Week 4
BIO 1306/1406 – Modern Concepts in Bioscience II

Hello and Welcome to the weekly resources for Biology 2!

This week is Week 4 of class, and typically in this week of the semester, your professors are covering these topics below. If you do not see the topics your particular section of class is learning this week, please take a look at other weekly resources listed on our website for additional topics throughout of the semester.

We also invite you to look at the group tutoring chart on our website to see if this course has a group tutoring session offered this semester.

If you have any questions about these study guides, group tutoring sessions, private 30 minute tutoring appointments, the Baylor Tutoring YouTube channel or any tutoring services we offer, please visit our website www.baylor.edu/tutoring or call our drop in center during open business hours. M-Th 9am-8pm on class days 254-710-4135.

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

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.

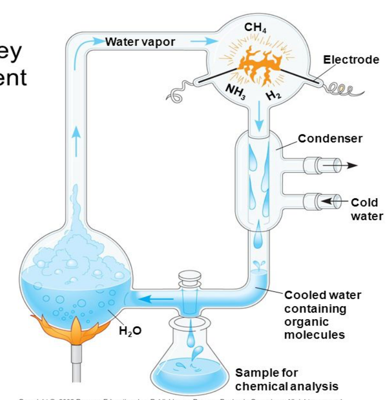
The Origin of Species, Macroevolution; History of Life on Earth- Campbell chapters 24, 25

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

Miller-Urey Experiment



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 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

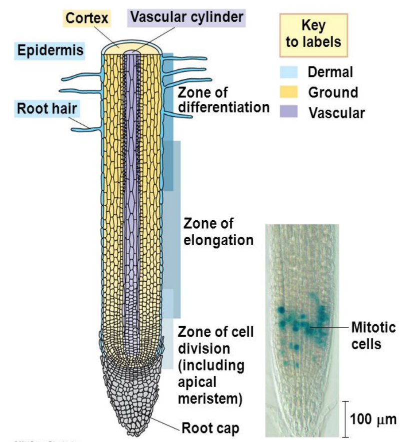
Epidermis (non-woody plants) a single layer of tissue that provides a boundary with the environment

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

Figure 35.13



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

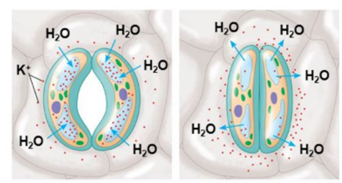
Lateral Meristem: secondary growth occurs via lateral divisions of the **vascular cambium** (adds secondary xylem and phloem) and the **cork cambium** (turns waxy epidermis and periderm → bark)

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

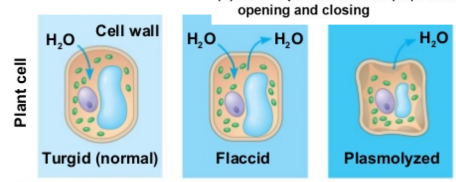
Resource Acquisition and Transport in Vascular Plants – Campbell Ch. 36

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:

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 CO_2/O_2 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)
Water moves from **high water potential to low water potential** down its osmotic gradient.
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.



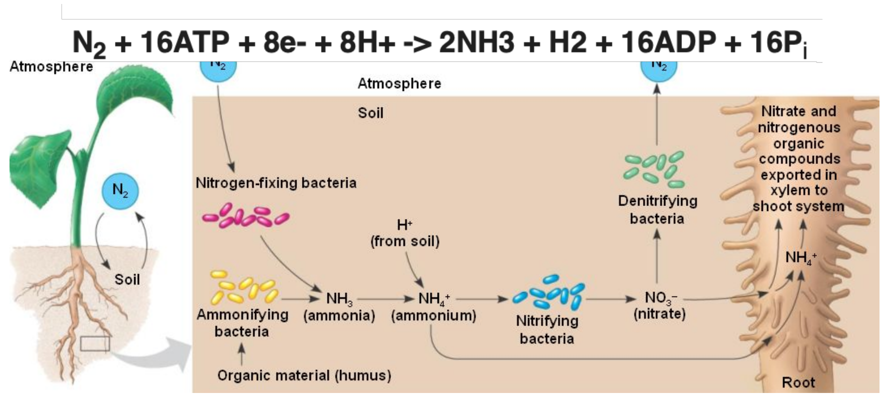
(b) Role of potassium ions (K^+) in stomatal opening and closing



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

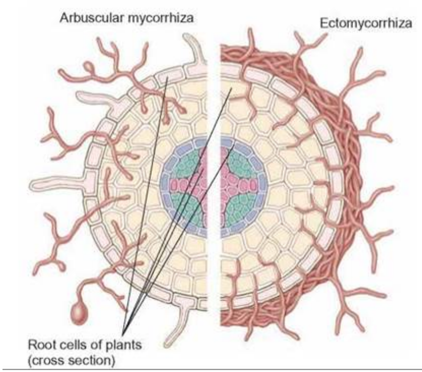
Mutualistic relationships are common between plants, soil, and other organisms.
Rhizobacteria- live in close proximity to the **rhizosphere** (soil surrounding plant roots)
Endophytes- live in between cells within the plant
Nitrogen Cycle: nitrogen containing substances are removed from the air and soil, 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

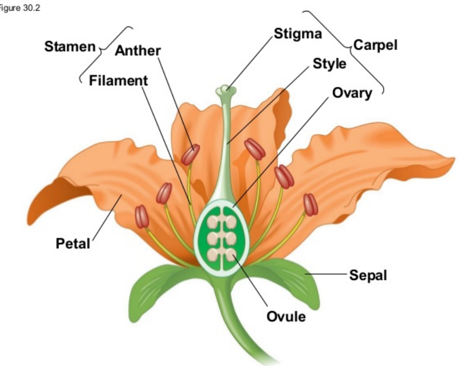
Other Nutritional Adaptations of Plants:

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:

Figure 30.2



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 pollenated 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=9F6TfdN4wU0

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

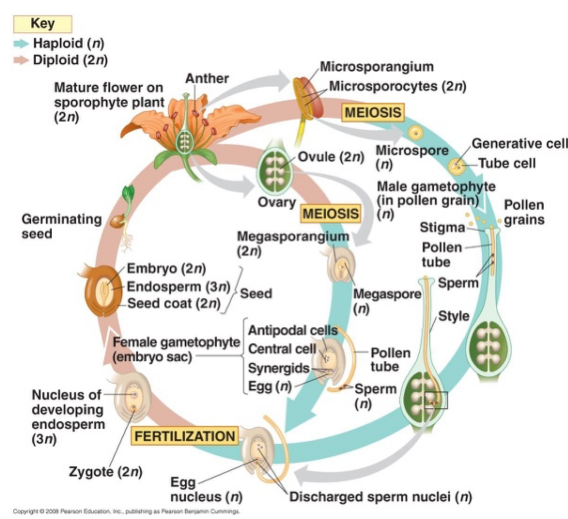
Megaspore: of the four megaspores, only one survives before dividing three times with no cytokinesis to form a cell with 8 haploid nuclei.

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 sav

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=xe99TGccbxo

To learn about Seed Germination, check out this video:
https://www.youtube.com/watch?v=_be5P30G36U&pbjreload=101

To learn more about fruit structure and function, check out this video:
https://www.youtube.com/watch?v=nax2mH1bFa4

Plant Responses to Internal and External Signals- Campbell Ch. 39

Hormones: Molecules produced in low quantities and transported to another site to produce a response

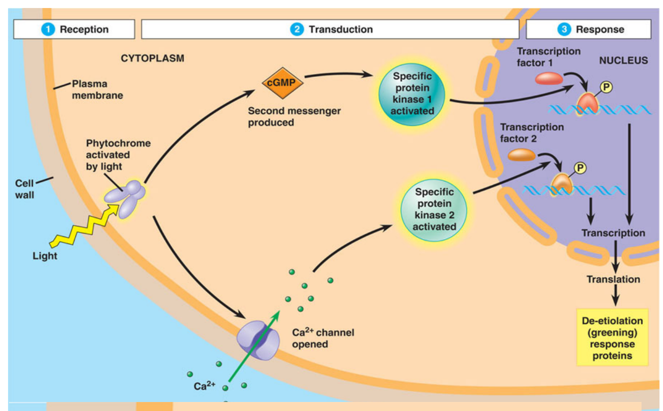
Signal Transduction in Plant Cells:

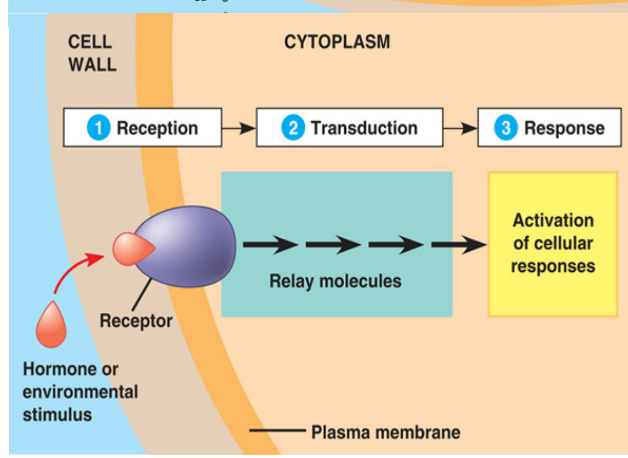
Transduction: the transformation of a physical stimulus from the environment into a cellular response
Etiolation: morphological adaptations that allow plants to grow in darkness before emerging (thin shoots; unexpanded leaves)
De-Etiolation: aka. greening: shoot and root elongation; development of ***chlorophyll-bearing*** 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 grown; 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_f) and the far-red absorbing form (P_{fr}) is what controls and triggers various events in the plant

-Phytochromes also assists 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 influences 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)

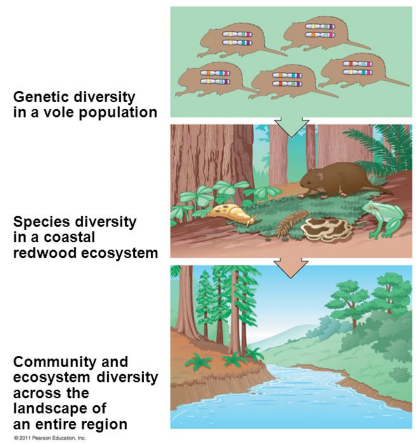
Effector-triggered immunity- both a local and a general defense against pathogens; restricts the spread of a pathogen by impairing the pathogen's cell wall integrity, metabolism or reproduction; produces salicylic acid that activates a signal transduction pathway

Herbivory: animals eating plants; plants have several defenses:

Molecular-Level Defense: chemical compounds to deter attackers

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

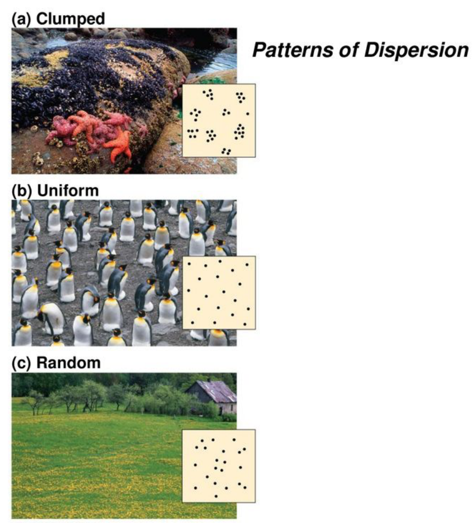
Figure 56.3



Population Ecology- Campbell Chapter 53

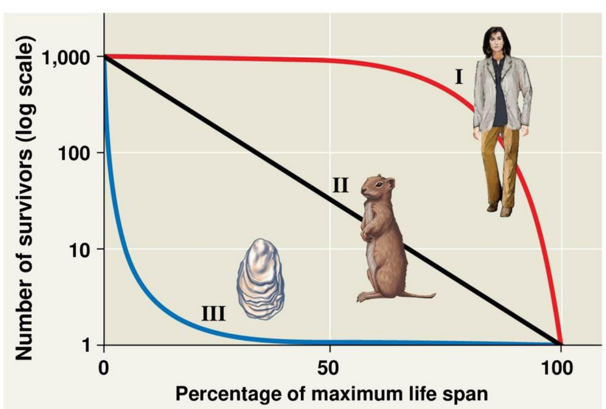
Dispersal is the movement of individuals or gametes away from their areas of origin or centers of high population density. There can be a difference between where a species could live **(Potential Range)** and where it actually lives **(Actual Range). Density** is the number of individuals per area and **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

Figure 40.16 Idealized survivorship curves: types I, II, and III



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.

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=NSGWfXO0-8o
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***

Thanks for checking out these weekly resources!
Don't forget to check out our website for group tutoring times, video tutorials and lots of other resources: www.baylor.edu/tutoring ! Answers to check your learning questions are below!

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.