BSCI124 Semester Notes
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Plant Diversity

Plant Systematics
- Common names (can be problem)
- Evolved over centuries/languages

Scientific Names
- **Genus:** similar plant species
- **Families:** Genera
- King David Came Over For Great Spaghetti (Taxonomic Hierarchy)
    - **Kingdom**
        - **Division**
            - **Class**
                - **Order**
                    - **Family**
                        - **Genus**
                            - **Species**

Species Name
- Single scientific name in Latin (binomal)
- Genus: first name
- Species: second name

6 Kingdoms
- Living Organisms
    - 3 Domains
        - Archaea
        - Eubacteria
        - Eurkaryota
    - 6 Kingdoms
        - Archaebacteria
        - Eubacteria (true)
        - Protists
        - Plantae
        - Fungi
        - Animalia

Plant Divisions
- There are ten
- Know four:
    - Bryophyta: mosses, liverworts
    - Pterophyta: ferns
    - Coniferophyta: conifers
    - Magnoliophyta: flowering plants

Species
- Set of individuals closely related by descent from common ancestor and can reproduce with one another, but not other species

- Groups of actually or potentially natural
- Morphological
- Biological
- Evolutionary
- Some species look very different
- Some look the same but due to **polyploidy (more than diploid # of chromosomes)** cannot interbreed

Carolus Linnaeus

- Swedish Scientist, "Father of Systematic Botany"
- Established binomal system of nomenclature
- Started sexual system of plant classification
- Risque Language

Evolution

- Genetic change in population of organisms that occurs over life time, often adapts to environment
- Must be genetically inherited, not acquired

Evolution of Evolutionary Thinking

- Lamarckism (later disproved)
    - French naturalist
    - Theory: organisms driven by some inner force toward greater complexity but thought it could pass acquired traits to offspring
- Charles Darwin
    - Publishes *On the Origin of Species by Means of Natural Selection* after trip around globe (most influential text of all time)
    - **Natural Selection**: differential survival and reproduction of individuals with inheritable characteristics (works on phenotype)
        - **Variation**
        - **Overproduction**
        - **Competition**
        - **Survival to reproduce**

Artificial Selection

- Selective breeding as practiced by humans on domesticated animals and plants (i.e. dogs; teosinte, modern corn, tomato)

Rates of Evolution

- Fossil record gives 2 interpretations about pace of evolution
    - **Gradualism** (traditional view): evolution occurs as a slow and steady accumulation of changes in organism
    - **Punctuated Equilibrium** (more support): evolution proceeds with periods of inactivity, followed by rapid evolution

Evidence for Evolution and Plant Adaptations

Evidence

- Three types of Natural Selection
    1. Directional Selection: one extreme is favored over the other and the average trait
    2. Stabilizing Selection: average trait favored over extreme traits
    3. Disruptive Selection: extreme traits favored over average trait
- Evidence for evolution in living (extant) organisms:
    1. Comparative anatomy
    2. Mimicry and Protective coloration
    3. Developmental biology
    4. Biogeography
    5. DNA; biochemistry and molecular biology
- Evidence from extinct organisms: fossils
- Adaptations; Coevolution

1. Comparative Anatomy
    - **Homologous organs**: organs similar in form in different organisms due to common evolutionary origin; may have different function (human arm, bat wing; lettuce leaves, pea tendrils)
    - **Analogous organs**: have similar look and/or function in diff organisms but don't share common evolutionary origin (insect v. bird wings; pea/grape tendrils)
    - **Convergent evolution**: process where unrelated organisms in similar environment evolve similar structures (cacti & milkweed)
    - **Vestigial organs**: organs (or parts of) that are non-functional/degenerate
2. Mimicry and Protective Coloration
    - **Mimicry**: a harmless species may resemble a dangerous species
    - **Protective coloration**: coloration that allows an organism to blend in env.
3. Developmental Biology
    - Early embryos of different animal species look very much alike—they share common features (gills, tail, etc)
4. Biogeography
    - Unequal distribution of organisms, species originated once in one place
    - **Endemic species:** occur only in particular area; usually rare (Darwin's finch)
5. Biochemistry and Molecular Biology
    - Genes provide evolutionary record
    - If we evolved from common ancestor we have same DNA

Fossil Record- Most compelling evidence for evolution

- Records for last 4 billion years; rare event and incomplete but ever growing

Adaptations- a process by which genetic changes occur during evolution

- Promote survival and reproductive success as response to environmental pressures; they are universal & without them species can become extinct
- May originate as mutations

- Plant adaptations
    - Protection: plants try to avoid predation form herbivores (thorns)
    - Coloration: different flower colors attract different pollinators
    - Morphological adaptations: strawberry grow underground
    - Leaves: adapted to many functions in different plants

Coevolution

- The long term evolutionary adjustment of one group of organisms to another
- Mutual evolutionary influence between two species; they evolve together
- Pollination: coevolution of plants and insects; flowers, insects, birds

Ways in which two organisms can interact: **symbiosis**

- **Paratism**: interaction benefits one organisms but is detrimental to another
- **Commensualism**: benefits one, but neutral to the other; epiphytes grow on top of another plant for support and position
- **Mutualism**: both organisms benefit; i.e. **lichens**: fungi and algae
    - Plant-Microorganisms Symbiosis
        - Nitrogen-fixing bacteria and legumes
        - **Mycorrhizae**: fungal growth in plants
    - Co-evolution
        - Acacia trees and ants

Viruses, Prokaryotes, Fungi

Viruses

- Non-living, cannot self replicate (so it needs a host), not a kingdom
- Virus structure:
  - Just a protein coat for protection (**capsid**) and nucleic acid (DNA/RNA) for info on how to make more copies of same virus
  - Must invade living cell to reproduce
- Virus is Cellular Parasite
  - Uses cells machinery of host to replicate and produce more viruses
  - Come in many shapes, sizes, varieties
  - Antibiotics kill bacteria, not viruses
- Viruses cause diseases (in plants, animals, bacteria, & fungi)
  - Herpes, hepatitis, rabies, flu, HPV, SARS, Norovirus (stomach flu), HPV
  - Plant viruses: TMV, rose mosaic, spots on fruit, wheat stunt

Six Kingdoms

- **Archaebacteria**: prokaryotic ancient bacteria, live in harsh environments
- **Eubacteria**: prokaryotic bacteria, have cell walls
- **Protista**: algae, slime molds, protozoa (have cell wall but not cellulose)
- **Fungi**: mold, mildew, mushrooms; rooted in ground, have cell wall
- **Plantae**: complex multicellular eukaryotes, obtain food by photosynthesis
- **Animalia**: complex multicellular eukaryotes, obtain food by ingestion

Living Organisms

- **Prokaryotic**: lack membrane-bound organelles (eubacteria, archaebacteria)
  - Small and haploid only
- **Eukaryotic:** have membrane-bound organelles (protista, plantae, fungi, animalia)

Bacteria

- Bacterial chromosome and plasmids
- Asexual reproduction; binary fusion; mutations occur
- Bacterial shapes
  - Form cocci, bacilli, spirilli
  - Some strains have flagella (whip-like appendages for swimming)
- What do they eat?
  - Most bacteria **heterotrophic**: obtain food from other organisms
  - Some are **vitotrophic**: make their own food (i.e. anabaena)
- Bacterial Pathogens
  - Typhoid, tuberculosis, Bubonic Plague, syphilis, gonorrhea, e. coli, salmonella, listeria
- Bacterial Control
  - Disinfectants
  - Antibiotics (penicillin)
  - Low temperatures (slows growth)
  - High temperatures (kills it)

    - Low oxygen
- Beneficial Bacteria
    - **Nitrogen-fixation:** convert atmospheric N into useful N
    - **Decomposition**
    - **Intestinal Bacteria:** supply vitamíns (K), lactic àcid
- Bacterial Cells
    - We have more bacterial cells in body than human cells
    - 200 species of bacteria in the mouth
    - 100 trillion in the whole body→mostly beneficial
- Commercial Uses of Bacteria
    - Yogurt, sour cream, fermentation (vinegar, cheese)
    - Genetically-engineered bacteria produce insulin and antibiotics and other important chemicals
    - Can also help clean up oil spills

Eukaryotes

- Fungi, protista, plantae, animalia
- Arose from endosymbiosis
    - **Endosymbiont Theory:** chloroplasts and mitochondria are descendents of once free-living prokaryotes that were engulfed by larger cells (symbiotic relationship)
    - Fungi cell wall=chitin; plant cell wall=cellulose

Kingdom Fungi

- Characteristics
    - Non-photosynthetic; absorb nutrients by absorption (produce digestive enzymes to break down complex molecules)
    - Reproduce sexually and asexually→successful
- Major decomposers:
    - Chytridiomycota- forms flaggelated spores
    - Zygomyota- bread mold
    - Ascomycota- formes spores in ascus
    - Basidiomycota- form mushrooms
    - Deuteromycota- only reproduce asexually
- Morphology
    - Most fungi come in hyphae (thread-like strands); other are yeasts
    - Form spores to spread with wind, air, soil (allergies)
- Structure & Reproduction
    - Basidiomycota (mushrooms): genetically compatible fuse
    - Nuclei don't fuse→heterokaryotic hyphae→mushroom (Dikaryon)
    - Underneath cap the n+n cells are called gills
    - Nuclei combine, form zygote, undergo meiosis, produce haploids
- Mycorrhizae (fungus roots) (symbiotic, mutualistic relationship)
    - Certain fungi grow into roots to supply water, P and N
    - 90% of plants need it to survive
- Fungi as Antiobiotics: Produces penicillin
- Pathogenic fungi: grow within a host, using host as food for replication
    - Athlete's foot

    - Yeast infections
    - Ring worm
    - Mycotoxins
        - Harmful, toxic chemicals accumulate in food
- Plant diseases caused by Fungi (causes majority)
    - Lawn diseases, apple scab, fire blight
- Fungi plant pathogens
    - Dutch elm disease (beetles feed on wood)
    - Irish Potato Famine (1 mill deaths, massive migration)
- Commercial Uses
    - Yeast for fermentation; breaks down sugar, produces alcohol
    - Brewing of alcoholic beverages
    - Bread making (help dough rise)
    - Cheese production (blue cheeses)
- Summary of Fungi
    - Diverse group of organisms (molds to mushrooms)
    - Composed of branched hyphase
    - Reproduce sexually or asexually, by spores
    - Fungi are absorptive, they secrete enzymes to break down stuff
    - Important decomposers
    - Cause majority of plant diseases
    - Commercially important: fermentation, food

Algae, Bryophytes, and Ferns

Kingdom Algae

- Belong to Kingdom Protista (eukaryotes), but no true organs
- More photosynthetic, like plants
- Require more moist environments bc they lack a waxy cuticle

General Features of Algae

- Can be micro or macroscopic
- Lack vascular tissues—no xylem or phloem
- Illustrate importance of photosynthesis to the Earth's ecology

Diversity

- Millions of species
    - Diatoms and Kelps
    - Dinoflagellates
    - Red and Green Algae

1. Diatoms
    - Large group of Algae (many unidentified), recently evolved
    - Live in oceans, provide basis food chain in many aquatic environments
        - Provide phytoplankton (can reproduce asexually then sexually)
    - Mostly uni cellular, silica in cell walls
2. Kelps or Brown Algae
    - Closely related to diatoms, look very different
    - Live in rocky coasts in temperate zones, open seas, cold waters
    - Multicellular; very long; holdfast, stipe, blade, air bladder/float
3. Dinoflagellates
    - Mainly uni-cellular, green or colorless, some bioluminescent
    - Unusual nucleus: chromosomes always visible
    - Mostly asexual reproduction
    - Important in food chains in warm, tropical oceans; Red Tide
4. Red Algae
    - Some of the oldest eukaryotic organisms (2 billion year old fossils)
    - Abound in tropical, warm water
    - Act as food and habitat for many marine species
    - Thin films to complex filamentous membranes
    - Why red?
        - Accessory pigments; can photosynthesize in deep water
    - Commercial uses
        - Carrageenan, lotions, toothpaste, jellies, food, agar
    4. Green Algae
    - Largest and most diverse group
    - Found in fresh water and on land; can live on rocks, trees, soil
    - Structures:
        - Single cells
        - Filaments

- Colonies
- Thalli
- Terrestrial plants arose from a green algal ancestor; have chloropyll a/b
- Commercial value
  - Oxygen and food for aquatic organisms
  - Lichens: green algae and fungi symbiosis
  - Some consumed by humans

Benefits of Algae
- Food chain, lichens, shelter, provide oxygen

Harmful Algae
- Algal blooms- sudden population explosions (clog of water, bad taste)
- Toxic to animals
- Red Tide

Kingdom Plantae
- Evolved from algae
- Algae cant survive on land (only in moist environments)
- Plants had to evolve to survive on land
- Evolutionary of tree plants, from primitive to advanced traits
- Green algae→bryophytes→ferns→gymnosperms→angiosperms

Ancestor of Plants: Green Algae
- Both have photosynthetic pigment, use starch to store, have cellulose, have alternation of generations, form cell plate during cell division

Living on Land
- Obtaining enough water
  - Evolved roots to anchor and absorb water/dissolved minerals
- Preventing water loss
  - Evolved waxy cuticle, sex organs, and resistant coat on spores
- Getting enough energy
  - Obtain sunlight for photosynthesis; grow taller or adapt to low light
- Photosynthesis/Water Dilemma
  - Plant need pores for gas exchange (photosynthesis) but stomata allow water to leave; so stomata open during day and close at night
- Multicellularity:
  - Better roots, protect gametes, grow tall, but water issue
  - Plants evolved vascular tissues, xylem and phloem
- Sexual Reproduction
  - Algae have motile gametes and single sex organs
  - Land plants developed multicellular sex organs (genetic variability)
- Life Cycle
  - Water-dependent life cycle
  - Developed dryness-resistant spores and seeds
  - Evolved to large size
  - Gametophyte→sporophyte

Plant Life Cycle: Alternation of Generations
- Plants spend part of life in 1n stage and then 2n stage (both multicellular)

Bryophytes

- Mosses, liverworts
- Non-vascular plants (no xylem, phloem)
    - Limits size and place they live
- Cuticle, mulitcellular gametangia, stomata
- Require moist environment for growth and sexual reproduction
- Alternation of generations
- Dominant gametophyte generation (1n)
- Rhizoids anchor (not true roots, but stems)

Bryophyte Reproduction

- Gametophyte plant produces multicellular sex organs
    - Archegonia: eggs
    - Antheridia: swimming sperm
- Sporophyte occurs after egg is fertilized by sperm
- Grows into archegonium of gametophyte plant (dependent on it)
    - Foot
    - Seta (stalk)
    - Capsule (spore case)
- If spore lands on suitable place, it will germinate into protonema (gametophyte generation)

Significance

- Small and inconspicuous but important part of biosphere
- Food for mammals, birds
- Important to prevent soil erosion along streams
- Commercially- peat moss (fuel, soil conditioner)

Ferns

- Important group of plants; 12,000 species
- Have developed vascular tissue
- Live in moist tropics, woodlands, stream banks
- Alternation of generations but sporophyte generation is dominant

Fern Sporophyte Generation (2n)

- Sporophyte produces spores (reproductive cell that will grow and develop into a gametophyte)

Fern Sporophyte Morphology

- Fronds (complex leaves); fiddleheads
    - Photosynthesis/reproduction
    - Under fronds, spores are produced in sporangia clusters (sori)
        - Sori are not covered, or covered by cap (indusium)
    - Meiosis occurs producing haploid spores
- Underground horizontal stem: rhizome, where true roots arise

Significance of Ferns

- Ecologically important: hold and form soil to prevent erosion
- As food: fiddleheads eaten
- As ornamental plants
- Coal formation from ancient ferns

Fern Alternation of Generations Drawing:

Gymnosperms and Angiosperms

Gymnosperms

- Means "naked seed", the seeds lack protective enclosure
- More advanced than ferns—no spores, but seeds
- Species: conifers (pine trees), cycads, ginkgo

Evolution of gymnosperms

- Evolved from fern-like ancestors, advancements over ferns:
    1. Seeds
    2. Don't depend on water for fertilization (have air-borne pollen)
    3. Have dominant sporophyte generation
    4. Have more efficient vascular system

Gymnosperm Life Cycle

- Alternation of generations
- Dominant sporophyte generation (2n); produce male and female sperms
- Gametophyte generation (1n) contained and dependent

Sporophyte Generation

- Heterosporous (produces 2 types of spores)
    - Megasporangium: undergoes meissis to produce megaspores (female)
    - Microsporangium: undergoes meiosis to produce haploid micro spores, germinate to produce male gemetophyte (pollen)

Gymnosperm Pollen

- Many use wind for pollination and pollen dispersal
- Contains male gametophyte (haploid, 1n)

Wood produced by gymnosperm sporophyte

- Woody plants, very efficient/effective vascular system
- Xylem→wood of tree, phloem→bark of tree
- Wood formed from secondary growth

Primary vs. Secondary Growth

- Primary: occurs in apical meristems of shoots & roots; increase length/height
- Secondary: derived from secondary/lateral meristems; increase in width
    - Common in trees (wood and bark)
    - Vascular cambium forms secondary xylem/phloem

Annual Rings (not in tropical trees)

- Xylem formed by vascular cambium during one growth season
- Early spring wood- vessel diameter large, xylem walls thin
- Late summer wood- vessel diameter small, thick walls

Gymnosperms

- Soil prevent soil erosions; drugs/meds, reduce greenhouse gas effect
- Conifers most important; largest and most familiar groups
    - Adapted to temperate to cold regions
    - Narrow leaves (needles) to help conserve water
    - Covered by resins for protection from predators, fire, etc
- Bear seeds in cones

- Staminate cones (male); ovulate cones (female)
- Seeds produced on open scale, don't produce flowers or fruit

Gymnosperm seed: diploid embryo, fleshy seed coat

- Mainly wood plants that include oldest living, most massive, and tallest

Angiosperms

- Means "covered seed"
- Have flowers, have fruits with seeds
- Live everywhere—dominant plants in the world, 88% of plant kingdom
- Most successful and advanced plants on earth; most important for humans

Evolution of Angiosperms

- Advancements over gymnosperms:
  - Have flowers, fruits, seeds; double fertilization of endosperm in seed

Angiosperm Life Cycle: flower has male and female sex organs

Flower Structure

- Stamens: male sex organs; composed of anther (produces pollen)
- Capel: female sex organs
- Ovary: enlarged basal portion of carpel
- Stigma: receptive portion of carpel for pollen grains to adhere
- Non-reproductive parts:
  - Sepals (green): outermost whorl of leaf-like bracts
  - Petals (colored): inner whorl of leaf-like bracts
  - Both can have various shapes/colors
  - Tepals: petals and sepals of similar shape and color

Angiosperm Life Cycle

- Heterosporous: forms two different types of spores (micro and mega, male and female)
- Male: pollen grains contain tube nucleus and generative cell (2 sperm nuclei)
- Female: gametophyte contains egg and 2 polar nuclei

Double Fertilization

- Pollen Grain germinates stigma forming pollen tube, grows down to ovary
- One sperm nucleus fertilizes haploid egg→2n zygote
- Another sperm nucleus unties with 2 polar nuclei, forms triploid endosperm

Seeds

- Fertilized egg grows into zygote, which grows into plant embryo (2n)
- Endosperm is stored food tissue (3n) for the embryo to grow
- Mature ovule becomes seed coat and/or fruit

Monocot v. Dicot

- Angiosperm divided into both
- As zygote grows into embryo, first leaves of young sporophyte develop and called cotyledons (seed leaves)
- Monocots: corn, lily, grasses
- Dicots: trees, veggies, fruit
- Endosperm is kept in dicot

FEATURE	MONOCOTS	DICOTS
Cotyledons		
Leaf venation	parallel	broad
Root system	Fibrous	Tap
Number of floral parts		In 4's or 5's
Vascular bundle position	Scattered	Arranged in a circle
Woody or herbaceous	Herbaceous	Either

- Monocot absorbs endosperm tissue during germination

Pollination

Pollination: the transfer of pollen from the male anther to the female stigma

Importance

- **Sexual reproduction** is important for evolution
  - It produces variable offspring→diversity and variation
  - Is advantageous to an organism if it happens with someone other than itself (outbreeding=good; inbreeding=bad)
  - **In animals:** easy because there are separate males/females
  - **In flowering plants**: not so easy bc most flowers have both male and female parts (**perfect flowers**)
  - Flowering plants have evolved in special ways to insure outbreeding/outcrossing and to prevent inbreeding
  - **Imperfect flowers:** either male or female only.

Function of Flower

- To attract pollinators with colorful petals, scent, nectar, and pollen
- **Complete flower**: has all four organs (sepals, petal, stamens, pistols)
- **Incomplete flower**: are missing any or 1 or more floral organs

Reproductive Organs

- Female (**carpel-pistol**); contains:
  - **Stigma**: where pollen sticks to
  - **Style**: long tube connecting stigma to ovary
  - **Ovary**: enlarged base structure where ovules are located (will become the fruit
  - **Ovule**: contains female gametophyte, becomes the seed
- Male (**stamen**); contains:
  - **Anther**: part of the stamen that produces pollen
  - **Filament**: stalk-like structure that holds anther
  - **Pollen**: immature male gametophyte

Non-reproductive Floral Organs

- **Petals**: whorl of flower organs; brightly colored to attract pollinators
- **Corolla**: whorl of petals in a flower (all petals together)
- **Sepals**: whorl of leaf-like organs outside corolla; help protect unopened flower bud
- **Calyx**: whorl of sepals in a flower

Pollination & Fertilization

- Pollen contains 2 nuclei: sperm and tube nucleus
- Sperm nucleus is protected in gametophyte tissue
- For pollen sperm to be successful there must be **pollination**: a method to get pollen from the male anther to the stigma
- Pollen sticks to stigma, starts growing pollen tube
- Fertilization occurs when tube begins to grow toward egg

Double Fertilization

- One sperm nucleus (1n) fertilizes egg, producing zygote, becomes plant embryo inside seed
- Another fuses with polar nuclei, resulting in triploid (3n) endosperm (food source for young embryo)

Strategies to Avoid Self-Pollination

- **Timing**- male/female structures mature at different times
- **Morphological**- strcutrure of male/female organs prevents self-pollination (imperfect flower)
- **Biochemical** (most efficient)- chemical on surface of pollen and stigma/style that prevent pollen tube germination on same flower (incompatible)

How do plants get pollen from one plant to another?

- Wind pollination: used by gymnosperms/flowering plants; not very efficient
- Animals: used by many flowering plants; insects, birds, mammals

Coevolution

- **Coevolution**: interactions between two different species as selective forces on each other, resulting in adaptations that increase their interdependency
- Example: animal-flowering plant interaction
    - Plants evolve method to attract animal pollinators
    - Animals evolved specialized body parts/behaviors to aid pollination

Pollen

- Shape and form of pollen is related to its method of pollination
- Insect-pollinated species have sticky or barbed pollen grains
- Wind-pollinated are lightweight, small, smooth

Palynology: the study of pollen

- Useful in many fields: petroleum geology, archaeology, anthropology, criminology, aerobiology

Animal Pollinators

- Bees: most important group of flower pollinators
    - Live on nectar and feed larvae, also eat pollen
    - Guided by sight/smell; see yellow + blue colors
    - Flowers have honey guides and bee landing platforms
- Butterflies & Moths
    - Also guided by sight and smell; can see red and orange
    - Moth-pollinated flowers are white/pale, sweet odor
- Flies & Beetles
    - Like flowers that smell like dung or rotten meat
    - Lay eggs there but die due to lack of food
    - Pollinate dull colored flowers, but strong odor
- Birds
    - Good sense of colors (yellow or red); bad sense of smell
    - Flowers provide fluid nectar more than insects, pollen large/sticky
- Mammals: Bats & Mice
    - Bats pollinate at night→flowers are white, strong odors/lots of pollen

Why do Animals Pollinate Plants?

- Food, nectar (matches their energy requirements), pollen (high in protein)
- Flowers produce: normal and sterile pollens

Plant Prostitution: Mimicry

- Some plants take advantage of insect sex drive, deceive them
- Certain orchids look like female wasps, males try to mate but just pollinate

Fruits and Seeds

Seed

- Matured ovule, containing:
  - A plant embryo
  - A food supply
  - Covered by a seed coat

Embryo

- The seed contains a well-formed multicellular young plant embryo (germ)
- Embryo is diploid and will become whole plant

Nutritive Tissue

- Seed contains food supply
- Stored food contains enough energy for the embryo to grow through the soil, when seedling is unable to photosynthesize
- Food source can be the endosperm (3n) as result of double fertilization

Seed Coat

- Thick, protective coat—outer layer of the seed
- Formed from megasporangium

Gymnosperm seeds

- Single fertilization produces the diploid embryo 2n
- Food course is the haploid megagametophyte

Flowering Plant Seed

- In angiosperms there is double fertilization
  - Produces diploid embryo and triploid endosperm
  - Endosperm is the food source

Fruit

- Fruit is mature (in flowering plants) ripened ovary that contains the seeds
- Pericarp- ovary wall
- Function of fruit: to protect the seeds and disperse them
  - Ovary: fruit; ovule: seed
- 3 fruit types
  - Simple
  - Aggregate
  - Multiple

A. Simple Fruit

- Develops from a single ovary of a single carpel
- Can be either fleshy or dry
- Simple Fleshy Fruit
  1. Berry: entire fruit wall is soft and fleshy; slimy inside
     - One of the most common
     - Grapes, tomatoes, bell peppers, bananas
  2. Hesperidium: a berry with tough, leathery rind (peel)
     - Oranges, lemons, other citrus

3. Drupe: outer part of fruit wall is soft and fleshy, inner part is hard and stony
    - Cherry, peach, plum
4. Pepo: also a fleshy fruit with a tougher, outer ring
    - Squash family, pumpkin, melons, cucumbers
5. Pome: most of the fleshy part of pomes develops from enlarged base of the perianth that has fused with ovary wall
    - Apples and pears

- Simple Dry Fruit
    i. Capsule: fruit is dry and splits open along several seams
        1. Cotton
    ii. Legumes: dry and split along two seams
        1. Pea pods, bean pods, peanuts
    iii. Ones that do not open at maturity
        1. Caryopsis: seed coat is fused to ovary wall (cereal grains, wheat, rice)
        2. Nuts: single ovary wall and seed coat remain separate, ovary wall is very hard

B. Aggregate Fruit
- Develops from one flower with many separate pistils/carpels, all ripening simultaneously
    - I.e. strawberry, raspberry, blackberry

C. Multiple Fruit
- Develops from ovaries of several flowers borne/fused together on same stalk
    - I.e. pineapple

Seed Dispersal Is Important Because...
- It spreads progeny in order to colonize new environments
- Reduces competition for resources with parents
- Reduces chances of predators destroying all of the plant's yearly seed production
- Types of seed dispersal:
    - Self
        - Forceful ejection, explosive fruits (squirting cucumber)
            - Peanut plant sews its own seeds
    - Wind
        - Special devices for this
        - Plumes catch wind currents: dandelions
        - Trees take advantage of their great heights
    - Water
        - Flotation devices to travel by water, or may have air spaces and corky floats: coconut
    - Animal
        - Most commonly used method
        - Plants coevolved with animals to accomplish seed dispersal
        - Many plants depend on animals for this; may offer nutritional reward

- Animals lern to recognize ripened fruit colors
- Fleshy fruits eaten and dispersed with feces
- Some dry fruit cling to animals
- Some are Velcro-like or sticky that cling to animal fur

Human Uses of Plants

Introduction to Agriculture

- **Agriculture**: the science, art, practice of cultivating soil, producing crops, and raising livestock
- Around 10,000 years ago: shift from foraging/hunting/gathering to farming
- Cultural evolution, began in different parts of the world
    1. The Near East: "Fertile Crescent" of Mesopotamia
    2. The Far East: Southeast Asia, along Yellow/Yangtze River
    3. New World: modern day Mexico and Peru

    ***Modern regional cuisine still reflect these early centers of agriculture

Domesticated Plants

- Genetically distinct from wild progenitors
- Wild plants: natural selection; domesticated: artificial selection
- Most domesticated plants (traits chosen for our benefit) can't survive in wild

Cultivated Plants

- From centers of origin, plants/animals dispersed to other parts of world
- Wild ancestors of domesticated plants still exist; help develop new varieties and are important for maintaining genetic diversity of crop plants

Modern Agriculture

- World: food and fiber that sustains the entire population produced on 3% land; 97% land is non-crop or non-grazing (tundra, desert, forest, mountain)

Agriculture in the U.S.

- 16% land used at crop land; 34% used for pasture and grazing
- Corn, wheat, soybeans, hay: planted on 80% of crop land
- There's been steady increase in agricultural yield per acre in U.S. crops without any significant increase in new land:
    - Improved crop varieties—higher yield
    - Improved agricultural practices
    - Improved pest control—resistant cultivars
    - Tailored fertilization of crops

Human Nutrition

Introduction

- Eat to fulfill energy needs; daily nutritional needs supplied by:
    - Macronutrients—required in large amounts
    - Micronutrients—required in small amounts

Calories

- Calorie: amount of energy required to raise 1 gram of water 1 degree C
- Food energy measured in kilo calories (kcal=1000 calories)
- Humans require 1200-3200 calories per day (avg=2000 calories)

Macronutrients

- **Carbohydrates** (C, H, O) (1:2:1 ratio)

- Monosaccharides
  - Glucose is most abundant
  - Fructose (in fruit) and galactose also important
- Disaccharides (composed of two monosaccharides)
  - Sucrose (table sugar; glucose + fructose) most common
  - Lactose (gluc + gal): milk sugar
  - Maltose: found in germinating grains (2 glucose)
  - Provide no nutritional value, just calories
- Polysaccharides (hundreds/thousands sugar units) (complex carbs)
  - Starch: long glucose chain found stored in plants (potato, wheat, rice, beans corn)
    - Broken into glucose by saliva enzymes
  - Glycogen: storage form of glucose in body; excess=fat
  - FIBER
    - Polysaccharide derived from plant cellulose
    - Not digestible, provides bulk
    - Soluble dietary fiber: oat, reduces cholest/heart risks
    - Insoluble dietary fiber: fruit, bran, veggies; absorbs water, prevents constipations, may prevent cancers

- **Proteins**
  - Introduction
    - Large complex molecules, perform many functions
    - Made from amino acids (20 different to make thousands)
    - Sources: meat, fish, cheese, milk, egg, beans, corn, whole wheat
  - Essential Amino Acids (EAA)
    - Cells in body can make 11 out of 20 amino acids
    - The 9 they can't make are EAAs: can't be stored by body so must be taken in the diet
  - Complete Proteins
    - Contain all essential amino acids
    - Proteins from animal sources are complete
    - Proteins from plant sources are incomplete
  - Protein Digestion:
    - Requires digestive enzymes (which are also proteins)
    - Some proteins can't be broken down completely
    - High quality proteins:
      - Contain all EAAs
      - Are fully digestible
      - Free their amino acids, which are absorbed readily
- **Fats**
  - Introduction (composed of C, H, O)
    - Have glycerol head (hydrophilic) and hydrophobic tail (fatty acid)
    - Serve many vital functions: energy, storage, insulation, hormones
  - Triglycerides

        - 95% of lipids come from fats and oils called triglycerides
        - Triglycerides= glycerol + 3 fatty acids
        - Fatty acid chains vary—determine characteristics of triglyc
    - Essential Fatty Acids
        - Body can make most fatty acids except three (essential)
        - Linoleic, linolenic, and arachidonic acid (found in veg oils)
    - Saturated v. Unsaturated Fatty Acids
        - Depends on Carbon-Hydrogen bonding of fatty acid chain
        - Carbon atoms joined by single bond: **saturated fatty acids**
        - Carbon-carbon double bonds: **unsaturated fatty acids**
        - **Saturated fatty acids:** solid at room temp (butter, lard)
        - **Unsaturated fatty acids:** liquid at room temp (oils)
    - Saturated (unhealthy) v. Unsaturated (healthy) Fats
        - Saturated: excess leads to obesity, heart disease, cancer
        - Unsaturated: lowers risk of heart disease, lowers cholesterol
            - Omega-3: salmon, flax, avocado, walnuts
    - Trans Fatty Acids
        - When oils are hydrogenated they change their shape
        - Very unhealthy=fried/processed foods, margarine
        - Raise bad cholesterol & harden the arteries
    - Cholesterol (subcategory of lipids called steroids)
        - Important for making cell membranes and human hormones
        - Animal products: eggs, butter, meat, cheese
        - Plant products contain unsaturated fat, lowers cholesterol
        - Good v. Bad
            - Low Density Lipoprotein (LDL) is bad: causes blockage of arteries, restricts blood flow causing heart attacks
                - Atherosclerosis: hardening of arteries
            - High Density Lipoprotein (HDL) is good: decreases LDL

Micronutrients (vitamins and minerals)

- **Vitamins**
    - Some are called coenzymes because they are essential for proper functioning of certain enzymes
    - Fat-soluble vitamins: A, D, E, K
    - Water-soluble vitamins: B-complex, C
- Vitamin A
    - Important vitamin in formation of vision pigments
    - Maintains healthy/smooth skin, bone & tooth development
    - Animal sources: liver
    - Plant sources: yellow, orange, dark green fruits and vegetables
    - Lack of causes night blindness, dry skill, infections, bad bone growth
- Vitamin B Complex
    - 8 vitamins, all water soluble
    - Most act as coenzyme, help in food breakdown and energy release
    - Deficiency: fatigue, weakness, depression, dermatitis, anemia
    - Sources: meat, fish, chicken, whole grains, seeds, nuts, legumes