Hey everyone! I hope that Exam I went well for those who have taken it, and that those who haven’t are feeling confident! If you need any additional help, group tutoring sessions are a great resource, as is making a 30-minute appointment through the tutoring center. This resource will be longer than most due to differences in material covered between sections, but hang in there!

**Keywords:** Speciation, Reproductive Isolation, Macroevolution, Miller and Urey, Population ecology, Vascular Plants, Angiosperms, Plant Nutrition, Plant responses to stimuli

**Our Group Tutoring sessions will be every Wednesdays from 6:45-7:45 PM in Sid Rich 075. You can reserve a spot at https://baylor.edu/tutoring. I hope to see you there!**

**Topic of the Week:**

This week in Biology 1306, we will be covering Speciation, the Origin of Life and Population Ecology! Campbell Chapters 24, 25, 35, 36, 37, 38, 39, and 53.

**The Origin of Species, Macroevolution: History of Life on Earth-** Campbell chapters 24, 25

**Macroevolution** describes how species evolve. According to the Biological Species Concept, members of a Species can interbreed and form viable, fertile offspring. When species become Reproductively Isolated and can no longer interbreed, Speciation, or two new species arising from one, can occur. Reproductive Isolation can be either Prezygotic, or before the creation of a zygote, or Postzygotic, after the creation of a zygote.

**Prezygotic Isolating Mechanisms** include: Behavioral Isolation, Mechanical Isolation, Habitat Isolation, Temporal Isolation, and Genetic Isolation

**Postzygotic Isolating Mechanisms** include: Hybrid breakdown, Reduced hybrid fertility, and Reduced hybrid viability

- **Allopatric Speciation** occurs when members of a population are kept APART by a geographic barrier; **Sympatric isolation** occurs when the members of a population are not geographically isolated and are in the SAME area

Chemical and physical processes, along with natural selection, made the origin of life possible on early Earth. In their experiment, Miller and Urey found that organic compounds, or biotic molecules, could be synthesized from abiotic factors. This led to the theory that life originated near Alkaline Hydrothermal Ocean Vents. The first organic macromolecules thought to be synthesized near these ocean vents are RNA Polymers. This is due to the fact that RNA Polymers will self-generate if monomers are present. These early molecules were packaged into Protocells, or droplets with membranes that maintain an internal chemistry different than that of the surroundings. From these protocells came single celled organisms and eventually multicellular organisms who later colonized land. Once on land, the rise and fall of dominant groups reflects plate tectonics, which can cause allopatric speciation, mass extinctions, like at the end of the Permian period, and adaptive

All diagrams, tables, and external information is property of Campbell Biology and Pearson Education Inc.
radiation following a mass extinction where the survivors of the extinction adapt into important ecological niches.

**Vascular Plant Structure, Growth, and Development – Campbell Ch. 35**

**Classifying Plant Organs:**
- **Roots:** plant organs which anchor vascular plants in the soil. These have a high surface area for absorbing water and minerals
- **Taproots** - have a long core root with lateral roots branching.
- **Fibrous roots** - have a thick tangle of roots under the soil.

**Shoots:** Stems and leaves
- **Stems:** support growth and transport
- **Leaves:** photosynthesis/gas exchange, modulate heat control, and energy (sugar) storage

**Types of Tissues of Plant Organs:**
- **Vascular Tissue:** xylem and phloem
- **Dermal Tissue:** tissues which protect the plant from external environment and prevent desiccation
- **Epidermis** (non-woody plants) - a single layer of tissue that provides a boundary with the environment
- **Ground Tissue:** tissue not categorized as dermal or vascular; may be internal to the vasculature (pith) or external to the vasculature (cortex).
- **Cuticle:** a thin, waxy layer over which covers the upper epidermis of leaves
- **Periderm** (woody plants): tissues that replace the epidermis in woody plants

**Meristems and Plant Growth**
- **Determinate Growth:** growth that has specific genetic limits, such as flowers, thorns, or leaves
- **Indeterminate Growth:** growth which is active throughout a plant’s life (meristematic)
- **Primary Growth:** The growth that extends the roots and shoots (increases the length of section)
- **Apical Meristem:** primary growth occurs in the roots and shoots.
  - **Zone of cell division:** houses stem cells which constantly divide
  - **Zone of elongation:** is where the actual lengthening happens
  - **Zone of differentiation:** cells differentiate into the 3 tissue types (ground, dermal, vascular).
  - **Shoot apical meristem:** where most primary shoot growth occurs
- **Apical Dominance:** when an axillary bud is inhibited the nearer it is to an apical meristem; prevents the formation of lateral branches
- **Secondary Growth:** Lateral growth which increases the width of the plant
- **Lateral Meristem:** secondary growth occurs via lateral divisions of the vascular cambium (adds secondary xylem and phloem) and the cork cambium (turns waxy epidermis and periderm → bark)

**Check out this video to learn more about vascular plants:**
https://www.youtube.com/watch?v=h9oDTMXM7M8

**Resource Acquisition and Transport in Vascular Plants – Campbell Ch. 36**

Recall that **xylem** (water and mineral) and **phloem** (sugar and solute) are the types of vascular tissue that conduct water throughout vascular plants. To start, here is some vocabulary to be familiar with:

All diagrams, tables, and external information is property of Campbell Biology and Pearson Education Inc.
Phyllotaxy: the arrangement of leaves on a plant as determined by the shoot apical meristem alternate (1 leaf/node), whorled (2 leaves), or opposite (more than 2 per node)

Self-Pruning: leaves at lower levels that are shaded can’t photosynthesize efficiently, and are selectively removed via programmed cell death

Leaf Area Index: the ratio of leaf area on the top layer to the ground area covered by a plant

NOTE: During photosynthesis, leaving stomata open for CO₂/O₂ exchange results in water loss

Routes of Solute and Water Transport: there are different routes of transport in plants

Apoplastic Route: water and solutes move along the continuum of the apoplast, the extracellular portion of cells and the internal portion of non-living cells (xylem)

Symplastic Route: water and solutes move across the cytosol and pass through plasmodesmata (ie the symplast), the cytosolic compartment of all living cells of a plant

Transmembrane Route: water and solutes move between cells through cell membranes and walls

Bulk transport, check out this video (7:08): https://www.youtube.com/watch?v=bsY8j8f54I0

Osmosis: the free diffusion of water based on its water potential. \( \Psi_s + \Psi_p = \Psi \)

Water Potential: physical property determining the direction of water movement based on:

Solute Potential: osmotic potential; proportional to solute molarity

Pressure Potential: the physical pressure on the system (positive or negative)

Turgor Pressure: the amount of force pushing out on the cell wall from water in the cell

Turgid: high tonicity due to water gain with high turgor pressure

Flaccid: tonicity when the cell loses water and has low turgor pressure

Plasmolysis: when the cell membrane separates from the cell wall

Stomata: pores on leaves that regulate water transpiration and gas exchange

Guard Cell: cells which regulate the opening of stomata

When guard cells are flaccid, the stomata close. When guard cells are turgid, the stomata open. Guard cells pump K⁺ ions out to close stomata and pump K⁺ in to open stomata.

Plant nutrition often involves relationships with other organisms- Campbell Ch. 37.3

Mutualistic relationships are common between plants, soil, and other organisms.

Rhizobacteria- live in close proximity to the rhizosphere (soil surrounding plant roots)

Endophytes- live in between cells within the plant

Nitrogen Cycle: nitrogen containing substances are removed from the air and soil, are utilized by organisms, and then returned back to the air and soil for reuse

Nitrification: ammonia \((NH_3^-)\) is oxidized into nitrate \((NO_2^-)\) and then nitrate is further oxidized into \((NO_3^-)\).

Ammonium \((NH_4^+)\) can be used as a nitrogen source and is derived using 2 different methods:

1. Nitrogen-fixing bacteria convert gaseous nitrogen (found in air) into \((NH_3^-)\),
which can acquire a hydrogen from the soil and produce ammonium

2. **Ammonification**: decomposers convert organic nitrogen from dead sources into ammonium

**Nitrogen Fixation**: atmospheric nitrogen \( (N_2) \) is reduced to \( (NH_3) \) by bacteria
-Nitrogen fixation by **Rhizobium bacteria** requires an **anaerobic environment**, which can only be accomplished inside the root cortex; this is why the Rhizobium bacteria assume the **bacteroid** form.

**Mycorrhizae**: a **mutualistic symbiotic** fungus which increases root SA to facilitate absorption

**Ectomycorrhizae** - form a thick sheath of branching **hyphae** (mycelia) over the surface of the root; usually formed in woody plant species

**Arbuscular Mycorrhizae** - embedded within the root

Check out this video for further explanation of the **Nitrogen Cycle**:
https://youtu.be/UrP1E-yM7Cs

**Other Nutritional Adaptations of Plants:**

- **Epiphytes** - a plant that grows on another plant (**commensalistic relationship**)
- **Parasitic Plants** - absorb water, minerals, and sometimes photosynthetic products from their living hosts
- **Carnivorous Plants** - do have photosynthetic capabilities but supplement their diet by capturing and ingesting insects and other small organisms

**Angiosperm Reproduction and Biotechnology - Campbell Ch 38.1-2**

Flowers are the sporophytic structures of angiosperms. They are **determinate shoots**, meaning they cease growing after the flower forms. Complete flowers have all 4 basic flower organs. Incomplete flowers lack sepals, petals, stamens, or carpels. Here is some flower vocabulary that you should be familiar with:

- **Receptacle**: where floral organs attach
- **Sporophylls**: modified leaves for reproduction
- **Simple pistil**: single unfused carpel
- **Compound pistil**: multiple fused carpels; can have one loved stigma, or multiple stigma
- **Inflorescences**: groups of flowers that grow in clusters ex.
- **Sunflowers**
- **Stamen**: the male part of a flower
- **Carpel**: the female part of a flower

*be able to recognize descriptions of each part of the flower shown in figure 30.2 (above)*

**Pollination** is the transfer of pollen to the part of a seed plant containing the ovules. In angiosperms, the transfer is from an anther to a stigma. 80% of angiosperm pollination is biotic. Among the abiotic, 98% is wind and 2% is water. The primary purpose of **nectar** is to reward the pollinators and **natural selection** favors derivations in floral structure of physiology that make it more likely for a flower to be pollinated.

**Wind Pollination** - Flowers are often small, green and inconspicuous because they do not need to attract pollinators. They often do not produce nectar or scent
- Wind is an inefficient pollinator, but this is compensated for by production of copious amounts of pollen grains
Bee Pollination- 60% of flowers use insect pollinators; bees are the most important and depend on nectar and pollen for food
- Bee pollinated flowers have a delicate, sweet fragrance, and bring colors, specifically yellow and blue
- Many bee pollinated flowers have ultraviolet markings called Nectar Guides to help bees find the flowers

Moth and Butterfly Pollination- Flowers are often sweetly fragrant
- Butterflies can perceive many bright colors, but moth flowers are typically white or yellow which stand out at night

Bats Pollination- Often light colored and aromatic flowers
- Bats transfer pollen when they eat the flowers

Fly Pollination- Reddish, fleshy flowers that resemble carrion or dead flesh

Bird Pollination- Large and bright red or yellow flowers with little scent because birds can’t smell well
- The flower’s sugary nectar meets the high energy requirements of birds

Angiosperm Life Cycle
The life cycle of an angiosperm is extremely complex. Rather than go into detail in this resource about the specifics of this process, I will define the moving pieces. Please check out this video for a very good walk through of the process of angiosperm reproduction and fruit development:
https://www.youtube.com/watch?v=9F6TfJn4wU0

Female:
Embryo sac: female gametophyte
Micropyle: the gap between the two integuments
Megasporocyte: the cell in the megasporangium of each ovule which enlarges and undergoes meiosis forming 4 haploid megaspores
Megaspore: of the four megaspores, only one survives before dividing three times with no cytokinesis to form a cell with 8 haploid nuclei.
Synergids: flank the egg and help guide the pollen tube toward the embryo sac
Polar Nuclei: share the cytoplasm of one cell in the embryo sac
Integuments: surround the ovule
Ovary: eventually becomes the fruit

Male:
Pollen sacs: the microsporangia; each anther contains four
Microsporocytes: four are created within each pollen sac; each gives rise to a haploid male gametophyte, a pollen grain, which contains two cells: the generative cell and tube cell
Generative cell: passes into the tube cell during maturation; the cell which will fertilize the egg; this will divide mitotically into two cells prior to fertilization
Tube cell: the large cell which grows toward the micropyle in response to chemical attractants produced by the synergids and then kills one synergid in order to enter the embryo sac

Endosperm: the 3n cell fertilized by one of the generative cell nuclei; forms a milky which turns solid and serves as the nutrient source for a seed depending on whether the seed is a Eudicot or a Monodicot. See this video to learn more about the difference:
https://www.youtube.com/watch?v=xG9TGeccbox

All diagrams, tables, and external information is property of Campbell Biology and Pearson Education Inc.
Hormones: Molecules produced in low quantities and transported to another site to produce a response

Signal Transduction in Plant Cells:

Transduction: the transformation of a physical stimulus from the environment into a cellular response

Etiolation: morphological adaptations that allow plants to grow in darkness before emerging (thin shoots; unexpanded leaves)

De-Etiolation: aka. greening: shoot and root elongation; development of chlorophyll-bearing leaves

The De-Etiolation Process in Plants:

Reception: light strikes the membrane phytochrome protein (little light needed to respond)

Transduction: two pathways emerge using a secondary messenger (cGMP) and Na^+

Path 1: cGMP activates a protein kinase (PK1)

Path 2: phytochrome opens a Na^+ channel, whose ions activate a protein kinase (PK2)

Response: PK1 will phosphorylate Transcription Factor 1 (TF1); PK2 will phosphorylate TF2. This leads to the transcription of genes coding for de-etiolation proteins.

Hormones (Table 39.1):

Auxin: controls stem elongation and controls apical dominance

Tropism: the growth of a shoot toward or away from a stimulus (phototropism: specific to light)

Cytokinins: regulate division in roots and shoots; promote lateral growth; regulate solute movement

Gibberellins: sex differentiation, pollen and pollen tube development and sperm elongation

Abscisic Acid (ABA): inhibits growth

Ethylene: promotes ripening of fruit, lateral branching of shoots and pineapple flowering

Brassinosteroids: promote division in shoots; low concentration increase root growth while high concentrations reduce growth

Jasmonates: regulate fruit ripening, floral development/pollen production; responds to pathogens or herbivores

Strigolactones: control seed germination and apical dominance; recruits mycorrhizal fungi

Watch this video on plant hormones: https://www.youtube.com/watch?v=HdwIcIkSoBY

A plant’s ability to respond to and absorb light is crucial for its survival.

Photomorphogenesis: key events in plant growth and development that are dependent on light

Two Major Classes of Light Receptors:
**Blue-Light Photoreceptors**- initiates phototropism, light-induced opening of stomata, and the light-induced slowing of hypocotyl elongation that occurs when a seedling breaks ground.

**Phytochromes**- absorb mostly red light; regulate seed germination and shade avoidance.
- In most cases, the light absorbing portion of the phytochromes are photoreversible.
- The interconversion between the phytochromes red-absorbing form \(P_r\) and the far-red absorbing form \(P_{fr}\) is what controls and triggers various events in the plant.

**Phytochromes also assist in maintaining the plant’s measure of time**

---

**Some More Definitions:**

**Circadian Rhythms:** sleep movements and physiological processes that occur with a consistent frequency of about 24 hours that are not directly influenced by environmental variables.
- Interactions between the amount of light phytochromes absorb and the natural biological clock of the plant allows the plant to measure the days and seasons.

**Photoperiodism:** physiological response to specific night or day lengths.
- **Short-day plants/ long-night plants:** requires a light period shorter than a minimum critical length to flower.
- **Long-day plants/ short-night plants:** flower only when the light period is longer than a certain maximum number of hours.
- **Day-neutral plants:** unaffected by photoperiod.

**Gravitropism:** plants’ response to gravity; roots display positive gravitropism (with gravity) and shoots exhibit negative gravitropism (away from gravity).

**Statoliths:** components that settle to the lower portion of the cell due to gravity; helps plant detect gravity’s direction.

**Thigmomorphogenesis:** changes in physical form that result from mechanical perturbation (wind, touch, any mechanical stress).

**Thigmotropism:** change in directional growth in response to touch by another organism.

---

**How do plants respond to Abiotic Stressors?**

**Drought:** plants will reduce rate of transpiration, stomata will close, synthesis of abscisic acid will increase and be released, photosynthesis will decrease.

**Flooding:** leads to oxygen deprivation which will in response, stimulate production of ethylene, causing root cortex cells to die to provide “snorkels” for air to get in.

**Salt Stress:** causes a water deficit by lowering the water potential gradient, reducing water uptake.

**Heat Stress:** can denature plant enzymes; stomata will close to conserve water but this prevents evaporative cooling from occurring; in response, plant will synthesize heat-shock proteins to protect other proteins from denaturation.

**Cold Stress:** membranes become less fluid, and the lipids form crystalline structures.

---

**How do plants defend against pathogens and herbivores?**

The **epidermis** and the **periderm** of the plant body initially provide a physical barrier against infection.

**Second line of defense is 2 immune responses:**

**PAMP-triggered immunity**- if the plant recognizes molecular sequences that are specific to certain pathogens, a chain signaling response begins and produces **phytoalexins** (antimicrobial chemicals).

**Effector-triggered immunity**- both a local and a general defense against pathogens; restricts the spread of a pathogen by impairing the pathogen’s cell wall integrity, metabolism or reproduction; produces salicylic acid that activates a signal transduction pathway.

**Herbivory:** animals eating plants; plants have several defenses:

**Molecular-Level Defense:** chemical compounds to deter attackers.

---

All diagrams, tables, and external information is property of Campbell Biology and Pearson Education Inc.
Cellular-Level Defense: vacuoles can be used to store chemicals to deter attackers; raphide crystals can also release an irritant into the attackers' soft tissues
Tissue-Level Defense: hardened sclerenchyma makes chewing difficult
Organ-Level Defense: organ shapes can either be unappealing or can be difficult/painful to ingest
Organism-Level Defense: physiological changes due to mechanical damage
Population-Level Defense: coordinated behavior can ward off predators
Community-Level Defense: species can recruit/ assist another species that is a predator of the herbivore and in return receive protection

Population Ecology- Campbell Chapter 53
Dispersal is the movement of individuals or gametes away from their areas of origin or centers of high population density. There can be a difference between where a species could live (Potential Range) and where it actually lives (Actual Range). Density is the number of individuals per area and dispersion is the pattern among spacing among individuals in that area.

There are three different types of dispersion we will discuss:

Survivorship Curves- describe the death patterns in types of communities.
Type 1- low death rates at the beginning and middle, then steep at the end ex. humans
Type 2- constant death rate over the lifespan
Type 3- high death rate in young, but flattens out for those who survive

Population sizes can also be “selected” in different ways. Those that undergo density dependent selection, or selection for traits that maximize reproductive success in crowded environments are R-selected Populations. Those that undergo density independent selection are K-selected Populations.

Remember, there is always a tradeoff between reproduction and survival. There is competition. Among individuals in the population and the resources available that limit that population.

All diagrams, tables, and external information is property of Campbell Biology and Pearson Education Inc.
CHECK YOUR LEARNING

1. What was the product in the Miller-Urey Experiment?
2. What survivorship curve makes sense for sea turtles? (high early death rate that decreases over time)
3. What is the difference between allopatric and sympatric speciation?

THINGS YOU MAY STRUGGLE WITH

1. R-selected and K-selected populations: K is density dependent; R is density independent. Spend time with this and make sure you know the difference! Check out this video if you are struggling: https://www.youtube.com/watch?v=NSGWfXO0-8q
2. The Hardy Weinberg Experiment: Check out this video starting at 5:29 https://www.youtube.com/watch?v=NNijmxsKGbc&t=318s

Study Tips:

*** Review all vocabulary in each chapter and make sure you understand what the terms mean***

That’s all folks.

If you have any questions, feel free to reach out to the tutoring center or use the link at the top of the resource to make an appointment.

Answers:

1. Organic compounds synthesized from abiotic/inorganic factors.
2. Type 3
3. Allopatric speciation occurs when members of a population are Apart. Sympatric speciation occurs when members of a population are in the Same environment.

All diagrams, tables, and external information is property of Campbell Biology and Pearson Education Inc.