BIO1042

Exam and Study Notes

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Food Webs and Tropic Cascades

- Reserves maintain biodiversity
- Understand the first law of thermodynamics
    - Energy cannot be created or destroyed, only transformed from one form to another
        - Energy flows
        - Matter cycles
- Understand the main elements of wetland food webs including energy flow and nutrient cycling
    - Littoral zone is the shore line of a lake
    - Limnetic zone is an open area of a lake
    - Check lab manual for more
- Describe the main food chains present in wetlands, the main invertebrate taxa and some of the consequences of altering wetland processes and trophic structure
    - Grazing food chain
        - Living food chain
    - Detrital food chain
        - Remains of once living organisms
- Understand the concept of a 'tropic cascade' and how 'bio-manipulation' is used to improve wetland water quality
    - Predators supress the abundance of their prey
        - When they are removed, the trophic level below increases
    - Bio-manipulation
        - The modification of an aquatic food web to enhance grazing by zooplankton to control algal biomass
            - Bio-manipulation
                - Top down control of water quality
            - Nutrient reduction
                - Bottom up control of water quality
                - Proposes a unidirectional influence from lower to higher trophic levels
                - In this case, presence or absence of mineral nutrients determines community structure including abundance of primary producers
- Understand the concept of an ecosystem
    - An ecosystem consists of all he organisms living in a community, as well as the abiotic factors with which they interact
    - Regardless of an ecosystem's size, its dynamics involve two main processes
        - Energy flows
        - Chemical cycling
- Understand the second law of thermodynamics
    - Every exchange of energy increases the entropy of the universe (increases the disorder and randomness)
        - Energy conversions are not completely efficient and some energy is always lost as heat
- Understand the law of conservation of mass
    - Matter cannot be created nor destroyed
        - Chemical elements are continually recycled within ecosystems
        - Ecosystems are open systems, absorbing energy and mass and releasing heat and waste products
- Integrate these concepts, to appreciate that energy flows through an ecosystem, and nutrients largely cycle within it

- Primary production is the amount of light energy converted to chemical energy by autotrophs during a given period of time
- The total primary production is known as the ecosystems gross primary production
- Net primary production is GPP minus energy used by primary producers for respiration
    - Only the NPP is available to consumers
- Standing crop is the total biomass of photosynthetic autotrophs at a given time
- Trophic efficiency is the percentage of production transferred from one trophic level to the next
- Certain aquatic ecosystems have inverted biomass pyramids: producers are consumed so quickly that they are outweighed by primary consumers
- Turnover time is a ratio of standing crop biomass to production

Plant adaptations

- Understand the basic functions and requirements of plants
    - Four basic functions of a plant
        - Photosynthesis
            - Light interception
            - Gas exchange
        - Mechanical support
            - Static loads
            - Dynamic load
        - Reproduction
            - Spore release
            - Pollen capture
            - Seed and fruit release
        - Hydraulics
            - Absorption
            - Transport
            - Evaporation
    - All plants need the same resources, namely light, H_2I and nutrients
        - Plants are so diverse because they have many different solutions/adaptations to these problems
    - Constraints and trade-offs
        - Biological constraints are physical or biological processes that limit the phenotype possible for evolution
        - Organisms must obey the laws of chemistry and physics
        - Trade-offs among functions
            - Allocations of energy
            - Zero-sum dynamics
- Understand the difference between behavioural, structural and physiological adaptations of plants to
    - Light
        - Adaptations to improve performance at low light
            - Behavioural
                - More chlorophyll
                - Increased stacking of grana thylakoids
                - Thinner and broader leaves
            - Structural
                - Grow from ground and support yourself (trees)

            - Grow from ground and be supported by someone else (lianas)
            - Grow from within crown of tree (epiphytes and hemi-epiphytes)
                - Water and nitrate storage in tuberous aerial roots
                - May not reproduce until roots have reached ground
                - Eventually kill host and support themselves
    - Adaptations to improve performance when there's lots of light
    - Too much light causes photo inhibition and photo-oxidative damage
        - Structural
            - Reflective leaf surfaces
                - Hairy leaves (increases scattering)
                - Shiny leaves (increases reflectance
        - Biochemical mechanisms to prevent photo-oxidation
        - Adjust leaf angle relative to incoming sunlight
        - Leaf hangs vertically in high intensity light
- Water
    - Plant water relations and water-use efficiency are central to their survival
    - Behavioural
        - Avoid the problem
            - Only grow when water is available
                - Ephemeral/opportunistic species
            - Only grow where water is always available
                - Habitat specialists
        - Tolerate the problem
            - Seed heteroblasty (variability in timing of germination)
            - Drop leaves during dry periods
            - Deeper, larger roots
    - Physiological
        - In mesophytes (require conditions that are not too wet nor too dry) water loss is controlled by closure of stomata
        - As water is lost from the plant, changes in turgor stimulate production of abscisic acid, causing stomata closure
    - Structural
        - Plants can lose water through leaf surface if diffusion gradient is strong enough
        - Xerophytes have anatomical (and physiological) adaptations that allow them to survive when little water is available
        - Leaf modifications
            - Waxy leaf surfaces so the thick cuticle prevents water loss from epidermal cells
            - Hairs increase boundary layer of still air over leaf surface
            - Sunken stomata makes air directly above stoma still (often protected by hairs)
            - Leaf rolling surrounds one leaf surface with a layer of still air
        - Water acquisition and storage
            - Enhanced root systems
                - Deep tap roots to exploit water table
                - Widespread shallow roots to take advantage of small rainfall events
            - Swollen stems and trunks

            - Store water in stems and trunks for use when soil water supply is depleted
        - Too much water?
            - Soil can be saturated, thus less oxygen for root tissue
                - Plants have aerial roots, such as mangroves
- Nutrients
    - Critical because most physiological activities requires nutrients
    - Strategies to increase nutrient acquisition
        - Root structure
            - Root hairs increase the surface area for absorption of nutrients
            - In some cases the root system is hugely enhanced
        - Symbiotic associations
            - With bacteria
                - Most common with Rhizobium spp. And legumes
                - Bacteria fix N_2 from the atmosphere and pass on fixed-N to the plant in return for carbohydrate
            - With fungi
                - Ecto (outside cells) and endo (inside cells) mycorrhizae allow plant root systems to exploit more soil
                - Ectomycorrhizae form a net or sheath around roots without entering plant cells
                - Endomycorrhizae actually penetrate the plant cells
                - In arbuscular mycorrhizas the fungus forms highly branched structures called arbuscules within the plant cells to aid exchange of materials between the plant and fungus
        - Carnivory
            - If soil nutrients are limiting, carnivory can make significant contributions to plant nutrition and growth
- Temperature
    - Most favourable T range for metabolic function of plants is 10-25 degrees
    - Fluctuations in solar radiation (heating) and advection of cold air (cooling) make T fluctuate beyond these limits
    - These fluctuations may occur diurnally or seasonally
    - Heat increases the kinetic energy of molecules, accelerating their movement, so bonds within molecules are loosened and membrane lipid layers are more flexible
    - Cold increases the energy required for activating biochemical processes, so reactions are slower and membrane lipid layers become more rigid
    - Activity limit is the temperature beyond which the metabolic activities are reduced to a minimum
    - Lethal limit is the temperature beyond which permanent injury occurs
    - Heat stress
        - Avoid the problem (evasion)
            - The structural adaptations of plants to avoid high light stress will also reduce heat overload
        - Heat tolerators