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**IDX G9 BIOLOGY S STUDY GUIDE ISSUE 4**

**By Emma and Mya**

**4.5 Aquatic Ecosystems**

Conditions Underwater

* Aquatic organisms are affected by water depth, temperature, flow, and amount of dissolved nutrients

Water Depth

* Photic zone: sunlit region near the surface in which photosynthesis can occur
* Deep as 200 meters in tropical areas
* Photosynthetic algae---phytoplankton
* Zooplankton---eat phytoplankton
* Aphotic zone: below photic zone where photosynthesis can’t occur
* Benthos: aquatic organisms live on, or in, rocks and sediment on the bottom of lakes, streams, and oceans
* Habitat = benthic zone
* When water is shallow: algae and rooted aquatic plants can grow
* When below photic zone: chemosynthetic autotrophs are the only primary producers

Temperature and Currents

* Currents can dramatically affect water temperature, because they can carry water that’s significantly warmer or cooler

Nutrient Availability

* Include oxygen, nitrogen, potassium, phosphorus
* Dissolved substances in water affect organisms

Freshwater Ecosystem

* Only 3% of Earth’s surface water is freshwater, but it provides terrestrial organisms with drinking water, food, and transportation
* Total global water: 96.5% is ocean, 2.5% is freshwater, other saline water 0.9%
* In the 2.5% of freshwater: 68.7% are glaciers and ice caps, 30.1% is groundwater, 1.2% is surface or other freshwater

Rivers and Streams

* Running water, organisms adapt to fast currents
* High oxygen level, little plant life
* Animal food = plants and other small animals

Lakes and Ponds

* Inland body of standing water
* Food webs are a combination of plankton and attached algae and plants
* Water flow in and out, and circulates between surface and benthos
* Circulate = distribute hear, oxygen, and nutrients

Freshwater Wetland

* Wetland: an ecosystem win which water either covers the soil or in present at or near the surface for at least part of the year
* Nutrient rich and highly productive
* Good for agriculture
* Breeding ground for many organisms
* Helps: 1. Purify water by filter pollutants

2. prevent flooding: absorb large amount of water and slowly release the water

* 3 main types: bogs, marshes, swamps (divide based on vegetation)

Freshwater Ecosystem

* Estuaries = saltwater wetlands
* Formed where a river meets the sea
* Contain mixture of fresh and salt water
* Serve as spawning and nursery ground for ecologically and commercially important fish species

Salt marshes

* Temperate estuaries
* Salt-tolerant grass above low-tide line and seagrass below water

Mangrove swamps

* Tropical estuaries
* Several species of salt-tolerant trees---mangroves

Marine Ecosystem

* Divided based on depth and distance from shore

Intertidal zone

* Organisms submerge to water at high-tide and expose to air at low-tide
* Subjected to changes in weather (either regular or extreme)
* Battered by waves and currents
* Rocky intertidal community: exists on exposed rocks of shore
* Barnacles and seaweed permanently attach themselves to rocks

Neritic zone (Coastal Ocean)

* From low-tide mark to outer edge of continental shelf
* Continental shelf: shallow border that surrounds the continent
* Water supplied with nutrient in runoff freshwater = highly productive
* Kelp forests:
* Live in cold, nutrient rich water
* Grow up to 50 feet tall
* Coral reefs: calcium rich skeletons build up reef

Open Ocean

* Edge of continental shelf and extend outward
* More than 90% of world ocean area
* Depth: 500m – 10,000m
* Photic zone (divide based on light penetration)
* Low nutrient level, support smallest species of phytoplankton
* Most photosynthesis occurs in top 100m
* Aphotic zone (divide based on light penetration)
* Permanently dark
* Food web based on fall from photic zone or chemosynthetic organisms
* Organism expose to high pressure, frigid temperatures, total darkness
* Bioluminescent organisms
* Benthic environments: high productivity
* Deep-sea vents support chemosynthetic primary producer

**5.1 How populations grow**

* Population: a group of organisms of the same species that lives in a given area

Marine Ecosystem

* Sampling: a technique sometimes used to estimate population size
* Organisms in a few small area is counted
* Random quadrat sampling
* Population size = mean number of organisms per quadrat x total area

Area of each quadrat

* Capture-mark-release-recapture
* Population size = (n1 x n2)/n3
* N1 = number of initially caught and marked
* N2 = number of second caught
* N3 = number of marked in N2

1st n1/n0



Is equal to

n3/n2

2nd



* Researches study geographical range, density, and distribution, growth rate, and age structure

Geographical range

* Area inhabitated by a population
* Its range can vary enormously in size, depend on species

Density and Distribution

* Population Density: number of individuals per unit area
* Number vary for differ species in same place
* Distribution: how individuals are spread out across the range of population

1. randomly 2. uniformly 3. In clumps



Growth Rate

* Determines a population increases, decreases, or stays the same
* Negative growth rate = decreasing

Age structure

* The number of males and females of each age a population contain
* Plants: most can’t reproduce until a certain age
* Animals: only females can reproduce

Population Growth

* Factors: birth rate (fertility/natality), death rate (mortality), immigration/emigration rate
* Immigration + Natality > Emigration + Mortality => Population growth
* Immigration + Natality = Emigration + Mortality => Population stable
* Immigration + Natality < Emigration + Mortality => Population decline
* Immigration: individuals move into its range from elsewhere
* Emigration: individuals move out of the population’s range

Exponential Growth

* Under ideal conditions with unlimited resources
* J-shaped curve
* Lag-phase: slow growth period
* Exponential Growth: growth rate is proportional to size of population

Logistic Growth

* Occurs when a population’s growth slows and then stops, following a period of exponential growth

Phases of Growth

* Growth curve: S-shaped curve

1. Exponential growth phase

* Few predators
* High natality, low mortality
* Plentiful resources = no competition

1. Transitional phase

* Predators increase, have diseases
* Natality decreasing, mortality increasing
* Competition for resources

1. Plateau phase

* Immigration + Natality = Emigration + Mortality => Population stable
* Carrying capacity: the maximum number of individuals of a particular species that a particular environment can support
* Limited by:
* Food and water availability
* Space for territories and nesting
* Availability of mates
* Disease
* Predation
* Environmental change

**5.2 Limits to Growth**

Limiting factors

* Limiting factor: a factor that controls the growth of a population
* Determine the carrying capacity of an environment for a specie

Density-Dependent Limiting Factor

* Operate strongly only when population density --- the number of organisms per unit area reaches a certain level
* Don’t affect small, scattered population as much

Competition

* Individuals compete for food, water, space, sunlight, mates, and other essentials for living
* Lower birthrates, increase death rates
* Emigration increase, immigration decrease
* Cycle: less species = competition low => immigration increase, emigration decrease => more species = competition high =>immigration decrease, emigration increase

Predation and Herbivory

* Predator-Prey Relationships
* Populations of predators and prey cycle up and down
* Opposite to each other
* Herbivory effects
* Populations of plants and herbivores cycle up and down
* Opposite to each other
* Human as Predators
* Human and the food that’s eaten cycle up and down

Parasitism and Diseases

* The denser the host population, the more easily parasites spread from one host to another

Stress from overcrowding

* Overcrowding = fighting = high levels of stress
* Weaken immunity
* Females neglect and kill or eat their off springs
* Lower birthrates, higher deathrates
* Increase rates of emigration

**6.1 A Changing Landscape**

The effect of human activity

* Agriculture, development, industry
  + Effect quality of earth’s natural resources including soil water, and atmosphere

Agriculture

* Monoculture: Clearing large areas of land to plant a single highly productive crop year after year
  + But impacts natural resources (e.g. water and soil)
* Fertilizer production consumes fossil fuels
* Increase use of pesticides and insecticides which enter water and cause biological magnification

Development

* Dense human communities produce lots of wastes
* Wastes not disposed properly 🡪 affect air, water and soil resources
* Also consumes farmland and divides natural habitats into fragments

Industrial Growth

* Require lot of energy to power
* Burning fossil fuel effect environment
* Discarded wastes directly into air, water, soil

Ecosystems goods and services

* Services: Processes or actions that produce goods
* Goods: Things that can be bought and sold, have value in terms of dollars and cents
* Ecosystem can’t provide goods and services 🡪 society spend money to produce
  + E.g. water by streams, rivers, lakes, and filtered 🡪 water quality fall 🡪 mechanical or chemical treatment to provide drinking water

Renewable and Nonrenewable resources

* Renewable can be produced/ replaced by healthy ecosystem (wind, energy, trees but not forest)
* Nonrenewable cannot be replenished within amount of time (oil, coal, gas)

Sustainable Resource Use

* Sustainable development: Provide for human needs while preserving the ecosystems that produce natural resources
  + Preserve long-term environmental health of biosphere
  + Important for non-renewable resources

**6.2 Using Resources Wisely**

Soil Resources

* Healthy soil support both agriculture and forestry

Soil Erosion

* Topsoil: Mineral-rich and nutrient-rich portion of soil
  + Absorb and retain moisture
  + Rich in organic matters and nutrients
  + Low in salts
  + Renewable if managed properly
* Soil Erosion: Removal of soil by water or wind
* Desertification: Combination of farming, overgrazing, seasonal drought, climate change
* Deforestatio :Loss of forests, lead to severe erosion, especially grazing and plowing after defrost

Actions on Soil Erosion

* Minimize through management of agriculture and forestry
  + Leave stems and roots of previous year crop in soil to hold soil in place
  + Crop rotation: Plant different crops at different seasons/ year to prevent nutrient loss
  + Contour plowing: Plant fields of crops across instead of on slope (similar: terracing)

Freshwater Resources

* For goods and services, including drinking, industry, transportation, energy and waste disposal

Pollutions

* Pollutant: Harmful material that can enter biosphere
  + Single point sources: Pollutants from single source, such as factor or oil spill
  + Nonpoint sources: Pollutants from many smaller sources, such as grease and oil washed off streets by rain or chemicals released into air by factories and automobiles

Water Pollution

* Nonpoint resources
* Industrial and agricultural chemicals
  + Biological magnification: Pollutants concentration increase at higher trophic levels if it can’t be eliminated from body
    - PCBs: Organic chemicals widely used in industries
    - DDT: Pesticides in agriculture
* Residential Sewage
  + Rich in nitrogen and phosphorous, can stimulate bloom of bacteria and algae which robs water of oxygen

Water Quality and Sustainability

* Watershed: All land whose ground waters, streams, and rivers drain into same place, such as lake or river
  + Densely growing plants and vegetation absorb excess nutrients and filter out pollutants, purifying water 🡪 Important so protect them for watershed conversation

Air Pollution

* Smog
  + Grey-brown haze formed by chemical reactions among pollutants by industrial processes and automobile exhaust
* Acid rain
  + Nitrogen and sulfur compounds by burning fossil fuels form nitric and sulfuric acids in air, which fall as acid rain
  + Kill plants
  + Change chemistry of soils and surface water
  + Acid precipitation dissolve and release mercury and other toxic elements from soil
* Greenhouse gases
  + Excess greenhouse gases
  + Burning of fossil fuels 🡪 CO^2 (greenhouse gases)
  + Raise cattle and farm rice 🡪 methane
* Particulates
  + Microscopic particles that enter nose or lungs

**6.3 Biodiversity**

* Total of all genetically based variation in all organisms in biosphere

Ecosystem diversity

* Variety of habitats, communities, and ecological processes in the biosphere

Species diversity: Total of different species in particular area

Genetic diversity: Total of different forms of genetic info carried by a particular species

Richness: Number of different species present

Evenness: If habitat has similar abundance for each species present, habitat would be considered even

Simpson’s diversity index:

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Description automatically generated

* Consider richness and evenness
* Higher diversity value 🡪 Greater biodiversity
  + Max D= 1 (infinite diversity)
  + Min D= 0 (no diversity/ only one kind of species)

Agriculture Value

* Wild plants may carry genes we can use
* Disease and pest resistance, other useful traits

Medical

* Wild species are original source of many medications
  + Painkillers like aspirin, antibiotics like penicillin

Ecosystem Value

* Number and variety of species in ecosystem can influence ecosystem’s stability, productivity, and value to humans (ecosystem goods and services)

Threats to biodiversity

Altered habitats

* Development or agriculture splits ecosystems into pieces = habitat fragmentation

Hunting Wildlife

* Push species to extinction by hunting
* CITES (Convention on International Trade in Endangered Species) bans the hunting of endangered species

Introduced Species

* Alien species (organisms introduced to new habitat) can become invasive and threaten biodiversity, out competing native species

Pollution

* Pollutants in the environment

Climate Change

* If conditions change beyond organism’s tolerance, organism must move to suitable location or face extinction
* Species in fragmented habitats vulnerable because they may not be able to migrate

Conserving Biodiversity

Protect Individual Species

* Captive breeding
  + Bred and raised in protected surroundings
  + Ultamite goal: Release animal to wild

Preserving habitats and ecosystems

* Ecological hotspot: Place where significant number of species and habitats are in immediate danger of extinction

Considering local interests

* Tax credits
  + e.g. to people who’ve installed solar panels on bought hybrid cars
* Ecotourism
* Carbon credits to companies
  + Any unused carbon quota maybe sold back or traded to other companies