lost to activities such as mowing

# Plant Biology Basics, How Plants Grow

## Cell division

The first stage of cell growth is cell division. Cell Division occurs in the marginal meristems and produces

Leaves

Buds

Adventitious roots

# Plant Biology Basics, How Plants Grow

The second stage of plant growth is **cell elongation**. Cells can enlarge in all dimensions but also can enlarge in one dimension resulting in elongation (length) or diameter (girth).

The third stage of plant growth is **cell differentiation**. Differentiation in plants refers to the processes by which distinct cell types arise from precursor cells and become different from each other. The structure or function of differentiated cells are specialized for a particular function.

# Short Summary

**What is hybrid vigor?**

*Hybrid vigor is the tendency of a hybrid to show characteristics superior to both parents.*

**What is pollination?**

*Pollination is the sexual propagation of a plant.*

**What increases the diameter of a plant?**

*Cell division and enlargement*

# Quick Questions

**How does growth occur?**

*Through cell division, elongation and differentiation*

**Where does elongation occur?**

*Elongation occurs at the apical meristems.*

**What is aerobic respiration?**

*Aerobic respiration is the release of energy from stored sugars and starches.*



# Plant Biology Basics, How Plants Grow

**Plant growth hormones** are substances produced by the plant to regulate and control its growth.

These chemicals are active at very low concentrations and can be translocated from where they are produced to where they are needed.

# **Plant Biology Basics, How Plants Grow**

## **Plant growth requirements**

**Nutrients**

**Water/humidity**

**Light**

**Temperature**

**Air**

# Plant Biology Basics, How Plants Grow

## Nutrients

There are three primary nutrients, also called *macronutrients*, nitrogen, phosphorus, and potassium.

**Nitrogen** has a major role in plant growth, development and is responsible for the dark green plant color

# Plant Biology Basics, How Plants Grow

Generally nitrogen-containing fertilizer will be used to sustain vigorous growth

**Nitrate nitrogen** which is soluble and not tightly bound by the soil. In sandy soil or with excessive moisture nitrates can leach below the root zone or converted to a gas and be lost to the atmosphere.

**Ammonium nitrogen** can be converted to gas and be lost to volatilization.

# Plant Biology Basics, How Plants Grow

## Nutrients

**Phosphorus** is important for early root growth and vigor.

Minnesota adopted a phosphorus lawn fertilizer law to prevent excess phosphorous in turf applications from polluting ground waters.

# Plant Biology Basics, How Plants Grow

## Nutrients

**Potassium** is important for plant growth and survival. Potassium helps the plant tolerate heat and cold stress. Potassium deficiencies in soil can lead to higher incidence of diseases, reduced tolerance to environmental stress, and more pest problems.

Potassium movement in soil varies by soil type, coarse texture soils are most prone to potassium leaching.

# Plant Biology Basics, How Plants Grow

## Secondary macro-nutrients

Secondary macro-nutrients may be available in some soils but may need to be supplemented in other soils.

Calcium

Magnesium

Sulfur

# Plant Biology Basics, How Plants Grow

## Micronutrients

micronutrients are found in lower quantities in plant tissues. The essential micronutrients are

- Boron
- Chlorine
- Copper
- Iron
- Manganese
- Molybdenum
- Zinc
- Nickel?



# Short Summary

**Nitrogen has the primary role in plant growth and development..**

**Too much or too little water stresses plants and increases pressure from pests and diseases.**

**Soil testing will help determine the need for macro-nutrients, secondary macro nutrients, and the need for supplemental fertilizer.**

# Quick Questions

**What are the three macronutrients need by plants?**

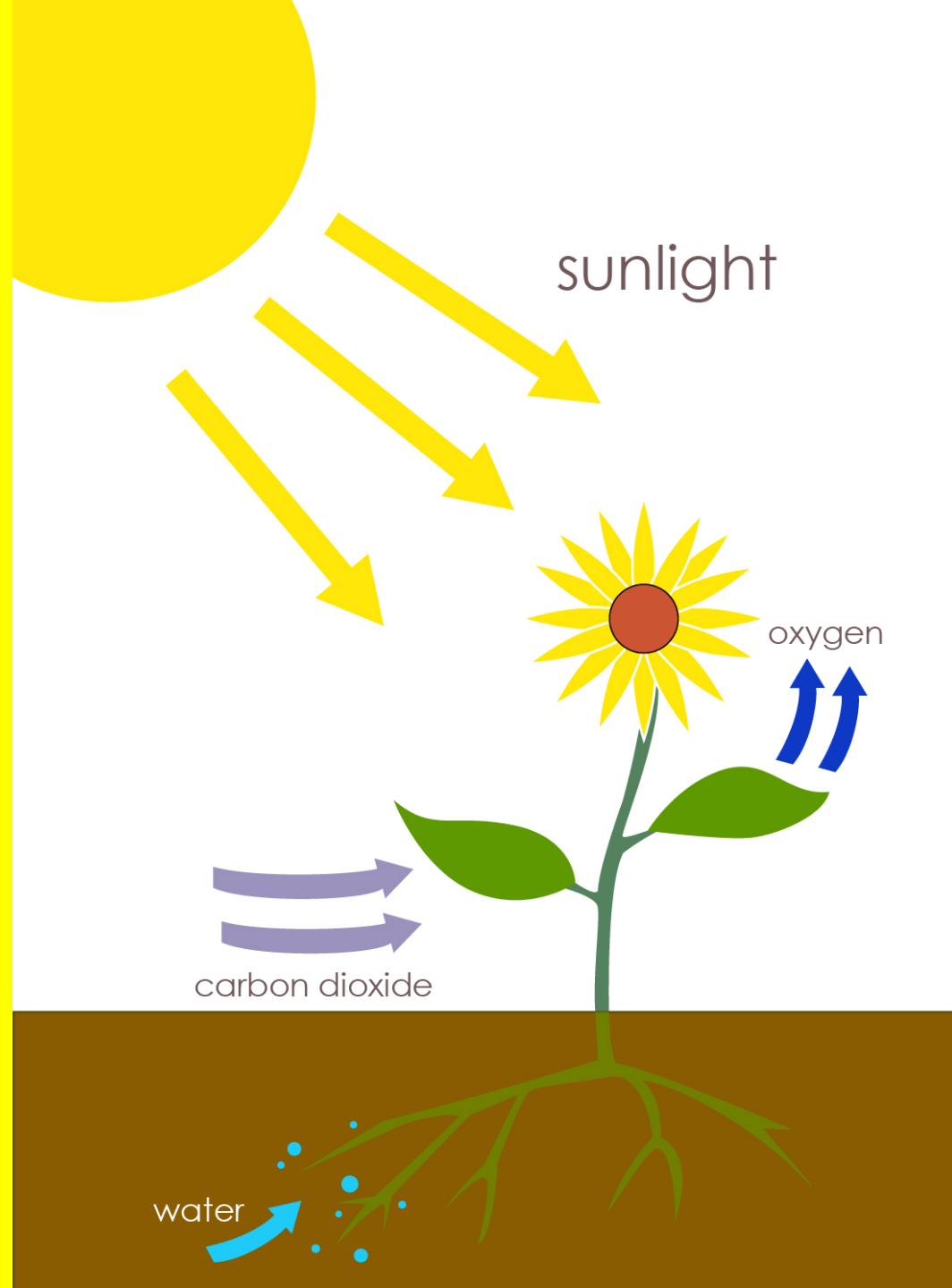
*Nitrogen, Phosphorus and potassium*

**What are the two types of nitrogen in fertilizer?**

*Nitrate and ammonium nitrogen*

**What is relative humidity?**

*The measure of the amount of moisture in air.*



# Plant Biology Basics, How Plants Grow

## Light

Light is required for *photosynthesis*.

Different plant species have different requirements for the number of hours of sunlight required for optimal growth.

# **Plant Biology Basics, How Plants Grow**

## **Temperature**

**Temperature influences a number of plant processes such as blooming and dormancy.**

**Germination is directly related to temperature.**

**Low soil temperatures limit nutrient and other chemical uptake.**

**Soil temperatures can also be used to determine the timing of preemergence herbicides and fertilizers.**

# **Plant Biology Basics, How Plants Grow**

## **Air**

**Air is required for aerobic respiration of all plant cells.**

**Air circulation and soil aeration are important.**

**Wind can damage or dry out plants.**

**Greenhouses require ventilation.**

# Plant Biology Basics, How Plants Grow

## Selective herbicides

Selective herbicides control certain types of plants.

The herbicide 2,4-D will control broad leaf weeds dicots, but not grasses, monocots. Other selective herbicides will control grasses.

Broadleaf plants have broad, flattened leaves with netted veins, dandelions and roses .

# **Plant Biology Basics, Influences on Pesticide Application Success**

## **Growth cycle**

**Knowledge of the plant growth cycle is useful in selecting when weeds are the most susceptible to herbicide application.**

**Applying herbicide to an annual weed that has already gone to seed is ineffective.**



# Plant Biology Basics, Influences on Pesticide Application Success

## Growth cycle

Select a time when weeds are the most susceptible to herbicide application.

Applying herbicide to an annual weed that has already gone to seed is ineffective.

Some weeds best controlled prior to emergence.

Track soil temperatures to determine when crab grass reaches , 55 degrees F, the temperature for germination.

# **Plant Biology Basics, Influences on Pesticide Application Success**

## **Leaf penetration**

**Some leaf shapes have a larger surface area which provides more area for herbicide penetration**

**If the cuticle of the leaf epidermis is waxy, the herbicide contact/penetration will be reduced.**

**Surfactants may improve leaf absorption**

# **Plant Biology Basics, Influences on Pesticide Application Success**

## **Targets for herbicides**

**Meristems are areas of active growth and are therefore good targets for herbicides.**

**Systemic pesticides will be translocated to growing points where they will cause the most injury.**

# **Plant Biology Basics, Influences on Pesticide Application Success**

## **Pesticide Transportation and Translocation**

**Pesticides can enter plants below ground through the roots and above ground through the leaves.**

**Since plants store food as carbohydrates the best time for pesticide treatment for many perennials is in the fall when plants are translocating herbicides to the roots. This helps with long term control.**

# Short Summary

**Light is required for photosynthesis.**

**If the cuticle of the leaf epidermis is waxy, the herbicide contact/penetration will be reduced.**

**Broadleaf plants have broad, fattened leaves with netted veins.**

**Pesticides can enter plants below ground through the roots and above ground through the leaves.**

# Quick Questions

**When is the best time to apply a herbicide to perennials?**

*In the fall when plants are storing carbohydrates.*

**What is the soil temperature when crab grass should be treated with herbicide?**

*55 degrees F*