

# AP Biology Plants Notes Barron's

## CLASSIFICATION OF PLANTS

### I. **Bryophytes**- non-vascular plants

Ex: mosses, liverworts, hornworts

### II. **Tracheophytes**- vascular plants

#### A. **Seedless plants**- reproduce via spores

#### B. **Seed plants**

##### 1. **Gymnosperms**- cone-bearing

Ex: cedars, sequoias, redwoods, pines, yews, and junipers

##### 2. **Angiosperms** (Anthophyta)- flowering plants

Ex: roses, daisies, apples, and lemons

###### a) **Monocotyledon**

Ex: grasses (corn, wheat, rye, oats)

###### b) **Dicotyledon**

Ex: peanuts

## BRYOPHYTES

- primitive plants
- lack transport vessels (xylem & phloem)
- absorb water from diffusion through air
- flagellated sperm must swim through water to fertilize egg
- lack lignin-formed tissue; cannot grow vertically and are restricted to moist habitats
- grow on rocks, soil, and trees
- exhibit alternation of generations

## TRACHEOPHYTES

- plants with vascular tissue
- tracheophyte characteristics:
  - Xylem and phloem for transport

- Lignified transport vessels to support the plant
- Roots absorb water while also anchoring and supporting the plant
- Leaves increase photosynthetic surface
- Life cycle with a dominant sporophyte generation
- 2 groups of tracheophytes: seeds and seedless
- With seeds are far more advanced and more numerous than w/o seeds

#### Ferns- Seedless Plants

- ferns are the most widespread seedless tracheophytes
- reproduce via spores
- **homosporous**- produce one type of spore which develops into a bisexual gametophyte
- have vascular tissue and can grow to be several feet tall
- still are restricted to moist habitats (sperm still have to swim to fertilize)

#### Seed Plants

- **heterosporous**- produce two kinds of spores: megaspores and microspores
  - **Megaspores**- develop into female gametophytes
  - **Microspores**- develop into male gametophytes
    - sperm of seed plants have no flagella
    - do not require moist environment to fertilize
- two types of seed plants: gymnosperms and angiosperms

#### *Gymnosperms: The Conifers*

- first seed plants to appear on Earth
- seeds are not enclosed in fruit
- exposed seeds on modified leaves that form cones...better adapted to dry environment
  - needle shaped leaves
    - thick, protective cuticle
    - relatively small surface area
- depend on wind for pollination
- ex: pines, firs, redwoods, junipers, sequoia

#### *Angiosperms: The Flowering Plants*

- reproductive structures are flowers and fruits
- most diverse plant species
- 90% of all plants
- ovary becomes fruit
- ovule becomes seed
- fruits protect dormant seeds and aid in dispersal
- two groups: monocots and dicots

Characteristic	Monocot	Dicot
Cotyledons (seed leaves)	One	Two
Vascular bundles in stems	Scattered	In a ring
Leaf venation	Parallel	Netlike
Floral parts	Usually in 3s	Usually in 4s or 5s
Roots	Fibrous Roots	Taproots

#### STRATEGIES THAT ENABLED PLANTS TO MOVE TO LAND

- **Cell wall**
  - made of cellulose
  - lend support to cells that must maintain shape
- **Roots and root hairs**
  - absorb water and nutrients from the soil
- **Stomates**
  - open to exchange photosynthetic gases
    - release O<sub>2</sub>
    - absorb CO<sub>2</sub>
  - close to minimize excessive water loss

- **Cutin**
  - waxy coating on leaves
  - helps prevent excessive water loss from leaves
- **Gametangia**
  - protective jacket of cells
  - forms around gametes and zygotes
  - prevents drying out
- **Sporopollenin**
  - a tough polymer
  - resistant to almost all kinds of environmental damage
  - protects plants in harsh terrestrial environment
  - found in walls of spores and pollen
- **Seeds and pollen**
  - means of dispersing offspring
  - include a protect coat which prevents desiccation
- gametophyte generation has been reduced
- Xylem and Phloem vessels enable plants to be tall
- Lignin embedded in xylem and other plant cells provides support

#### PRIMARY AND SECONDARY GROWTH

- **meristem**- tissue which continually divides and generates new cells; the reason why plants continue to grow for as long as they live
- **Primary growth** = elongation of the plant down into the soil and up into the air
- **Apical meristem** is the source of primary growth; located at the tips of roots and buds of shoots
- **Lateral meristem** provides **secondary growth** which is increase in girth
- \*non woody plants only have primary growth\*
- **woody plants**- secondary growth is responsible for the gradual thickening of shoots and roots formed from earlier, primary growth

## PLANT TISSUE

- three types of tissue:
  - dermal tissue
  - vascular tissue
  - ground tissue

### *Dermal Tissue*

- covers and protects the plants
- includes epidermis and modified cells (guard cells, root hairs, cells which produce waxy cuticle)

### *Vascular Tissue*

- consists of xylem and phloem
- these transport water and nutrients around the plants
- xylem up, phloem down

### *Xylem*

- water and mineral-conducting tissue
- consists of two types of elongated cells: tracheids and vessel elements
  - both types of cells are dead at functional maturity
- **tracheids**
  - long, thin cells that overlap and are tapered at the ends
  - water passes from one end to another through **pits**--areas with no secondary cell wall
  - secondary cell walls are lined with **lignin**
    - bc of this, they help function as a support system as well as carry water
- **vessel elements**
  - wider, shorter, thinner walled, and less tapered than tracheids
  - aligned end to end
  - ends of vessel elements are perforated to allow free flow of water through the vessel tubes (as opposed to unperforated tracheids)

- seedless vascular plants and most gymnosperms have only tracheids
- most angiosperms have tracheids and vessel elements
- xylem is what makes up wood

### *Phloem*

- carries sugars from photosynthetic leaves to rest of the plant via active transport
- phloem vessels consist of chains of **sieve tube members/elements**
- ends of these members/elements contain **sieve plates** which facilitate the flow of fluid from one cell to the next
- sieve tube members and plates are alive at maturity
  - they lack nuclei, ribosomes, and vacuoles
- each sieve tube member is connected to at least one companion cell
- **companion cells**
  - do not contain a full complement of cell organelles
  - nurtures the sieve tube elements

### *Ground Tissue*

- most common tissue type in a plant
- functions in support, storage, and photosynthesis
- **\*\*\*keep in mind form relates to function as a theme\*\*\***
- three types of cells:
  - parenchyma
  - collenchyma
  - sclerenchyma

### *Parenchymal Cells*

- classic plant cells
- primary cell walls are thin and flexible
- no secondary cell walls
- protoplasm contains one large vacuole
- the cell itself carries out most metabolic functions

- Parenchymal cells in leaves (mesophyll cells) contain chloroplasts and carry out photosynthesis
- Parenchymal cells in roots contain plastids and store starch
- most of these cells retain the ability to divide and differentiate into other cells types (stem cells) after the plant has been injured
- an entire plant can be regenerated from one parenchymal cell

#### *Collenchymal Cells*

- have unevenly thickened primary cell walls
- lack secondary cell walls
- while mature they are alive
- function is to support the growing stem

#### *Sclerenchymal Cells*

- have very thick primary and secondary cell walls
- fortified with lignin
- function is to support the plant
- two forms of these cells: fibers and sclereids
- fibers are long and thin and usually occur in bundles
- sclereids are short and irregular in shape
- make up tough seed coats and pits

## ROOTS

### *Function and Structure*

- three functions
  - **absorb nutrients** from soil
  - **anchor** the plant
  - **store food**
- specialized tissues and structures organized to carry out these functions:
  - **epidermis**
    - covers surface of root

- modified for absorption
    - **root hairs** (slender cytoplasmic projections) extend out from each cell and greatly increase absorptive surface area
  - **cortex**
    - consists of parenchymal cells which contain many **plastids**
    - stores starch and other organic substances
  - **Stele** (vascular cylinders)
    - consists of vascular tissue (xylem and phloem)
    - surrounded by one or more layers of tissue called **pericycle**
    - **pericycle** is where **lateral roots** arise
  - **Endoderm**
    - tightly packed layer of cells (**endodermis**) which surrounds vascular cylinder
    - **Casparian strip**- a continuous strip of **suberin** (waxy material which is impervious to water and dissolved minerals) which is wrapped around each endoderm cell
    - endoderm function is to select what minerals enter the vascular cylinder and body of the plant
- **Apical meristem**
  - located at the tips of roots
  - provides **primary growth** (elongation of plant into soil and up in the air)
  - three zones of cells at different stages of primary growth:
    - **zone of cell division**: meristem cells; actively dividing and responsible for producing new cells that grow down into the soil
    - **zone of elongation**: cells elongate; responsible for pushing root cap
    - **zone of differentiation**: cells undergo specialization into three primary meristems that give rise to three tissue systems
      - protoderm becomes epidermis
      - ground meristem becomes cortex



- procambium becomes primary xylem and phloem

### *Types of Roots*

- **taproot**- a single large root which gives rise to lateral **branch roots**
- in dicots, taproot is the primary root
- some taproots collect water deep in the soil
- others are modified for storage
- **fibrous root system** holds the plant firmly in place
- **adventitious roots**- roots that arise above ground
- **aerial roots**- stick up out of the water and serve to introduce air into the root cells
- **prop roots**- grow above ground and help support plant

## STEMS

### *Primary Tissue of Stems*

- **vascular bundles**: runs the length of the stem; strands of vascular bundles make up vascular tissue
- vascular bundle contains xylem on the inside, phloem on the outside, and meristem tissue in between
- monocot- vascular bundles are scattered throughout the stem
- dicot- vascular bundles are arranged in a ring around the edge of the stem
- stem ground tissue consists of **cortex** and **pith**...parenchymal tissues modified for storage
- apical meristem supply cells for plant growth; located at tips of shoots and roots

### *Secondary Growth in Stems*

- produced by **lateral meristem**
- it replaces epidermis with a second dermal tissue, usually one which is thicker and tougher, like bark
- a second lateral meristem adds layers of vascular tissue
- **wood** is secondary xylem that accumulates over time

## THE LEAF

- organized to maximize sugar production while minimizing water loss
- **epidermis** is covered by a **waxy cuticle** made of **cutin** to minimize water loss
- **Guard cells**
  - modified epidermal cells
  - contain chloroplasts
  - are photosynthetic
  - control the opening of stomates
- inner leaf consists of **palisade** and **spongy mesophyll** (photosynthetic)
- vascular bundles (veins) are located in mesophyll and carry water and nutrients from soil to the leaves; also carry sugar from leaves to rest of plant
- **bundle sheath cell**- specialized mesophyll cell, surround veins; separate from mesophyll

#### *Stomates*

- controlled by guard cells
  - guard cells change shape to open and close stomates
- 90% of water that leaves via transpiration escapes through stomates
- guard cell walls are not uniformly thick
- cellulose **microfibrils** help guard cells change shape
  - when guard cells full of water...they open (become **turgid**)
  - when guard cells lose water...they close (become **flaccid**)

## TRANSPORTATION IN PLANTS

### *Transport of Xylem*

- xylem fluid rises against gravity without energy
- pushed up by root pressure
- pulled up by transpirational pull (**transpiration** is the evaporation of water from leaves)
- **root pressure**
  - results from water flowing into the stele from soil as a result of high mineral content in the root cells

- **guttation**: the secretion of droplets of water from the pores of plants as a result of root pressure
- **transpirational pull**
  - transpiration causes negative pressure (tension) to develop in the xylem
  - **cohesion**-the sticking together of particles of the same substance
    - cohesion of water due to strong bonds between water molecules (H-bonds)
    - makes it possible to pull a column of water up the xylem
  - **transpirational pull - cohesion tension theory**
    - *for each molecule of water that evaporates from a leaf by transpiration, another molecule of water is drawn in at the root to replace it*
- factors which affect the rate of transpiration
  - high humidity (slows it down)
  - low humidity (speeds it up)
  - wind (can reduce humidity near stomates)
  - increased light intensity → increased photosynthesis → increased amount of water that must be transpired → increased rate of transpiration

## PLANT REPRODUCTION

### *Asexual reproduction*

- clone- **vegetative propagation**
- root, stem, or leaf of a plant produces an entirely new, genetically identical plant
- Ex: grafting, cutting, bulbs, runners

### *Sexual Reproduction in Flowering Plants*

- flower is the sexual organ of the plant
- fertilization begins with **pollination**
  - when one pollen grain lands on a flower's **stigma**
  - pollen must have 3 haploid nuclei (1 **tube nucleus** & 2 **sperm nuclei**)
- *Steps of Pollination*
  1. pollen grain absorbs moisture and sprouts...produces pollen tube

2. pollen tube burrows down the style into the ovary
  3. 2 sperm nuclei travel down the pollen tube into the ovary
  4. once inside, the 2 remaining sperm nuclei enter the ovule through the **micropyle**
  5. 1 sperm nucleus fertilizes the egg and becomes an **embryo**
  6. 1 sperm nucleus (the other one) fertilizes the **two polar bodies** and becomes the **triploid endosperm** (the food for growing the embryo)
    - a. This process is called **double fertilization**
  7. After fertilization:
    - a. ovule → seed
    - b. ovary → fruit
- food reserves remain in endosperm for monocots
  - food reserves move to **cotyledons** for dicots; mature dicot seeds thus lack endosperms

### *The Seed*

- Seed Parts:
  - **seed coat**
  - **embryo**
    - **hypocotyl**
      - becomes lower part of stem
    - **epicotyl**
      - becomes upper part of stem
    - **radicle**
      - aka **embryonic root**
      - first organ to emerge from germinating seed
  - cotyledon/endosperm

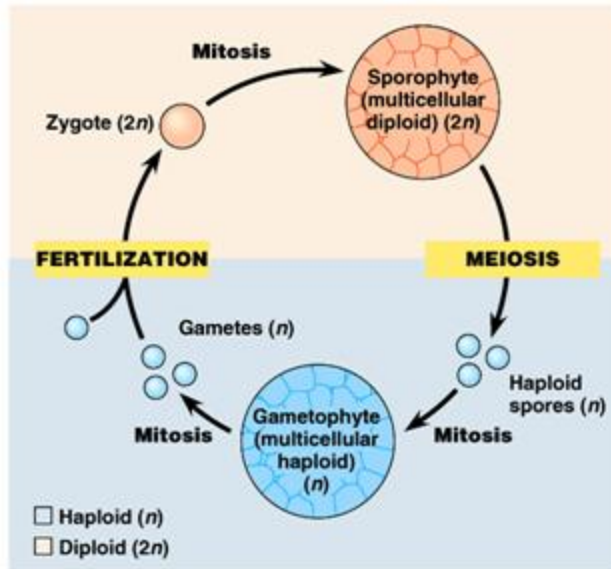
### *Dormancy and Germination*

- seed coat keeps water and oxygen away from embryo
- seed releases chemical that inhibit germination
- changes in environment cause a break in dormancy
- seed will germinate if:

- seed coat is damaged
- chemical inhibitors are removed
  
- Steps of Germination
  1. absorption of water (**imbibition**)
  2. force from imbibition with expand the seed and cause the coat to break
  3. seed undergoes metabolic changes and enzymes are activated
  4. RNA begins protein synthesis
  5. seed begins to use the carbohydrates, amino acids, and lipids stored in endosperm/cotyledon
  6. germination is complete once the radicle emerges from the seed coat

#### ALTERNATION OF GENES

- **alternation of genes** characterizes sexual life of plants
- **haploid** and **diploid** generations alternate with each other
- **gametophyte** produces gametes via mitosis
- gametes fuse during fertilization to yield  $2n$  zygotes
- each zygote develops into a **sporophyte** which produces haploid spores by meiosis
- each haploid spore forms a new gametophyte



## PLANT RESPONSES TO STIMULI

### *Hormones*

- help coordinate growth, development, and response to environmental stimuli
- produced in very small quantities but have a profound effect
- **signal transduction pathways** amplify the hormonal signal and connect it to specific cell responses
- hormones can have multiple effects on a plant
- can also work cooperatively with other hormones, or can oppose each other

#### 1. AUXINS

- responsible for **phototropisms** due to unequal distribution of auxin
- enhance **apical dominance**...the preferential growth of a plant upward
- stimulate stem elongation and growth by softening the cell wall
- Indoleacetic Acid (IAA)** is a naturally occurring auxin
- when used as rooting powder, causes roots to develop quickly in a plant cutting

#### 2. CYTOKININS

- stimulate cytokinesis and cell division
- Delay **senescence** (aging) by inhibiting protein breakdown

- c. are produced in roots and travel upward

### 3. GIBBERELLINS

- a. promote stem and leaf elongation
- b. 100 naturally occurring gibberellins have been i.d.-ed
- c. work with auxins to promote cell growth
- d. induce **bolting**, the rapid growth of floral stalk

### 4. ABSCISIC ACID (ABA)

- a. inhibits growth
- b. enables plants to withstand drought
- c. closes stomates during times of water stress
- d. counteracts the breaking of dormancy during winter thaw
- e. promotes seed dormancy

### 5. ETHYLENE

- a. is a gas
- b. promotes fruit ripening
- c. is produced in large quantities in times of stress (drought, flooding, etc.)
- d. facilitates **apoptosis**: programmed cell death
- e. promotes **leaf abscission**: the leaf dies and falls from the plant

### *Tropisms*

- growth of a plant towards or away from a stimulus
  - **thigmotropism**- touch
  - **geotropism**- gravity; results from auxins interacting with **statoliths** (specialized plastids containing dense starch grains)
  - **phototropism**- light; results from unequal distribution of auxins, accumulate on side of plant without light and causes growth
- **positive tropism**- growth towards a stimulus
- **negative tropism**- growth away from a stimulus

### *Photoperiodism*

- **photoperiod**- environmental stimulus used by plants to detect time of year; relative length of day and night
- **circadian rhythm**: biological, 24-hour clock set in a plant
- **photoperiodism**: physiological response to the photoperiod
- plants actually respond to length of darkness, not length of light
- **phytochrome**: photoreceptor responsible for keeping track of length of light and dark
- 2 types: **Pr** (red-light absorbing) and **Pfr** (infrared light absorbing)
- synthesized in Pr form; once exposed to light Pr converts to Pfr; in darkness Pfr reverts back to Pr

