Second Half of BIO 1150-01

03/05/2018

Topic: Bacteria and Archaea

The three-domain system: The Present Tree of Life: Eukarya, Archaea, Bacteria

Eukarya:

* The plants and animals and humans

Archaea: (Not as well studied)

* Extremophiles – live in extreme environments
  + Extreme halophiles – high salt environments
    - Halobacterium
  + Extreme thermophiles – high temp environments
    - Thermophilus aquatic
* Methanogens – things that live in low qxygen, swamps environments as such
* **Archaea** have polysaccharides and proteins but **lack peptidoglycan** in their cell walls. Bacteria does have peptidoglycan in their cell walls

Bacteria:

* They are very successful, able to occupy different environments, small, unicellular, well organized, variety of shapes.
* Proteobacteria: related with 5 groups of bacteria
  + Alpha – known with bean plants
  + Beta – fix nitrogen in aquatic systems
  + Gamma – accumulate sulfur
  + Delta – have different life styles
  + Epsilon – cause for stomach or aggravate from stomach ulcers
* Other Groups
  + Caldiamide -
  + Spirochetes -
  + Cyanobacteria – can photosynthesis
  + Gram – positive Bacteria – Streptomyces, hundreds of mycoplasmas
    - These are the more tough to kill deceases and viruses
    - Mycoplasmas, known as the smallest known cells
  + Gram – negative Bacteria
    - The thickness of peptidoglycan determines of the bacteria is gram-positive or gram-negative

Basic Comparison slide of the three parts of the tree of life.

Cell-Surface Structures

* Capsule
  + Slime layer – helps protect the cell wall
* Fimbriae
* Pili

Motility

* Taxis
  + Chemotaxi
* Flagella – Evolutionary “exaptations” from secretory protein system

Cell Wall

* Bacteria: have peptidoglycan in their cell wall
  + All proteobacteria are gram negative

Internal Organization and DNA

* Bacteria and Archaea both don’t have
* Lack compartmentalization
  + Specialized membranes perform metabolic functions
* DNA packaged in a circular chromosome in the nucleoid region
* Additional rings of DNA called **plasmids**

Reproductive and Adaptation

Key Features:

* Reproduce by splitting in half: binary fission. With short generation times

Prokaryotes have considerable genetic variation: why?

* 3 factors:
  + Rapid reproduction
  + Mutation
  + Genetic recombination

Bacteria Have two big functions

* Transformation: incorporating foreign DNA from the surrounding environment
* Transduction: movement of genes between bacteria by bacteriophages (viruses that infect bacteria)

Conjugation and Plasmids

* Conjugation: process where genetic material is transferred between prokaryotic cells
* F (fertility) factor is required for the production of pili

R Plasmids and Antibiotic Resistance

* Antibiotic-resistant strains of bacteria are becoming more common with increased antibiotics use: e.g., MRSA methicillin resistant *Staphylococcus aureus*

Diverse nutritional and Metabolic adaptations have evolved in prokaryotes

* Phototrophs
* Chemotrophs
* Autotrophs
* Heterotrophs

The Role of Oxygen in Metabolism

03/07/2018

Topic: Protists

* Protists are made of many kinds of creatures. Such as the blue whales, elephants, and humans.

Structural and Functional Diversity in Protists

* Protists are eukaryotes, have organelles and are more complex than prokaryotes
* Most are unicellular, some colonial and multicellular species
* They exhibit more structural and functional diversity than any other group of eukaryotes
* Multiple feeding styles

Endosymbiosis in Eukaryotic Evolution

* Endosymbiosis: the process in which a unicellular organism engulfs another cell, which then becomes a permanent symbiont.
  + Theory purposed by Dr. Lynn Margulis
* Examples
  + Mitochondria
    - Aerobic prokaryote
  + Plastids
    - Photosynthetic cyanobacterium
* Power point image of how a eukaryote feeds and evolves or changes. Slide 4
  + Tells how how the eukaryotes engulfs cells and then the cells that are engulfed or that help the eukaryotes gains benefits that the eukaryote gains by feeding new cells
* Slide 5: Tree of Protists grouped by DNA relation Also are the different groups we will discuss in class.
* Supergroup Excavata
  + Key features:
    - Modified mitochondria: not much detail
    - Unique flagella:
    - Cytoskeleton: they have coat of sorts
    - Includes the following clades: diplomonads, parabasalids, and euglenozoans
  + Excav, Para
    - Lack plastids, have modified microchondria
    - Live in arearobic environments: our gut, swamps
  + Diplomonads
    - Modified microchondria
    - Two equal sized nucli and multiple flagella
    - Lives in our stomach
  + Euglenozoan Clade
    - Feed on other food sources, eats other organisms, Live! For food and energy
    - They all have a crystalline rod inside the flagella. (Unknown function)
    - This includes:
      * Kinetoplastids and euglenids
  + Kinetoplastids
    - Have a single mitochondrion with an organized mass of DNA called kinetoplast
    - Include free-living consumers or prokaryotes in freshwater, marine, and moist terrestrial
    - The tsetse fly is what transfers the dessies to other organisms and allow it to spread
* Supergroup SAR Clade
  + Includes the clades stramenopiles, alveolates, and rhizarians
  + Stramenopile Clade
    - Important phototrophs as well as several clades of heterotrophs (over 100,000 species)
    - Most have hairy flagellum paired with a smooth flahellum
    - Stramenopiles include diatms., golden algae, brown algae, and oomycetes
  + Diatoms
    - Unicellular algae with a unique two part, glass-like wall of hdrates silica
    - Reproduce asexually, and occasionally sexually
  + Brown Algae
    - Largest and most complex algae, most are marine

Alternative of generations

* The alternation of multicellular haploid and diploid florms
  + Slides 14 and 15 given information on this topic
  + Oomycetes
    - Water molds, white rusts, and downy mildews
    - Most are decomposers or parisites with filaents(hyphae) that facilitate nutrient uptake
    - High ecological impacts, as in potato blight caused by *phytophthora infestans*
  + SAR: Alveolate Clade
    - Have membrane-bounded sacs (alveoli) us tinder the plasma membrane(they float)
    - They can be compared to our lungs we use to breath
    - The include:
  + Dinoflagellates
    - Have two flagella and each cell is reinforced by cellulose plates
    - Abundant components of phytoplankton, causing “red tides”
  + Apicomplexans
    - Parasites of animals
    - The apex contains a complex of organelles specialized for penetrating host cells and tissues
    - Most have sexual and asexual stages that require two or more different host species
    - Plasmodium, the causal agent of malaria, required both mosquitoes and humans to complete its life cycle
  + Ciliates
    - Use cilia to move and feed; have large macronuclei and small micronuclei
    - Genetic variation results from conjugation, in which two individuals exchange haploid micronuclei
  + SAR Rhizaria clade
    - DNA evidence supports **Rhizaria** as a monophyletic clade
    - **Amoebas** move and feed by **pseudopodia**; some but not all belong to the Rhizaria
    - Rhizarians include radiolarians, foraminiferans, and cercozoans
  + Foraminiferans
    - Named for porous, generally multichambered tests (shells)
    - Pseudopodia extended through the pores in the test
    - Many
* Supergroup Archaeplastida
  + Over a billion years ago, a heterotrophic protist acquired a cyanobacterial endosymbiont
  + The photosynthetic descendants of this ancient protist evolved into red algae and green algae
  + Includes red algae, green algae, and land plants
  + Reg Algae
    - Color due to an accessory photosynthetic pgment called **phycoerythrin**
    - Usually multicellular; the largest are seaweeds
    - Coastal waters of the tropics
  + Green Algae
    - **Green Algae** are paraphyletic group named for their grass-green choroplasts; two main groups are chorophytes and charophyceans
    - **Charophytes** are most closely related to land plants
      * Larger size and greater complexity evolved by chorophytes by:
        + Formation of colonies from individual cells
        + Formation of true multicellular bodies by cell division and differentiation
        + Repeated division of buclei with no cytoplasmic division
* Supergroup Unikonta
  + Includes animals, fungi, and some protists
  + This group includes amoebozoans and the opisthokonts
  + Unikonta: Clade Amoeboza
    - Amoeba that have lobe- or tube-shaped, rather threadlike, pseudopodia
    - They include slime molds, gymnamoebas, and entamoebas
  + Slime molds
    - Not fungi
    - Plasmodial and cellular forms
  + Plasmodial Slime Molds
    - Many species are brightly pigmented, usually yellow or orange

03/09/2018

Topic: How Plants Colonized Land

* Life on Land
  + For more than 3 billion years, life was found in water only.
  + Moving to land required adaptations to prevent water loss
  + Land plants evolved from green algae (charophytes)
    - Chara species
* Classification of land plants chart
  + Power point slide 4
* Derived traits of land plants (derived traits, not from ancestors passed down)
  + Alternation of generations and multicellular embryos dependent on the “mother” plant
  + Walled spores (w/ **sporopollenin**) produced in **sporangia**
  + Multicellular **gametangia** that produce gametes
  + Apical meristems
    - Give rise to growth
  + Other common traits
    - Cuticle
    - Symbiotic associations with fungi (mycorrhizae)
    - Secondary compounds; **lignin** for cell wall reinforcement
* Alternation of Generations
  + Slide 6 shows a image with the information Showing the evolution of plants moving to land by the end of the image cycle
  + Alternation of generations involves haploid and diploid multicellular stages
  + Gradual reduction of haploid stage (gametophyte) and loss of reliance on water is an evolutionary pattern
* Sporangia produce haploid spores by meiosis
  + Spores located on the sporophyte
  + Spores grow into gametophytes
  + Sporangium: inside
* Multicellular gametangia produce haploid gametes by mitosis
* Embryophytes retain embryo
* Apical meristems give rise to growth in elongation
  + Meristems contain tissues that give rise to growth of the root
    - They only have a purpose to divide and give rise to new cells
    - They help the success of new plants
* Cuticle protects against water loss, and is a barrier to pathogens
  + Prevents the leaf from drying out or stopping things from getting into the leaf
* Evolution of plants
  + Power point slide 12 shows a graph of plant evolution and there different groups
  + Non-vascular plants
    - plants with no circulatory system, no veins, cant transfer water through out the plant
    - Phyla: **Hepatophyta** (liverworts), **Bryophyta** (mosses) and **Anthocerophyta** (hornworts)
    - Life cycle is dominated by large gametophyte
    - Sporophyte is small and dependent on gametophyte
  + Slide 13 shows a life cycle chart for a non-vascular
    - There are separate males and separate females
    - Need to stay in moist environment and need water
    - The sperm cells can swim (sperm cells swim through the water to the egg)
    - Shows a cycle related to Haploid (n) (female structure)
    - Shows a cycle related to Diploid (2n) (male structure)
  + Hepatophyta (liverworts)
    - Very small plants
  + Bryophyta (mosses)
    - Very common mosses
    - Ex: polytrichum commune, hairy-cap moss
  + Peat (sphagnum moss)
    - Stores carbon (30%)
    - Good source of fuel (good to burn peat)
    - Harvesting is somewhat sustainable
  + Mosses retain nitrogen in soil
    - With moss the environment can save more and more nirtregen than without moss
    - Moss can be used to flavor drinks: Scotch Whiskey
  + Antherocerophyta (hornworts)
    - The sporophytes give rise to the rise of the wrots on these plants
  + Seedless vascular plants
    - Phyla: Lycophyta (club mosses, spike mosses and quillworts), Pterophyta (ferns, horsetails, whisk ferns)
    - Sporophytes are free-living and dominant form in life cycle; gametophyte is reduced
    - They are a little more advanced: Have a vascular system
  + Slide 22 shows a evolution chart for Seedless vascular plants
    - Example is of a fern
    - Shows a cycle related to Haploid (n)
    - Shows a cycle related to Diploid (2n)
  + Xylem and phloem cells transport water and materials
    - The vascular system
      * Reproduce more
      * Carries water thrugh out the plant
      * Two main parts
        + Phloem Cells
        + Xylem Cells
      * Lignia compound: give toughness to the ells, help retain water within the walls of the cells
  + True roots evolve
    - True roots have true leaves
    - Slide 25 a chart of evolution of leaves
  + Sporophyll and spore variations
    - **Sporophylls** are modified leaves with sporangia
    - **Sori** are clusters of sporangia on the undersides of sporophylls
    - **Strobili** are cone-like structures formed from groups of sporophylls, very tightly packed together
  + **Homosporous spore production** & **Heterosporous spore production** (slide 27)
    - Most seedless vascular plants are homosporous
    - All seed plants and some seedless vascular plants are heterosporous
  + Lycophyta
    - SelSpike moss
    - Quillwort
    - Club moss
      * Uses for these plants:
        + The plants will have there caps pop and allow there pods to release.
        + They were a replacement for gunpowder
        + The spores are very dry
  + Pterophyta
    - Most diverse seedless vascular plants
    - Largest
    - Have overtopping growth
    - Have megaphylls
    - Branching along length of roots
      * The ferns
        + Lady fern
        + A whisk fern
        + Field horsetail
  + Carboniferous forests

03/14/2018

Topic: The Evolution of Seed Plants

* Slide 2: Diagram of Plant Groups
* Slide 3: Another slide of a diagram Shows derived traits (they are traits you don’t see from the ancestor) ancestral traits are traits passed down from the ancestor
* Slide 4: summary of what we talked about on Friday
  + The smaller plants have larger gametophyte
  + Ferns and other seedless: have a smaller gametophyte copared to the mosses and other small plants
  + Seed plants further reduction of gametophytes
* Heterospory
  + The ancestors of seed plants were likely homosporous, they had a single type of spore.
  + Megasporangia produce megaspores that give rise to female gametophytes
  + Microsporangia produce microspores that give rise to male gametophytes
* Ovules and Production of Eggs
  + An **ovule** consists of a megasporangium, megaspore, and one or more protective **integuments**
  + Gymnosperm megaspores have one integument
  + Angiosperm megaspores usually have two integuments
* Pollen and production of sperm
  + Microspores develop into **pollen grains**, which contain the male gametophytes
  + Pollen eliminates the need for a film of water
  + When a pollen grain germinates, it gives rise to a pollen tube that discharges sperm into the female gametophyte within the ovule
* Slide 8: Diagram showing the growth and creation of seed development
  + Unfertilized Ovule
  + Fertilized Ovule
  + Gymnosperm Seed
* Evolutionary advantage of seeds
  + May remain dormant for days to years, until conditions are favorable for germination
  + Supply of stored food
  + Can be transported long distances by wind or animals
* Gymnosperms
  + Bear “naked” seeds typically on cones
  + Most are wind pollinated (plant to plant moving thanks to the wind blowing)
  + Sporangia on strobili
* Division Cycadophyta
  + Flagellated sperm
  + Beetle pollinated
  + Thrived during Cenozoic (very old, sperm can still swim)
    - Only 130 species today
    - Cycas revoluta
* Division Ginkophyta
  + Flagellated sperm
  + One species only
    - Ginkgo Biloba (also has flagella so the sperm is also able to swim)
      * Breaks the rule of not having fruit bearing around the seed.
      * They have different male and female plants called: Dioecies plants
      * Thought to be extinct before they became decoration trees
      * Only a few wild trees of this kind remain in Asia
* Division Gnetophyta
  + Have vessel elements
  + Show a more advanced polylemma cell
  + Three genera
    - Welwitschia
      * (grows in dry habitat, has the longest leaves in the world)
      * Leaves start at the stalk at the base and grow up and out.
      * Unknown longest length
      * Ovulate cones
    - Gnetum
      * Cone like structure
    - Ephedra
      * Also find in dessert like habitat
      * Tolerant of dry habitat
      * Used to make crystal meth
      * Found from Ephedrine
* Division Coniferophtya
  + Largest group (~500 species)
  + Most are cone producing evergreen
    - Dugless fie good timber
    - Sicouia: largest plant or organism in the world
    - Junipers
      * make fruit like structures
      * Can extract a flavor from to use as gin
    - Some of the pine made as ornementals
    - Briscone pine
      * Its very old
      * They are the oldest organisms on the planet. Can be 5,000 yrs old
      * Live in dry habitats
    - European Larch
      * They lose their needles every year
      * Needles turn yellow and fall off every year
* Slide 16: live cycle
  + Don’t get to overwhelmed in the life cycle with all the different terms
* Anthophyta (angiosperms)
  + Have a flower and a fruit
  + Animal pollinated, wind pollinated, or self pollinated
  + ~250, 000 species
* Flower structure (Basic flower structure, it’s a complete flower structure)
  + Bats are good pollinators
    - Bat pollenated flowers
      * They need to be open at night (nocturnal flowers)
      * It takes the nectar from the flower as food
* Fruit
  + These plants can produce flowering fruits
    - The fruits are made from the ovule
    - The number of seeds, can reflect what the flower looks like
      * and how many ovules are present
    - The shells are partly methods of transportation
    - They are used to help attract animals to help spread the seeds called:
      * seed dispersers
  + Can be fleshy or dry
* Fruits are dispersed
  + The helicopters found on maple trees
* Slide 21: another chart for a complete flower life cycle
* Angiosperms originated 140 mya (first flowering plants)
* Angiosperm phylogeny
  + Graph
* Basal angiosperms
* Monocots vs. Eudicots (last slide from lecture in class)
* Monocots (grasses and grass like plants like corn)
* Eudicots (leaf like plants)
* Co-evolution
  + Between plants and other organisms has contributed to diversification
* Medicine from seed plants

03/16/2018

Topic: Plant Structure and Growth

* Roots
* They appear in ferns and other small plants first and then as well in larger plants as well.
  + Anchor plant
  + Absorb water and minerals
  + Store carbohydrates, protein
* Large amount of absorption occurs through root hairs
  + Root hairs:
    - Increase surface area to maximize absorbion
* Modified roots
  + Prop roots:
  + Storage roots: used to help feed the plant for the next growth. Help it survive.
  + Buttress roots
  + “Strangling” aerial roots
  + Pneumatophores: good with help to gather oxygen for the plants to survive
* Stems
  + Raise and separate leaves
  + Support plant
  + Conduct materials from roots and leaves
  + Diagram of a reproductive shoot (flower)
    - Node: portion where the stem pops out
* Apical dominance
  + Inhibition of lateral buds on stem by an apical bud
  + Presence of the main point(growing bud) sets a dominance and stops the other buds from growing until it is finished growing
  + The lower bugs are more older where as the one son top are younger
  + How to test the domanint bud?
    - Cut off the apical bud itself. Stop the dominance
      * Then the buds underneath would grow out until one became the new dominant
* Modified stems
  + Serve functions other than just extending leaves, such as reproduction, storage
  + Rhizomes: (below ground structure and involved in asexual reproduction)ginger example
  + Bulbs: (union)
  + Stolons: strawberries asexual reproduction(clone of mom)
  + Tubers: potatoes modified stems not roots
    - Modified by natural selection
    - Good for storage to help grow next year’s potatoes
    - You tell them not roots because the will grow buds on one end and root at one end
* Leaves
  + Main photosynthetic organs Monocot: grass
  + Dicots: different forms of leaves
    - Simple: oak leave example
    - Compound: ash leave example
    - Double compound: honey locus leave example
* Modified leaves
  + Tendrils: help vining plants grab and hold onto things and help growth
    - Grape vines example
    - Pea plants
  + Spines
  + Storage leaves: good for holding water to survivie in dry habitiats
    - Example is alovara
  + Reproductive leaves
    - Baby plantlets growing off the leaf(form of asexual reproduction)
  + Bracts: ppintsetta
    - There are no pettles but bracts: they aid in reproduction and attraction of polinaters
* Plant tissue
  + Dermal: skin outer couvering
  + Vascular: circulatory system
  + Ground: cells and tissue that are not the first two but everything else in between
* Dermal tissue system
  + Epidermis with waxy cuticle
  + Periderm replaces epidermis in stems of woody plants
* Trichomes
  + Epidermal cells that can provide protection from herbivores and other stresses
  + They are little hairs that cover the plants called leaf hairs as well
    - Branched trichome
    - Glandular trichomes good with defence
* Vascular tissue the circulatory system
  + Xylem conducts water and minerals upward
  + Phloem conducts sugars from where they are produced to where they are needed; “source to sink”
  + Xylem and phloem are bundled n the stele in roots, dispersed in bundles in the stems
* Xylem
  + Dead and hollow at maturity
  + Tracheids more primitive: earliest livng cell, not very advanced
    - More primitive have them
  + Vessel elements more advanced and efficient, larger, fit in to end with other vessel elements
    - More advanced have these
  + But some can have both
* Phloem: like Xylem vessel cells
  + They are alive when active
  + Partlially alive at maturity
  + Companion cells provide cellular support when the cell is active
    - Without a companion the cell cant work
    - The phloem cell has no nucleus
* Ground tissue
  + All tissue that is neither epidermal nor vascular
  + Internal vascular tissue is pith
  + External to vascular tissue is cortex
  + Ground tissue includes cells specialized for storage, photosynthesis, and support
* Parenchyma cells
  + Thin-walled cells with large vacuole
  + Intercellular spaces may be present
  + Most common type of ground tissue
* Collenchyma cells
  + Flexible support with unevenly thickened cell walls
  + Most common to be exposed to is the strings in the stalk of celleary
* Sclerenchyma cells
  + Rigid support
  + Thick secondary walls with lignin
* Slide 21: Diagram of plants with indeterminate growth
  + This growth wil continue as long as they are allowed to grow
  + Only purpose is to make more cells and grow
  + Major growing points of the plant
* Types of life cycles
  + Annuals complete life cycle in one year
  + Biennials complete life cycle in two years
  + Perennials live many years
* Slide 23 Shows Primary root growth
* Slide 24 Shows Root structure
* Slide 25 Shows Lateral root growth
* Slide 26 Shows Primary growth of shoots growth in height
* Slide 28 Shows Stem structure
* Slide 29 Shows Leaf structure
  + All growth happens at the elongation tip
* Secondary growth
  + Lateral meristems add thickness to woody plants, a process called secondary growth
  + There are two lateral meristems: the vascular cambium and the cork cambium
    - The vascular cambium adds layers of vascular tissue called secondary xylem (wood) and secondary phloem
    - The cork cambium replaces the epidermis with periderm, which is thicker and tougher
* Slide 31 Diagram
* Slide 32 Diagram
* Slide 33 Diagram

Information for Exam

* Don’t worry about alpha gamma beta classification level. To in-depth

Plant structure and growth

* Todays lecture is part of the exa but a very small part.
* Mainly focus on the other lectures for studying first.
  + Last session in our mind
  + This lecture is also mainly for the next session for class.

Summary of main points from the class lectures for the Exam

Topic: Bacteria and Archaea

Topic Protists

Topic How Plants Colonized Land

Topic The Evolution of Seed Plants

Topic Plant Structure and Growth

Exam 5 Topics to study

03/21/2018

Plant Transport

Topic: Resource acquisition and transport in vascular plants

* Trade Offs (IMPORTANT)
  + A competing process if you have more of one you have less of the other and vis versa
* Overview of what a plant does
  + Plant does a lot with transportation regarding water and minerals (mineral nutrients)
    - A lot of this takes place in the roots of the tree or plant
    - Plants take in CO2 and then releases O2
    - Also produces CO2
    - At night take in O2 and release CO2
    - Day take in CO2 and release O2
    - H2O is also released
  + Plants have a stem structure similar to cat tail
  + There is a take in of light
    - This helps produce sugar for the plant or tree
* Shoots are optimized to capture light and reduce water loss
  + Leaves are there to take in sun light for the plant/tree for energy
  + Large leaves in tropical forests
    - High chance of water loss with bigger leaves
  + Small leaves in dry environments
    - Low chance of water lose with smaller leaves but dry/ windy environments give a high risk of water lose
  + Different leaf arrangement changes how light is captured and the amount collected
    - Alternate **phyllotaxy** limits overlapping of leaves in lower environments
      * One leaf per node
    - Opposite phyllotaxy may be advantageous in high light environments
      * Two leaves per node
* Leaf orientation optimizes light conditions
  + Some plants will move or change directions to gain the max amount of sun energy during the day (Example: Sunflowers)
  + More sunlight = greater reproduction, growth, and development
  + Some plants also know when they will have to much sunlight, they will then block sunlight so they don’t get to much
  + Heliotropism is what this is called: Directional movement in response to the direction of the sun.
* Roots are optimized to absorb and anchor
  + Taproot systems anchor tall plants (Dicot plants have the taproot system: two baby leaves in the single seed)
  + More branching in areas of high resources
  + Less branching in root of self
  + **Mycorrhizae** enhance root absorption (This is a fungus called fungal root)
    - They are mutualistic to plants (both parties benefit from symbiosis)
  + Roots are not simple and straight, tey are complex and twist and travel underground to find the best nurtrients and areas to grow and expand
* Substances move through the apoplast and/or the symplast
  + Under the ground: there is not just dirt
    - There are water particles surrounding the dirt particles
  + When water enters the cell molecules
    - There is the cell wall
    - Cytosol (different routes for the water to travel through)
      * Symplastic route (Plasmodesma)
        + This is cell to cell route
      * Transmembrane route (Plasma Membrane)
        + Outside the cell membrane but in the cell tissue

This is the Apoplastic route it travels through

* Movement of substances across cell membranes
  + **Proton** pumps set up chemiosmotic gradient, which is then used for co-transport
    - This pump allows you to tell the difference from plant and animal cells
    - Since only one of the two has it
  + **Ion** channels open in response to chemicals, pressure or voltage
* Water moves by osmosis
  + A Gradient in **Water potential** drives direction of water movement
    - **RULE!** Water moves from areas of higher water potential to areas of lower water potential
    - Water potential is designated as (symbol?) and is measured in Mpa = MegaPascals
    - Water potential is determined by solute concentration and physical pressure
      * Water potential = salute+pressure
      * The addition of solutes **decreases** water potential
      * Adding positive pressure **increases** water potential
* Slide 12 Diagram Shows how water potential works with salute and pressure changes
  + Pure water with no pressure or salute = a 0-water potential
  + Add salute: decreases water potential
  + Add pressure: increase water potential
  + Add negative pressure or tension: decrease water potential

03/23/2018

Topic: Resource acquisition and transport in vascular plants

* Turgor pressure and wilting
  + Turgio Cell:
  + Flaccio Cell:
  + Turgor loss in plants causes **wilting**, which can be reversed when the plant is watered
* Bulk flow
  + For long distances, plants rely on **bulk flow** for transport
  + Bulk flow is movement of liquid in response to a pressure gradient
  + Bulk flow is independent of solute concentration
* Moving water and minerals into xylem Slide 16
  + All vascular tissue is centered around the root
  + Root hairs important for soaking up water for the roots and plant
  + Vascular system has a protective layer around it to keep unwanted material and things from getting in the vascular cylinder called the endodermis
* Xylem
  + Dead and hollow and maturity
  + **Tracheids** more primitive
  + **Vessel elements** more advanced and efficient
  + They are part of the apoplastic route
  + They have many holes in its structure to help allow water molecules to pass through and not allow it to create blockage
* Water and minerals in the **xylem** move by bulk flow driven by transpiration
  + Is water pushed into the plants or pulled to the top?
* There is some pushing of water by root pressure due to pumping of minerals into xylem, but pressure is small
  + Guttation from hydothodes
* Cohesion-tension hypothesis explains how transpiration **pulls** water up
  + Briefly, transpiration causes the “pull” with negative water potential (= negative pressure or tension), then cohesion transmits the pull along the entire plant
    - Cohesion is the attractive force between each water molecule
  + Adhesion helps move water as well
    - Adhesion is the attractive force between the water molecule and the xylem wall
  + Transpirational pull goes from the stomata, through the xylem, through the roots, all the way into the soil solution
  + Think of water molecules being pulled by a chain through the xylem cells since water moves from high positive pressure to lower negative pressure
  + Hydrogen bonding allows the water molecules to stick together
* Slide 21 Diagram
  + Measurements of water potential
    - Soil has a slightly negative water pressure (why?)
      * Because of the ions dissolved in the water
      * Dissolved elements in water lowers water potential
    - From starting at the soil and going up, the water potential becomes more and more negative as we go to the tree trunk, leaves, and to the outside air
    - Through xylem cells this is always a one way trip
    - The whole process is driven by the sun’s energy
* Loss of cohesion and subsequent air bubbles cause cavitation
  + Air bubbles that can sometimes appear in xylem cells
    - In our bodies when this happens it’s called embolism
* Stomata balance the need for CO2 for photosynthesis with water loss through transpiration
  + These are guard cells here on slide 23 as shown
    - When cells full of solution then cells will open up when there is no solution, the cell will close
  + 95% of water loss is through stomata
* Stomata density is controlled by genetics and by environment
  + Desert plants have fewer stomata than forest plants
  + Stomata density has decreased since 1927 due to increase
* Control of stomatal opening and closing
  + Turgid guard cells open stoma
  + Triggered by opening of K+ channels
  + Guard cells are just special cells of the epidermis
  + Example: if we wanted to fill up a cell with water, what could we do to it?
    - Pump solute or ions into the cell to manipulate the guard cells
* Triggers to stomatal opening/closing
  + In the morning (stomata open)
    - Blue-light receptors
    - CO2 depletion
    - Internal circadian clock
  + Due to environmental stresses (stomata close)
    - Wind
    - High temperature
    - Abscisic Acid (a hormone) produced in response to water deficiency, which then causes stomatal closing
  + During day time if they close to not get to much sun, when CO2 is depleted they will open back up again.
* Adaptations in xerophytes Slide 27
* Translocation is the movement of photosynthetic products through the phloem
  + Phloem sap moves sugars from source to sink
    - Phloem sap also contains amino acids, hormones and materials
* Phloem
  + Partially alive to maturity
  + **Companion cells** provide cellular support
* Sugar is loaded into phloem usually through active transport
* Phloem movement is bulk flow by positive pressure
* Source sink relationships can be investigated with radiolabeling experiments
* Using aphids to study phloem sap

03/26/2018

Topic: Plant Signaling and Hormones

* Concept 39.1: Signal transduction pathways link signal reception to response
  + Plants have cellular receptors that detect changes in their environment
  + For a stimulus to elicit a response, certain cells must have an appropriate receptor
  + Stimulation of the receptor initiates a specific signal transduction pathway
* Reception
  + Internal and external signals are detected by receptors, proteins that change in response to specific stimuli
* Transduction (When the signal is received by the cell)
  + Second messengers transfer and amplify signals from receptors to proteins that cause responses
* Slide 6 Diagram
  + The final response that helps the plant grow in the environment it is in.
* Slide 5 Diagram
  + Protine kinase
    - phosphorylate proteins
      * This activates other proteins and gets them moving
  + Protein Phosphatases
    - Slows down proteins
* Concept 39.2: Plant hormones help coordinate growth, development, and responses to stimuli
  + Hormones are chemical signals that coordinate different parts of an organism
* Slide 7 Diagram
  + Studies on phototropism led to discovery of the first plant hormone
    - Pos: towards light
    - Neg: away from light
* Slide 8 Diagram
  + Fritz Went discovers auxin in 1926
    - He is known as the godfather of plants because of his discoveries.
* A Survey of Plant Hormones
  + In general, hormones control plant growth and development by affecting the division, elongation, and differentiation of cells
  + Plant hormones are produced in very low concentration, but a minute amount can greatly affect growth and development of a plant organ
* Slide 10 Diagram
  + A diagram to show the different hormones of plants and tells what they do
* Auxin
  + The Role of Auxin in Cell Elongation
    - According to the acid growth hypothesis, auxin stimulates proton pumps in the plasma membrane
    - The proton pumps lower the pH in the cell wall, activating **expansins** (loosen the cell wall and help it expand), enzymes that loosen the wall’s fabric
    - With the cellulose loosened, the cell can elongate
    - Helps the stems and the rest of the plant grow and get bigger by stimulating other things in the cells to help them grow, this is done by stimulating proton pumps
* Slide 12 Diagram
  + Example of the process of Elongation
* Lateral and Adventitous Root Formation
  + Auxin is involved in root formation and branching
  + An overdose of auxin can kill dicots
* Cytokinins (means cell division)
  + Cytokinins are so named because they simulate cytokinesis (cell division)
  + Cytokinins are produced in actively growing tissues such as roots, embryos, and fruits
  + Cytokinins work together with auxin to control cell division and differentiation
* Control of Apical Dominance
  + Cytokinins auxin, and other factors interact in the control of apical dominance, a terminal bud’s ability to suppress development of axillary buds
  + If the terminal bud is removed, plants become bushier
  + Slide 16 Diagram
    - Diagram of a Bean plant
* Gibberellins
  + Gibberellins have a variety of effects, such as stem elongation, fruit growth, and seed germination
  + Fruit Growth
    - In many plants, both auxin and gibberellins must be present for fruit to set
    - Gibberellins are used in spraying of Thompson seedless grapes
* Slide 18 Diagram
* GA promotes seed germination Slide 19 Diagram
  + This is the cell that gets cells to germinate when it is time to germinate
  + This is the enzyme that breaks down starch
* Abscisic Acid
  + Abscisic acid (ABA) slows growth
  + Two of the many effects of ABA:
    - Seed dormancy
      * Seed dormancy ensures that the seed will germinate only in optimal conditions
      * In some seeds, dormancy is broken when ABA is removed by heavy rain, light, or prolonged cold
      * Precocious germination is observed in maize mutants that lack a transcription factor required for ABA to induce expression of certain genes
    - Drought tolerance
* Slide 22 Diagram
* Ethylene (Also a Growth Inhibiting Hormone)
  + Plants produce ethylene in response to stresses such as drought, flooding, mechanical pressure, injury, and infection
  + The effects of ethylene include response to mechanical stress, senescence, leaf abscission, and fruit ripening
* Slide 24 Diagram (The Triple Response to Ethylene)
* Ethylene-insensitive mutants fail to undergo the triple response after exposure to ethylene
* Other mutants undergo the triple response in air but do not respond to inhibitors of ethylene synthesis
* Slide 26 Diagram
* Senescence
  + Senescence is the programmed death of plant cells or organs
  + A burst of ethylene is associated with apoptosis, the programmed destruction of cells, organs, or whole plants
  + Fruit ripening is also stimulated by ethylene
* Leaf Abscission
  + A change in the balance of auxin and ethylene controls leaf abscission, the process that occurs in autumn when a leaf falls
* Slide 29 Diagram

03/30/2018

Topic: Plant Responses to Environmental Stimuli

* Plant Responses to Gravity
  + - Response to gravity is known as gravitropism
    - Roots show positive gravitropism
    - Shoots show negative gravitropism
    - Plants detect gravity by the settling of statoliths
      * They fall to the bottom of the cell to determine what direction is down.
  + Statoliths are found in plastids called amyloplasts, in cells called statenchyma
  + Hypothesis: In root, Auxin orients on side of the root where satoliths have settled. Auxin inhibits cell elongation. In shoot, the opposite occurs.
* Mechanical Stimuli
  + Thigmomorphogenesis refers to adaptive changes in form that result from mechanical disturbance
  + Response controlled by ethylene, gibberellins, and auxin
  + Thigmotropism is growth in response to touch (vines and other climbing plants)
  + Some plants have particularly rapid touch-induced responses, such as thigmonasty (touch induced leaf folding)
  + Momisa pudica (Sensitive plant)
* Mechanical Stimuli: Signal Transmission
  + Relies on action potentials transmitted from source by sensory hairs through phloem sieve tubes by way of a strong, positive proton flux (H+ = +)
  + Signal reaches the pulvinus and stimulates a rapid unloading of K+ and sugars into the apoplast, H2O follows, loss of turgor, leaf collapses
* Plant Responses to Stresses Diagram Slide 7
  + High and Low Temp can put stress on plants and different temp will give different types of stress.
* Abiotic stresses: Drought
  + Water stress (drought stress)
  + “Too much water loss and not enough water to replace it”
  + H2O massabs < H2O masslost
* Drought Stress Responses (Will not go into details about this)
  + Physiological: Loss of turgor, stomata close, reduced growth
  + Biochemical: Decreased efficiency of RuBisCO, abscisic acid helps keep stomata closed
  + RuBisCO-ribulose 1,5-bisphosphate carboxylase-oxygenase
* Drought Stress Responses: RuBisCO Diagram Slide 10 (Will not go into details about this)
* Plant Response to Flooding
  + Oxygen deprivation induces ethylene (hormone) production : growth inhibiting hormone
  + Hormone causes apoptosis (programmed cell death), and opens “air tubes” that provide oxygen to submerged roots
* Abiotic Stresses: Salt Stress
  + Salt can be a direct toxin to plants
  + Salt can lower the water potential of the soil solution and reduce water uptake
  + Plants respond to salt stress by producing solutes, decreasing water potential in roots and increasing water uptake
* Abiotic Stresses: Heat Stress
  + Temps around above 90 to 100 degrees
  + Plants have a “sweating” response called evaporative cooling
  + Heat-shock proteins help protect other proteins from heat stress
  + These proteins work by guiding protein-folding as well as bind with other proteins and helps prevent denaturing
* Abiotic Stresses: Cold Stress
  + Cold temperatures decrease membrane fluidity
  + Plants alter lipid composition to compensate
  + Freezing causes ice to form in a plant’s cell walls and intercellular spaces
  + Antifreeze proteins prevent ice crystals from growing
* Plant Responses to Pathogen and Herbivore Attack (Things that try to eat plants)
* Biotic Stresses: Plant Pathogens
  + Include viruses, fungi, bacteria, phytoplasmas
  + Virulent pathogen: Plant has no recognition, can cause disease (Plant can’t fight back)
  + Avirulent pathogen: Plant can recognize, may harm but not kill (Plant can fight back)
  + First line of defense: The epidermis and periderm (bark)
* Plant Pathogen Recognition
  + Gene-for-gene recognition
  + Resistance (R) gene encoding R protein of plant recognizes avirulence (avr) gene product from pathogen
  + R proteins activate plant defenses by triggering signal transduction pathways leading to the hypersensitive response and systemic acquired resistance (SAR)
    - When the proteins can identify the attacker
  + Induction is typically associated with salicylic acid (SA) pathway
* The Hypersensitive Response
  + Induces production of H2O, phytoalexins, pathogenesis-related (PR) proteins, and Salicylic Acid (SA).
  + Stimulates changes in the cell wall that confine the pathogen (apoptosis around infection site)
* The Hypersensitive Response
  + Other early events include:
    - Phosphorylation of proteins
    - Production of reactive oxygen species (ROS) (e.g. H2O2)
    - Hypothesis: H2O2 plays a role in signaling
* Role of H2O2 in Stress Signaling (don’t worry much)
  + Mechanical stimuli promote the generation of H2O2 (e.g. leaves rubbing or insect feeding)
  + H2O2 shown to upregulated defense genes
    - Protease inhibitors
    - PR genes
    - Chitinases
    - Lipoxygenases
  + H2O2 show to reinforce cell walls via the oxidative cross-linking of proteins
  + Induces apoptosis
* Phytoalexins and PR Proteins (don’t worry much)
  + Phytoalexins
    - Antimicrobial and (sometimes) antioxidants
    - Rapidly accumulative at/near infection site
    - May degrade the cell wall, delay maturation, disrupt metabolism or prevent reproduction of the pathogen
  + PR proteins
    - Induced by infection (induction)
    - Some antimicrobial, attacking cell walls, some work as signals
* Systemic Acquired Resistance (long-distance response)
  + Systemic acquired resistance causes systemic expression of defense genes and is a long-lasting response (long-distance)
  + Salicylic acid (SA) is synthesized around the infection site and is likely the signal that triggers (long distance) systemic acquired resistance
* Biotic Stresses: Insect Herbivores Slide 23
* Plant Resistance to Insects: Defense Chemistry
  + Primary Metabolites: Fundamental to processes associated with growth of all plants (amino acids, sugars lipids, etc.)
  + Secondary Metabolites: Compounds that are not universally found in all plants. Usually associated with defense:

(don’t worry about structures for now)

* + - Terpenes
    - Phenolics
    - Glycosides
    - Alkaloids
* Plant Resistance to Insects: Mechanical Defense (physical defenses)
  + Trichomes
  + Sap discharge/flow
  + Formation of wound periderm
  + Silica in plant tissue (cereals) (How could this be a defense?)
  + Leaf toughness
* Insect Herbivory and Induced Defenses (don’t need to know)
  + Typically associated with Jasmonic Acid (JA) pathway
  + Some insect-induction (notably, phloem feeders) is associated with SA pathway
  + Insect feeding or even mechanical stimulation can induce transcriptional changes that upregulate defense mechanisms
  + OPRN3-RNAi is a type of tomato plant in which proper jasmonic acid signaling has been blocked using RNAi technology
* Induction of hormones and defenses in milkweed plants by Monarch caterpillar feeding (don’t need to know)
* Plant Resistance to Insects: Recruitment of Enemies
  + Volatile organic carbon (VOC) emission is induced by insect herbivory
  + VOC’s
    - Warn nearby plants
    - Attract parasitoids
    - Attract predators

04/02/2018

Topic: Biomes and Species Distributions

* Concept 52.1: Earth’s climate varies by latitude and season
  + The long-term prevailing weather conditions in an area constitute its climate
  + Four major abiotic components of climate are temperature, precipitation, sunlight, and wind
  + These factors determine the abundance, types, and distribution of organisms on earth
  + Macroclimate consists of large scale patterns
  + Microclimate consists of very fine scale patterns
* Global Climate Patterns (The sun drives all these changes)
  + Global climate patterns are determined largely by solar energy and the planet’s movement in space
  + The warming effect of the sun causes temperature variations, which drive evaporation and the circulation of air and water
* Slide 4 Diagram Latitudinal variation in sunlight intensity
* Slide 5 Diagram Global air circulation and precipitation patterns
  + This slide specifically shows that the wind blowing across the planet is moving in a way depending on how the earth is moving
  + Rising air masses release water and cause high precipitation, especially in the tropics
  + Dry, descending air masses create arid climates, especially near 30 degrees north and south
  + Cooling trade winds blow from east to west in the tropics; prevailing westerlies blow from west to east in the temperate zones
* Regional and Local Effects on Climate
  + Climate is affected by seasonality, large bodies of water, and mountains
* Slide 7 Diagram Seasonality
  + Earth has a constant tilt
  + Spines around itself once-a-day
  + Spines around the sun once-a-year
  + Seasonality at high latitudes is caused by the tilt of earth’s axis of rotation and its annual passage around the sun
  + Belts of wet and dry air straddling the equator shift throughout the year with the changing angle of the sun; winds shift too
* Slide 8 Image
* Slide 9 Diagram Bodies of water influence regional climates
  + California coast
    - The coast is rich for fishing
* Bodies of water influence wind patterns
  + During the day, air rises over warm land and draws a cool breeze from the water across the land
  + As the land cools at night, air rises over the warmer water and draws cooler air from land back over the water, which is replaced by warm air from offshore
  + Due to the daily warming and cooling cycle
* Slide 11 Diagram
  + Another daily pattern
  + More moist air flow, vegetation and life is more abundant rather than when the air cools down and becomes very cold
* Mountains
  + Rising air releases moisture on the windward side of a peek and creates a “rain shadow” as it absorbs moisture on the leeward side
  + Mountains affect the amount of sunlight reaching an area
  + In the Northern Hemisphere, south-facing sloped receive more sunlight than north-facing slopes
  + Temp Change Rule: Every 1,000 m increase in elevation produces a temperature drop of approximately 6 degrees C
* Slide 13 Diagram
* Slide 14 Diagram
* Microclimate
  + Microclimate is determined by fine-scale differences in the environment that affect light and wind patterns
  + Every environment is characterized by differences in :
    - Abiotic factors, including nonliving attributes such as temperature, light, water, and nutrients
    - Biotic factors, including other organisms that are part of an individual’s environment
* Concept 52.2: The structure and distribution of terrestrial biomes are controlled by climate and disturbance
  + Main distinction of a biome we have is what food is grown there and physical features
  + Biomes are major life zones characterized by vegetation type (terrestrial biomes) or physical environment (aquatic biomes)
  + Climate (temperature, precipitation, wind, etc.) is very important in determining why terrestrial biomes are found in certain areas
* Slide 17 Diagram
* General Features of Terrestrial Biomes
  + Terrestrial biomes are often named for major physical or climatic factors and for vegetation
  + Terrestrial biomes usually meld into each other, without sharp boundries, along ecotones; these may be wide or narrow
  + Vertical layering is an important feature of terrestrial biomes, and in a forest it might consist of an upper canopy, low-tree layer, shrub understory, ground layer of herbaceous plants, forest floor, and root layer
  + Similar charcteristics can arise in distant biomes through convergent evolution
    - Cacti in North America and euphorbs in African deserts appear similar but are from different evolutionary lineages
* Disturbance and Terrestrial Biomes
  + Disturbance in an event such as a storm, fire, or human activity that changes a community
    - For example, frequent fires can kill woody plants and mountain the characteristic vegetation of a
  + Describing Terrestrial Biomes
    - Terrestrial biomes can be characterized by distribution, precipitation, temperature, plants, and animals
  + Tropical Forest
    - Distribution is in equatorial and subequatorial regions
    - In tropical rain forests, rainfall is relatively constant, while in tropical dry forests precipitation is highly seasonal
    - Temprature is high year-round (25-29 degrees C)
    - Layerd vegetation; light competition is intense
    - High biodiversity
* Slide 22 Diagram
* Temperate Broadleaf Forest
  + Found at midlatitudes in the Northern Hemisphere, with smaller areas in Chile, South Africa, Australia, and New Zealand
  + Significant amounts of precipitation fall during all seasons as rain or snow; winters average 0 degrees C; summers are hot and humid (near 35 degrees C)
  + Vertical layers are dominated by deciduous trees in the Northern Hemisphere and evergreen eucalyptus in Australia
* Desert
  + Deserts occur in bands near 30 degrees, north and south of the equator, and in the interior of continents
  + Precipitation is ow and highly variable, generally less than 30 cm per year
  + Deserts may be hot or cold

04/04/2018

* Temperate Grassland
  + Found on many continents
  + Winters are cold (often below -10 degrees C) and dry; summers are hot (often near 30 degrees C) and wet
  + The dominant plants, grasses and forbs (small plants), are adapted to droughts and fire
  + Native mammals include large grazers such as bison and wild horses and small burrowers such as prairie dogs
  + Most grasslands have been converted to farmland
* Concept 52.3: Aquatic biomes are diverse and dynamic systems that cover most of Earth
  + Aquatic biomes account for the largest part of the biosphere
  + Marine biomes hve salt concentrations of about 3 percent
  + Oceans cover about 75 percent of Earth’s surface and have an enormous impact on the biosphere
  + Freshwater biomes have salt concentrations of less than 0.1 percent
  + Freshwater biomes are closely linked to soils and the biotic components of the surrounding terrestrial biome
* Slide 33 Diagram Zonation in Aquatic Biomes
  + Littoral Zone:
  + Limnetic Zone: Open zone
  + Photic Zone: Zone where light is penetrated
  + Benthic Zone: Bottom of the body of water
  + Aphotic Zone: No light
  + In oceans and most lakes, a temperature boundary called the thermocline separates the warm upper layer from the cold deeper water; many lakes undergo turnover
  + Describing Aquatic Biomes
    - Major aquatic biomes can be characterized by their physical environment, chemical environment, geological features, photosynthetic organisms, and heterotrophs
  + Lakes
    - Temperate lakes may have a seasonal thermocline; tropical lowland lakes have a year-round thermocline
    - Oligotrophic lakes are nutrient-poor and generally oxygen-rich often deep, also very cold
    - Eutrophic lakes are nutrient-rich and often depleted of oxygen; often shallow, often warmer
    - Zooplankton are drifting heterotrophs that graze on the phytoplankton
    - Invertebrates live in the benthic zone; fishes live in all zones with sufficient oxygen
  + Streams and Rivers
    - Headwaters are generally cold, clear, turbulent, swift, and oxygen-rich; they are often narrow and rocky
    - Downstream waters from rivers and are generally warmer, more turbid, and less oxygenated; they are often wide and meandering and have silty
    - They may contain phytoplankton or rooted bottoms aquatic plants
    - A diversity of fishes and invertebrates inhabit unpolluted rivers and streams
  + Different species live in different environments depending on these conditions
    - Brook Trout: like colder low nutrient rich rivers
    - Brown Trout: Like warmer waters and rich nutrient rivers
* Estuaries (good example for transition areas: rivers meeting the sea Like an ecotone)
  + An estuary is a transition area between river and sea and are nutrient-rich and highly productive
  + Salinity varies with the rise and fall of the tides
  + Estuaries include a complex network of tidal channels, islands, natural levees, and mudflats
  + Saltmarsh grasses and algae are the major producers
  + An abundant supply of food attracts marine invertebrates, fish, waterfowl, and marine mammals
* Marine Benthic Zone
  + The marine benthic zone consists of the seafloor below the surface waters of the coastal, or neritic, zone and the offshore pelagic zone
  + Organisms in the very deep benthic (abyssal) zone are adapted to continuous cold and extremely high-water pressure
  + Substrate is mainly soft sediments; some areas are rocky
  + Basis of the food chain are chemoautotrophic bacteria
* Concept 52.4: Interactions between organisms and the environment limit the abundance and distribution of species
  + Species distributions are the result of ecological and evolutionary interactions through time
  + Ecological time is the minute-to-minute time frame of interactions between organisms and the environment
  + Evolutionary time spans many generations and captures adaptation through natural selection
  + Ecologists ask questions about where species occur and why species occur where they do
* Dispersal and Distribution
  + Dispersal is the movement of individuals away from centers of high population density or from their area of origin
  + Dispersal contributes to the global distribution of organisms
* Natural Range Expansions and Adaptive Radiation
  + Natural range expansions show the influence of dispersal on distribution
    - For example, cattle egrets arrived in the Americas in the late 1800s and have expanded their distribution
* Global Climate Change
  + Changes in Earth’s climate can profoundly affect the biosphere
  + One way to predict the effects of furture global climate change is to study previous changes
  + As glaciers retreated 16,000 years ago, tree distribution patterns changed
  + As climate changes, species that have difficulty dispersing may have smaller ranges or could become extinct
* Species Translocations
  + Include organisms that are intentionally or accidentally relocated from their original distribution
  + If a transplant is successful, it indicates that its potential range is larger than its actual range
* Behavior and Habitat Selection
  + Some organisms do not occupy all of their potential range
  + Species distribution may be limited by habitat selection behavior in response to biotic and abiotic factors
* Influence of biotic factors on species distributions Graph: Slide 57
* Abiotic Factors
  + Abiotic factors affecting the distribution of organisms include:
    - Temperature
    - Water
    - Sunlight
    - Wind
    - Rocks and soil
  + Most abiotic factors vary in space and time

Final Exam Notes and Review

04/09/2018

Topic: 1

Section A: 1150 Population Ecology-Demographics and Population Growth

1. Concept 53.1 Dynamic biological processes influence population density, dispersion, and demographics
   1. A population is a group of individuals of a single species living in the same general area
   2. Populations are described by their boundaries and size
   3. Population ecology is the study of populations in relation to their environment, including environmental influences on density and distribution, age structure, and population size
2. Describing Populations
   1. **Density** is the number of individuals per unit area or volume
      1. Density: A Dynamic Perspective
         1. Population size can be estimated by either extrapolation from small samples (e.g., in quadrats or transects for plants), an index of population size (e.g., number of nests), or the **mark-recapture method**
         2. Transects: Walk along the area of the population. At every so often to a point, you check the surrounding and mark what kind of environment and what kind of species are in these areas as you check from spot to spot.
         3. Mark-recapture method
            1. Capture, tag, and release a random sample of individuals (s) in a population
            2. Capture a second sample of individuals (n), and note how many of them are marked (x)
            3. Population size (N) is estimated by:

N = sn\x

100 = (50 \* 20)\10

* 1. **Dispersion** is the pattern of spacing among individuals
     1. Patterns of Dispersion
        1. Environmental and social factors influence the spacing of individuals in a population.
        2. In a **clumped** (most common) dispersion, individuals aggregate in patches a clumped dispersion may be influenced by resource availability (food) and behavior (breeding)
        3. A **uniform** (evenly, also a very rare type of dispersity) dispersion is one in which individuals are evenly distributed
        4. It may be influenced by social interactions such as **territoriality**, the defense of a bounded space against (very energy depleting)
        5. In a **random** dispersion, the position of each individual is independent of other individuals
        6. It occurs in the absence of strong attractions or rep

1. Population sizes and densities are determined by:
   1. Births
   2. Deaths
2. Demographics
   1. **Demography** (for humans an example would be life insurance companies) is the study of the vital statistics of a population and how they change over time
   2. Death rates and birth rates are of particular interest to demographers
3. Life Tables
   1. A **life table** is an age-specific summary of the survival pattern of a population
   2. It is best made by following the fate of a **cohort**, a group of individuals of the same age
   3. Survivorship curves can be classified into three general types (Life History of an Organism)
      1. Type 1: low death rates during early and middle life and an increase in death rates among older age groups
      2. Type 2: a constant death rate over the organism’s life span
      3. Type 3: high death rates of the young and a lower death rate for survivors
4. Reproductive Rates
   1. For species with sexual reproduction, demographers often concentrate on females in a population
   2. A **reproductive table**, or fertility schedule, is an age-specific summary of the reproductive rates in a population

Section B: Concept 53.2: The exponential model describes population growth in an idealized, unlimited environment

1. It is useful to study population growth in an idealized situation to understand the captivity of species to increase and the conditions that may facilitate this growth
2. Per Capita (per head) Rate of Increase
   1. Change in population size = Births + Immigrants entering population – Deaths – Emigrants leaving population
   2. If immigration and emigration are ignored, a population’s growth rate (per capita increase) equals birth rate minus death rate
   3. The population growth rate can be expressed mathematically as where is the change in population size, **Δ**N/**Δ**t is the time interval, B is the number of births, and D is the number of deaths
   4. Births and deaths can be expressed as the average number of births and deaths **per individual** during the specified time interval B = bN, D = mN where b is the annual **per capita** birth rate, m (for mortality) is the **per capita** death rate, and N is population size
   5. The population growth equation can be revised From this **Δ**N/**Δ**t = bN - mN To this **Δ**N/**Δ**t=rt
   6. The per capita rate of population increase (r) is given by r = b – m
   7. Zero population growth (ZPG) occurs when the birth rate equals the death rate (r = 0)
   8. Change in population size can now be written as From this… To this…
   9. Instantaneous growth rate can be expressed as
      1. Where rinst is the instantaneous per capita rate of increase
3. Exponential Growth (exponential growth = J-shaped curves)
   1. Exponential population growth is population increase under idealized conditions
   2. Under these conditions, the rate of increase is at its maximum, denoted as rmax
   3. The equation of exponential population growth is
   4. The J-shaped curve of exponential growth characterizes some rebounding populations
      1. For example, the elephant population in Kruger National Park, South Africa, grew exponentially after hunting was banned

Section C: Concept 53.3: The Logistic model describes how a population grows more slowly as it nears its carrying capacity

1. Exponential growth cannot be sustained; a more realistic population model limits growth by incorporating carrying capacity
2. **Carrying capacity** (K) is the maximum population size the environment can support
3. Carrying capacity varies with the abundance of limiting resources
4. The Logiistic Growth Model
   1. In the logistic population growth model, the per capita rate of increase declines as carrying capacity is reached
   2. The logistic model starts with the exponential model and adds an expression that reduces per capita rate of increase as N approaches K
      1. dN/dt = rmax N((K - N)/K)
   3. Some populations overshoot K before settling down to a relatively stable density
   4. Some populations fluctuate greatly and make it difficult to define K
   5. Some populations show an Allee effect, in which individuals if the population size is too small (e.g., pollination limitation)

Topic: 2

Concept 53.4: Life history traits are products of natural selection

* An organism’s life history comprises the traits that affect its schedule of reproduction and survival
  + The age at which reproduction begins
  + How often the organism reproduces
  + How many offspring are produced during each reproductive cycle
* Life History traits are evolutionary outcomes reflected in the development, physiology, and behavior of an organism

Evolution and Life History Diversity

* Species that exhibit semelparity (grow for a while until environmental conditions say otherwise), or big-bang reproduction, reproduce once and die; best in variable environments
* Species that exhibit iteroparity, or repeated reproduction, produce offspring repeatedly; best in dependable environments

“Trade-offs” and Life Histories

* Organisms have a finite amount of resources available to them, which may lead to trade-offs between survival and reproduction
  + There is a trade-off between survival and paternal care in many birds
  + Tradeoffs exist between seed size and survival percentage in plants (many small seeds vs. few large seeds)

Concept 53.5: Many factors that regulate population growth are density-dependent

* There are two general questions about regulation of population growth
  + What environmental factors stop a population from growing indefinitely?
  + Why do some populations show radical fluctuations in size over time, while others remain stable?

Population Growth and Population Density

* In populations showing density-independent growth, birth rate and death rate do not change with population density
* In populations showing density-dependent growth, birth rates fall, and death rates rise (or otherwise vary) with population density

Mechanisms of Density-Dependent Population Regulation

* Density-dependent birth and death rates are an example of negative feedback that regulates population growth
* The important of these factors changes in intensity as population density changes

Competition for Resources

* In crowded populations, increasing population density intensifies competition for resources and results in a lower birth rate

Toxic Wastes

* Accumulation of toxic wastes can contribute to density-dependent regulation of population size

Predation

* As a prey population builds up, predators may feed selectively on that species

Intrinsic Factors

* For some populations, intrinsic (physiological/hormonal) factors appear to regulate population size

Territoriality

* In many vertebrates and some invertebrates, competition for territory may limit density

Disease

* Population density can influence the health and survival of organisms in the face of pathogens
* In dense populations, pathogens can spread more rapidly

Population Dynamics

* The study of population dynamics focuses on the complex interactions between biotic and abiotic factors that cause variation in population size
* Populations of some species fluctuate in regular cycles; in others, cycles are less clear

Population Cycles: Several hypotheses have been proposed to explain the hare’s 10-year interval

* Hypothesis 1: The hare’s population cycle follows a cycle of winter food supply
* If the hypothesis is correct, then the cycles should stop if the food supply is increased
* Additional food was provided experimentally to a hare population; the whole population increased in size but continued the cycle
* Hypothesis 2: The hare’s population cycle is driven by pressure from other predators
* In a study conducted by field ecologists, 90% of the hares were killed by predators

Stability and Fluctuation

* Both weather, food, and predator population can affect population size over time
  + Example, wolves and moose on Isle Royale

Factors leading to variable cycles

* Varying food quality for moose (spruce vs. aspen)
* Canine parvovirus affecting wolves
* Inbreeding in wolves leading to genetic mutations
* Warming temperatures leading to more ticks

Concept 53.6: The human population is no longer growing exponentially but is still increasing rapidly

* Graphs on slides: 23.24

Regional Patterns of Population Change

* To maintain population stability a regional human population can exist in one of two configurations
  + Zero population growth = High birth rate – High death rate
  + Zero population growth = Low birth rate – Low death rate
* The demographic transition is the move from the first configuration to the second and is associated with an increase in the quality of health care and improved access to education, especially for women

Age Structures

* Graph on slide: 26

Global Carrying Capacity

* Population ecologists predict a global population of 7.8-10.8 billion people in 2050; average estimate of K for humans is 10-15 billion

Limits on Human Population Size

* The ecological footprint concept summarizes the aggregate land and water area needed to sustain the people of a nation
* It is one measure of how close we are to the carrying capacity of Earth
* Our carrying capacity could potentially be limited by food, space, nonrenewable resources, or buildup of wastes
* Unlike other organisms, we can regulate our population growth through social changes

Topic 3

Community Ecology

* Community – A group of populations of different species (e.g., ants and birds) living close enough to interact.
* Characterized by:
  + Interactions between species (Part 1)

Part 1: Interspecific Interactions

* Interspecific Interactions – When two organisms (or populations) of different species interact.
* Examples of interspecific interactions include:

Competition

* + Competition
* Interspecific competition is a -/- interaction, where different species complete for a resource.
  + Grasshoppers and bison complete for grass in the Great Plains
  + Lynx and foxes complete for snowshoe hares
  + Garden plants and “weeds” complete for soil nutrients and water

Can species complete continuously for the same resources?

* Competitive exclusion – When two species compete, one wins, and the other is eliminated from the area.

Where do displaced species go?

* Worst Case: Extinction
* Best Case: New Niche
* Ecological niche – the sum of biotic and abiotic resources used by a species.
* Ecologically similar species can coexist in a community if their niches are different. The process of differentiation is called resource partitioning.

Competition can drive specialization and speciation

* Character displacement occurs when characteristics diverge more in sympatric populations than allopatric populations
  + Allopatric Populations
    - No direct competition for resources = no pressure for characteristics to change
  + Sympatric Populations
    - Direct competition for resources = high pressure for characteristics to change to give one population a competitive advantage

Types of Interspecific Interactions

* Competition
* Predation
* Herbivory
* Symbiosis
  + Parasitism
  + Mutualism
  + Commensalism
* Facilitation

Predation and Herbivory

* + Predation/Herbivory
* Predation – A +/- interaction between species where one species, the predator, kills and eats the other, the prey.
* Herbivory – A +/- interaction between species where an organism consumes plant or algal material.

Herbivory

Plant defenses:

* Spines and thorns
* Chemical toxins
  + Nicotine
  + Selenium
* Non-noxious feeding deterrents
  + Cinnamon
  + Cloves
  + Peppermint

Herbivore adaptions

* Chemical of sensing of noxious compounds
* Eating only a specific non-toxic part of the plant
* Specialized teeth or digestive systems

Predatory Adaptations

* Heat sensors
* Fangs
* Claws
* Poison
* Teeth
* Stingers

Prey adaptations

* Behavioral adaptations
  + Hiding/fleeing
  + Cryptic coloration – blending into your surroundings
  + Herd behaviors
  + Alarm calls
  + Stotting
  + Mimicry
  + Aposematic coloration – warning predators off with your color (e.g., poison dart frogs)

Mimicry

* Batesian mimicry – A palatable and/or harmless animal mimics an unpalatable/harmful organism
* Mullerian mimicry – When two (or more) poisonous/unpalatable organisms mimic each other.
* Aggressive mimicry – When a predator mimics its prey’s prey item to attract the prey.

Symbiosis

* + Symbiosis (parasitism, mutualism, commensalism)

Parasitism

* Symbiosis – When two or more species live in direct and intimate contact with one another.
* Parasitism – A +/- interaction in which one organism, the parasite, drives nourishment from another organism, its host, which is harmed in the process.
  + Endoparasites are parasites that live inside a host’s body
  + Endoparasites are parasites that live outside a host’s body
  + Parasitoids are parasites that eventually kill their hosts.

Mutualism

* Mutualism – a +/+ interspecific interaction
  + Obligate mutualism: at least one of the species cannot survive without its partner.
  + Facultative mutualism: both species can survive on their own.

Commensalism

* Commensalism – an interaction that benefits one species and neither harms nor helps the other species.
  + Hitchhikers – e.g., barnacles that live on whales or algae on turtle shells.

Facilitation

* + Facilitation
* Facilitation – When species have positive effects on each other without living in intimate contact.
  + Ecological Attributes (Part 2)

Part 2: (Ecological Attributes)

What is diversity?

* Species diversity – the variety of different kinds of organisms that make up the community.
  + Species richness – The number of different species in the community
  + Relative abundance – the proportion of the community that each species occupies.

Shannon’s Diversity

* General equation: H =
  + Where Pa = the proportion of the community made up by species a
* Community 1:
  + H =
* Community 2:
  + H =

Why does diversity matter?

* Diverse communities:
  + Better withstand environmental stresses (like droughts)
  + Are more productive and stable
  + More resistant to invasive species
    - Species not from that area that become established to the detriment of the native species previously occupying the space

What influences diversity?

* Interspecific Interactions?
* Trophic structure – the feeding relationships between organisms in a community
* Food chain – The process of moving organic matter (food) up trophic levels from autotrophs to decomposers.
* Food Web -

Why are food chains so short?

* Energetic hypothesis – the length of the food chain is limited by the inefficiency of energy transfer along the chain.
  + Only ~10% of the energy stored in the organic matter of each trophic level is converted to organic matter at the next
* Dynamic stability hypothesis – long food chains are less stable than short food chains. Population fluctuations at lower trophic levels are magnified at higher levels.

What influences diversity?

* Disturbance – type, intensity, frequency varies
* Intermediate Disturbance Hypothesis
  + Moderate disturbance levels result in highest diversity
  + High levels = exceed tolerance levels of most species
  + Low levels = allows competitively dominant species to persist

Topic 4

Ecosystems

* An Ecosystem consists of all the organisms living in a community, as well as the abiotic factors with which they interact
* Ecosystem dynamics involve two main processes: energy flow and chemical cycling
* Energy flows through ecosystems, whereas matter cycles within them

Concept 55.1 Physical laws govern energy flow and chemical cycling in ecosystems

Conservation of Energy

* The **first law of thermodynamics** states that energy cannot be created or destroyed, only transformed (into different forms of energy)
* Energy enters an ecosystem as solar radiation, is conserved, and is lost from organisms as heat. (deep sea communities rely on energy from the earth not solar radiation)
* The **second law of thermodynamics** states that every exchange of energy increases the entropy of the universe (systems move toward disorder, and energy such as heat)
* In an ecosystem, energy conversions are not completely efficient, and some energy is always lost as heat

Conservation of Mass

* The **law of conservation of mass** states that matter cannot be created or destroyed
* Chemical elements are continually recycled within ecosystems
* Ecosystems are open systems, absorbing energy and mass and releasing heat and waste products

Diagram Slide Primary focus on energy flow

* Terrestrial based diagram
  + Blue represents the chemical energy cycling
  + Red is the energy flow (heat)
  + There are also secondary and possible tertiary consumers and so on to consume the previous consumer and gain a part of the energy and heat from what it ate.

Concept 55.2: Energy and other limiting factors control primary production in ecosystems

* In most ecosystems, **primary production** is the amount of light energy converted to chemical energy by autotrophs during a given time period
* In a few ecosystems, chemoautotrophs are the primary producers
* The extent of photosynthetic production sets the spending limit for an ecosystem’s **energy budget**

Gross and Net Primary Production

* Total primary production is known as the ecosystem’s **gross primary production (GPP)**
* GPP is measured as the conversion of chemical energy from photosynthesis per unit time
* **Net primary production (NPP)** is GPP minus energy used by primary producers for respiration
* NPP is expressed as
  + Energy per unit area per unit time (J/m^2 \*yr), or
  + Biomass added per unit area per unit time (g/m^2 \*yr)

NPP varies by biome Diagram Slide 8

* NNP varies across the globe
* Darker colors (oceans, primary part of Africa the Sahara Desert) in diagram don’t have as much production as the lighter colors (Tropical areas around the equator)

Primary Production in Aquatic Ecosystems (light is very important with aquatic biomes)

* In marine and freshwater ecosystems, both **light** and **nutrients** control primary production
* Depth of light penetration affects primary production in the photic zone of an ocean or lake
* More than light, nutrients limit primary production in geographic regions of the ocean and in lakes
* A **limiting nutrient** is the element that must be added for production to increase in an area; often N and P (preventing you from collecting more of this nutrient to grow at your max potential)
* When there is to much of nutrients in a aquatic environment it is called Eutrophic

Graph Slide 10

* In some areas, sewage runoff has caused **eutrophication** of lakes, which can lead to loss of most fish species
* In lakes, phosphorus limits cyanobacterial growth more

Iron Limitation in Sargasso Sea Diagram Slide 12

* Some plants and people need metal as well in order to survive not just the energy gathered from plants and food.
* Table: Nutrient Enrichment Experiment for Sargasso Sea Samples
  + Would add nitrogen, phosphorus, and different metals (including iron and then excluding iron last nothing but iron with the chemicals)
  + Results: With iron everything grew crazy, without iron nothing could grow as much
  + Iron is needed for plant growth because> iron is present in a lot of the ions in photosynthesis for plants.

Primary Production in Terrestrial Ecosystems

* In terrestrial ecosystems, temperature and moisture affect primary production on a large
* Moisture and temperature are the big factors that will affect what happens in the ecosystem

Graph Slide 14 Simple figure about the relation of precipitation-x and net annual primary production-y

Nutrient Limitations and Adaptations That Reduce Them

* In terrestrial ecosystems, nitrogen is the most common limiting nutrient, but Phosphorus can also be limiting, especially in order soils
* Adaptations: mutualisms with bacterial symbionts and mycorrhizae, root hairs, cation exchange system

Concept 55.3: Energy transfer between trophic levels is typically only 10% efficient

* **Secondary production** of an ecosystem is the amount of chemical energy in food converted to new biomass during a given period of time (one thing that eats something else)
* An organism’s **production efficiency** is the fraction of energy stored in food that is used for growth, and not respiration
* Production efficiency = Net secondary production \* 100% / Assimilation of primary production

Diagram Slide 17

* Example of a big caterpillar eating a large leaf
* Shows the energy that is split up to be used to help run the caterpillar
* Caterpillar Production Efficiency of about 16%
* Birds and mammals have efficiencies in the range of 1 – 3% because of the high cost of **endothermy** (we try to keep regulating our temperature: we are endothermic species)
* Fishes have production of around 10%
* Insects and microorganisms have efficiencies of 40% or more

Trophic Efficiency and Ecological Pyramids

* **Trophic efficiency** is the percentage of production transferred from one trophic level to the next (feeding style of the species that is eating; what and how the species deals with the energy gained from the food eaten)
* It is usually about 10%, with a range of 5% to 20%
* Trophic efficiency is multiplied over the length of a food chain
* Approximately 0.1% of chemical energy fixed by photosynthesis reaches a tertiary consumer

Diagram Slide 20

* Energy Pyramid
* Bottom is 1,000,000 J of sunlight

Diagram Slide 21

* Energy Pyramid Data Gathered from experiments
* Certain aquatic ecosystems have **inverted biomass pyramids**: producers (phytoplankton) are consumed so quickly that they are outweighed by primary consumers
* **Turnover time** is the ratio of the standing crop biomass to production
* Dynamics of energy flow in ecosystems have important implications for the inefficient way of tapping photosynthetic production
* Worldwide agriculture could feed many more people if humans ate only plant material

Concept 55.4: Biological and geochemical processes cycle nutrients and water in ecosystems

* Gaseous carbon, oxygen, sulfur, and nitrogen occur in the atmosphere and cycle globally
* Less mobile elements include phosphorus, potassium, and calcium (Do not have a gaseous phase)
* These elements cycle locally in terrestrial systems but more broadly when dissolved in aquatic systems
* In studying cycling of water, carbon, nitrogen, and phosphorus, ecologists focus on four factors
  + Each chemical’s biological **importance**
  + **Forms** in which each chemical is available or used by organisms
  + Major **reservoirs** for each chemical
  + **Key processes** driving movement of each chemical through its cycle

The Nitrogen Cycle

* Nitrogen is a component of amino acids, proteins, and nucleic acids
* The main reservoir of nitrogen is the atmosphere (N2), though this nitrogen must be converted to NH4+ or NO3- for uptake by plants, via nitrogen fixation by bacteria
* Organic nitrogen is decomposed to NH4+ by ammonification, and NH4+ is decomposed to NO3- by nitrification
* Denitrification converts NO3- back to N2

Diagram Slide 27 Depiction of the Nitrogen Cycle

The Phosphorus Cycle

* Phosphorus is a major constituent of nucleic acids, phospholipids, and ATP
* Phosphate (PO4^3-) is the most important inorganic form of phosphorus
* The largest reservoirs are sedimentary rocks of marine origin, the oceans, and organisms
* Phosphate binds with soil particles, and movement is often localized

Diagram Slide 29 Depiction of the Phosphorus Cycle

Diagram Slide 30 Ignore This Slide

Topic 5

Conservation and Global Change (2)

Slide 2 Diagram Mass Extinctions Table

Scientists identify species, communities and ecosystems that are in danger

Conservation biology seek to conserve, preserve and restore biodiversity

Benefits of biodiversity

* Food
  + As many as 80,000 edible wild plant species could be utilized by humans
* Drugs and medicines
  + 40% of all prescriptions contain some natural product
  + Pharmaceutical companies actively prospect tropical countries for products
  + Rosy periwinkle

Slide 7 Diagram Some Natural Medicinal Products Table

Benefits for Biodiversity

* Americans spend ~$104 billion annually on wildlife-related recreation
* There are also human health benefits with going out in nature

Ecosystems provide ecosystem services

* $33 trillion global value per year
* $8B to build plant plus $300M/year to operate OR
* $1B in land acquisition and education

Threats to biodiversity

* Habitat loss
  + Limiting grow and species live and diversity because of a loss in territory
* Invasive/Introduced species
  + Can be a reason of killing or an extinction of a local species
* Overharvesting
  + Removing or lowering food availability for other species that they could need to survive
  + Or killing and hunting other species to a point that we are on the verge of extinction species for food or other resources
* Global change (availability of nutrients)
  + Excess N (nitrogen) causes Gulf of Mexico hypoxia
  + Slide 17 Graph Diagram
    - Rising CO2 levels drive temperatures up
      * From burning fossil fuels, plus massive deforestation
  + Slide 18 Graph Diagram
    - Changes in CO2 levels and temperature correlate over the long term
  + Slide 20 Graph Diagram
    - Decrease in acidity of precipitation

What effect is climate change already having on physical systems?

* Glacier Melting
* More Severe Storms
* Increase Drought Frequency

What effect is climate change already having on biological systems?

* Coral bleaching
* Polar bears and Declining Sea Ice
  + Polar bears need the ice to survive

Conservation Strategies (for smaller threats)

* Identifying areas for protection
  + Terrestrial biodiversity hot spots
  + Marine biodiversity hot spots
* Restoring ecosystems/habitat management
  + Bring the ecosystem back to a time where its more suitable for the animals to survive
* Providing connectivity
  + Allow a way for the animals and species to still get to there destination in the environment
* Creating preserves
  + Take what is there and keep it safe and don’t take anything out and try to keep it alive
* Increasing genetic diversity to reduce inbreeding