**IDX G9 BIO H STUDY GUIDE ISSUE 1**

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**3.1 What is Ecology?**

The Basics

* Biosphere
  + Consists of all life and all parts of the Earth with life
* Ecology
  + Scientific study of interactions among organisms and between organisms and their physical environment
  + Greek root: *oikos* (house)
    - Ecology: study of nature’s “houses” and inhabitants of “houses”
    - Economics: study of human “houses” and interactions w/ money and trade
* Levels of Organization (least to most inclusive)
  + 1. Individual organism
  + 2. Population: group of individuals of one species living in the same area
    - Species: similar organisms that can produce fertile offspring
  + 3. Community: all the different populations that live together in an area
  + 4. Ecosystem: all organisms in an area together w/ their physical environment
  + 5. Biome: group of ecosystems sharing similar climates and organisms
  + 6. Biosphere: our entire planet

Environmental Factors

* Environment: all conditions/factors surrounding an organism
* Biotic factor
  + Biological
  + Any living part of the environment an organism might interact with
  + E.g., insects and herons for a bullfrog
* Abiotic factor
  + Physical
  + Any nonliving part of the environment
  + E.g., water availability and temperature for a bullfrog
* Both types of factors can influence the other, shaping an environment with their dynamic mix

Ecological Methods

* Observation
* Experimentation
  + Can be used to test hypotheses
* Modeling
  + Can help understand events that happen over long periods of time or large distances
  + Use formulas based on data from observation and experimentation

**3.2 Energy, Producers, and Consumers**

Producers

* Autotrophs
  + Organisms that use solar/chemical energy to produce “food” (glucose)
  + Also called primary producers because they are the first producers of energy-rich compounds later used by other organisms
  + Essential to energy flow in the biosphere
  + Greek roots: *auto* (by itself), *trophikos* (to feed)
* Photosynthesis
  + Process in which light energy powers reactions to produce carbohydrates
  + Converts carbon dioxide and water into oxygen and energy-rich sugars and starches
  + Performed by:
    - Plants, on land
    - Algae, in freshwater and upper layers of the ocean
    - Bacteria (commonly cyanobacteria), in tidal flats and salt marshes
* Chemosynthesis
  + Process in which chemical energy is used to produce carbohydrates
  + Chemosynthetic bacteria power ecosystems
    - E.g., deep-sea volcanic vents or hot springs, coastal tidal marshes

Consumers

* Heterotrophs/Consumers
  + Organisms that must acquire energy and nutrients from other organisms
  + Carnivores
    - Kill and eat other animals
    - E.g., snakes, dogs, cats
    - Catching and killing prey requires energy, but meat is generally rich in nutrients and energy and easily digested
  + Herbivores
    - Eat plant leaves, roots, seeds, or fruits
    - E.g., cows, caterpillars, deer
  + Omnivores
    - Diets include both plants and animals
    - E.g., humans, bears, pigs
  + Scavengers
    - Consume carcasses of animals that were killed by other predators or died other ways
    - E.g., vultures, flies
  + Decomposers (Saprotrophs)
    - Release digestive enzymes to break down organic matter externally
    - Produce detritus: small pieces of dead and decaying plant/animal remains
    - E.g., fungi, bacteria
  + Detritivores
    - Feed on detritus particles, chewing/grinding them into even smaller pieces
    - Commonly digest decomposers living on/in detritus particles
    - E.g., mites, snails, shrimp, crabs
  + Beyond consumers categories
    - Strict categories don’t represent full complexity
    - Plant leaves are much less nutritious and harder to digest than seeds/fruits
      * Herbivores that eat different parts differ in obtaining and digesting food
      * Most birds don’t have the digestive systems to digest leaves
    - Hyenas, though classified as carnivores, will scavenge
    - Aquatic animals eat a mixture of algae, bits of animal carcasses, and detritus
    - Carnivorous plants and Euglenoids are mixotrophic (heterotrophy and autotrophy)

**3.3 Energy Flow in Ecosystems**

Food Chains and Food Webs

* Food Chain
  + A series of steps in which organisms transfer energy by eating and being eaten
  + Energy flows through an ecosystem in a one-way stream
  + E.g., algae (phytoplankton) -> krill (zooplankton) -> penguin -> seal -> orca
    - Plankton: small aquatic floating organisms
    - Orca: top predator, four steps removed from producer
* Food Web
  + A network of feeding interactions, representing interconnected food chains
  + Many animals eat more than one kind of food
  + Decomposers in food webs recycle nutrients, releasing them for primary producers to use
  + A change in population of one species can disturb other organisms in the web

Ecological Pyramids

* Trophic level
  + Each step in a food chain or food web
  + E.g., primary producer, primary consumer, secondary consumer, tertiary consumer
* Ecological pyramids show the relative amount of certain things at each trophic level in an ecosystem
* Pyramids of Energy
  + Show the relative amount of energy available at each level (kJ \* m-2 \* y-1)
  + About 10 percent of the energy in one trophic level is transferred to the next
  + The other 90 percent is lost as heat, non-ingested or non-digested parts, etc.
* Pyramids of Biomass
  + Show the relative amount of living organic matter at each level (g \* m-2)
  + Can be an inverted triangle when:
    - In winter, when producers die or lose leaf mass while consumers have stored mass
    - In the deep sea, w/ huge top predators (whales, giant squid) and producers that come and go quickly
* Pyramid of Numbers
  + Show the relative number of living organisms at each level
  + Can be inverted when:
    - Consumers are much less massive than their food sources
    - E.g., thousands of insects grazing on a single tree

**Side Topic: Properties of Water**

* Water’s polarity means there is a greater probability of finding its shared electrons closer to its oxygen atom
  + Polar molecules have unevenly distributed charges
  + Oxygen is slightly negative, hydrogen is slightly positive
* Hydrogen bond
  + Weak intermolecular attraction between hydrogen on one molecule and oxygen on another
* Cohesion
  + Attraction between molecules of the same substance
  + Causes surface tension
* Adhesion
  + Attraction between molecules of different substances
  + Causes menisci to form
* Capillary Action
  + Cohesion holds the continuous column of water as adhesion causes it to rise
  + Draws water out of roots into stems
* Solutions
  + Water’s polarity lets it dissolve ionic compounds and other polar molecules
  + Solute: the substance that is dissolved
  + Solvent: the substance in which the solute dissolves
* pH Scale
  + Measures concentration of H+ ions in a solution, ranging from 0 (very acidic) to 14 (very basic)
  + pH < 7: acidic, [H+] > [OH-]
  + pH = 7: neutral, [H+] = [OH-]
  + pH > 7: basic, [H+] < [OH-]
  + pH = -log[H+]
  + [H+] = -10pH

**3.4 Cycles of Matter (up to the carbon cycle)**

Recycling in the Biosphere

* Unlike the one-way flow of energy, matter is recycled within and between ecosystems
* Elements combine to form building blocks of organisms
* Biogeochemical Cycles
  + Biological, chemical, and chemical/physical processes that transfer elements
  + Powered by the flow of energy
  + Though not classified as a cycle, human activity is influential as well (e.g., deforestation)

The Water Cycle

* Water continuously moves between the oceans, the atmosphere, land, and living organisms
* Evaporation: liquid water becomes water vapor
* Transpiration: evaporation from plant leaves
* Condensation: cooling water vapor condenses into droplets around dust particles
* Precipitation: water falls from clouds as rain, snow, sleet, or hail
* Runoff: flow of water on the surface
* Groundwater: water absorbed into the soil
* Percolation: gradual filtering through a porous structure
* Forms of water
  + Water vapor, clouds, oceans, rivers/lakes, plants, groundwater, underground reservoirs

Nutrient Cycles

* Nutrients
  + A chemical substance that an organism must obtain from its environment to sustain life
  + E.g., carbon, nitrogen, phosphorus
  + Oxygen combines with these elements and cycles through parts of their journeys
* The Carbon Cycle
  + Forms of carbon
    - Carbon compounds (e.g., carbohydrates, lipids, proteins, and nucleic acids) in living organisms
    - CO2 in the atmosphere and dissolved CO2 in the hydrosphere
    - Carbonate rocks (CaCO3), fossil fuels (e.g., oil, coal), natural gas (CH4)
  + Processes
    - Photosynthesis, cellular respiration, feeding, decomposition, fossilization, combustion, dissolution, deposition