

# Ecology

## Module B, Anchor 4

### Key Concepts:

- The biological influences on organisms are called biotic factors. The physical components of an ecosystem are called abiotic factors.
- Primary producers are the first producers of energy-rich compounds that are later used by other organisms. Organisms that rely on other organisms for energy and nutrients are called consumers.
- Energy flows through an ecosystem in a one-way stream, from primary producers to various consumers. Pyramids of energy show the relative amount of energy available at each trophic level of a food chain or food web. A pyramid of biomass illustrates the relative amount of living organic matter available at each trophic level of an ecosystem. A pyramid of numbers shows the relative number of organisms at each trophic level in an ecosystem.
- Unlike the one-way flow of energy, matter is recycled within and between ecosystems. Water continuously flows between the oceans, the atmosphere, and land – sometimes outside organisms and sometimes inside organisms. Every organism needs nutrients to build tissues and carry out life functions. Like water, nutrients pass through organisms and the environment through biogeochemical cycles. The carbon, nitrogen, and phosphorus cycles are particularly important for life.
- A region's climate is defined by year-after-year patterns of temperature and precipitation. Global climate is shaped by many factors, including solar energy trapped in the biosphere, latitude, and the transport of heat by winds and ocean currents.
- A niche is the range of physical and biological conditions in which a species lives and the way the species obtains what it needs to survive and reproduce.
- By causing species to divide resources, competition helps determine the number and kinds of species in a community and determine the number and kinds of species in a community and the niche each species occupies.
- Predators can affect the size of prey populations in a community and determine the places prey can live and feed. Herbivores can affect both the size and distribution of plant populations in a community and can determine the places certain plants can survive and grow.
- Biologists recognize three main classes of symbiotic relationships in nature: mutualism, parasitism, and commensalism.
- Ecosystems change over time, especially after disturbances, as some species die out and new species move in. Secondary succession in healthy ecosystems following natural disturbances often reproduces the original climax community. Ecosystems may or may not recover from human disturbances.
- Biomes are described in terms of abiotic factors like climate and soil type, and biotic factors like plant and animal life.
- Ecologists typically divide the ocean into zones based on depth and distance from shore.
- The factors that can affect population size are the birthrate, the death rate, and the rate at which individuals enter or leave the population.

- Under ideal conditions with unlimited resources, a population will grow exponentially. Logistic growth occurs when a population's growth slows and then stops, following a period of exponential growth.
- Acting separately or together, limiting factors determine the carrying capacity of an environment for a species.
- Birthrates, death rates, and the age structure of a population help predict why some countries have high growth rates while other countries grow more slowly.
- Humans affect regional and global environments through agriculture, development, and industry in ways that have an impact on the quality of Earth's natural resources, including soil, water, and the atmosphere. Sustainable development provides for human needs while preserving the ecosystems that produce natural resources.
- Biodiversity's benefits to society include contributions to medicine and agriculture, and the provision of ecosystem goods and services. Humans reduce biodiversity by altering habitats, hunting, introducing invasive species, releasing pollution into food webs, and contribution to climate change.

### **Vocabulary:**

Biosphere	population	community	ecology
Ecosystem	biome	biotic factor	abiotic factor
Autotroph	primary producer	photosynthesis	heterotroph
Consumer	carnivore	herbivore	scavenger
Omnivore	decomposer	detritivore	food chain
Food web	trophic level	ecological pyramid	biomass
Nutrient	limiting nutrient	weather	Biogeochemical cycle
Climate	microclimate	tolerance	greenhouse effect
Habitat	niche	resource	predation
Herbivory	keystone species	competitive exclusion	principle
Symbiosis	mutualism	parasitism	commensalism
Succession	pioneer species	primary succession	secondary succession
Wetland	estuary	population density	age structure
Immigration	emigration	exponential growth	logistic growth
Carrying capacity	limiting factor	global warming	ecological hot spot
Demography	monoculture	Renewable resource	desertification
Ecological footprint	deforestation	acid rain	nonrenewable resource
Pollutant	smog	habitat fragmentation	sustainable development
Biodiversity	genetic diversity	ozone layer	biological magnification
Ecosystem diversity	species diversity	density-dependent	limiting factor
Extinction	Chemosynthesis	density-independent	limiting factor

### **Energy Flow in Ecosystems:**

1. What is a trophic level? List and describe the different trophic levels in ecosystems.

2. How do producers and consumers differ in how they obtain energy?
  
3. Describe how energy moves through an ecosystem. How is energy lost from ecosystems? What rule describes this loss?
  
4. What is the ultimate source of all energy on Earth?
  
5. Compare and contrast food webs and food chains.
  
6. Compare energy pyramids, biomass pyramids, and pyramids of numbers in terms of the information they give about ecosystems.

**Biogeochemical Cycles:**

1. Compare and contrast the movement of energy and matter in ecosystems.
  
2. List the steps of the water cycle. Which steps add water to the atmosphere? Which steps remove it?
  
3. List the steps of the carbon cycle. Which steps add carbon to the atmosphere? Which steps remove it?



5. What are the possible human causes of global climate change?

6. What is the evidence for global climate change?

7. What are the potential impacts of climate change?

**Ecosystems and Communities:**

1. What is a niche? What factors define a niche? How is it different from a habitat?

2. What is competition? How does competition affect the niche of an organism?

3. How do predation and herbivory affect prey/plant populations?

4. What is a keystone species? Why is the elimination of keystone species of such concern?

5. List and describe the types of symbiotic interactions between organisms.

6. What is succession? Describe the steps involved in both types of succession?

7. List the major biomes. What are the factors used to define a biome?

**Population Growth:**

1. Describe the different factors used to study populations.

2. What four factors affect the size of a population? Which increase it? Which decrease it?

3. Compare and contrast exponential and logistic growth.

4. What is a limiting factor? Compare and contrast density-dependent and density-independent limiting factors.

5. What is carrying capacity? How is carrying capacity related to limiting factors?

6. If a limiting factor was increased, what would happen to the population over time? Why?

7. What is the trend of human population growth over time? What challenges does this present for global ecosystems?

**Humans and the Environment:**

1. Compare and contrast renewable and nonrenewable resources. Provide examples of each.

2. Describe several problems associated with human resources use.

3. Describe several problems associated with agriculture.

4. Describe several problems related to increased human development.

# Ecology

## Module B, Anchor 4

### **Energy Flow in Ecosystems:**

1. What is a trophic level? List and describe the different trophic levels in ecosystems.

*A trophic level indicates the energy flow within an ecosystem. Producers are the initial level. They convert light or chemical energy into a form usable by other organisms. Primary consumers get their energy from producers. Secondary consumers get their energy from primary consumers. Tertiary from secondary, quaternary from tertiary, etc. Organisms can occupy multiple trophic levels. For example, an omnivore eats both plants and herbivorous mammals. This omnivore is both a primary and secondary consumer.*

2. How do producers and consumers differ in how they obtain energy?

*Producers make their own food using energy from the sun or from inorganic chemicals. Consumers ingest other organisms for food.*

3. Describe how energy moves through an ecosystem. How is energy lost from ecosystems? What rule describes this loss?

*Energy flows through an ecosystem from producers through upper level consumers. Energy is lost as heat or is used for work. The 10% rule governs this: only 10% of the energy in one trophic level moves to the next.*

4. What is the ultimate source of all energy on Earth?

*sun*

5. Compare and contrast food webs and food chains.

*A food chain shows one simplistic set of feeding relationships. A food web shows all the interacting feeding relationships in a community.*

6. Compare energy pyramids, biomass pyramids, and pyramids of numbers in terms of the information they give about ecosystems.

*An energy pyramid shows the amount of energy in each trophic level. A biomass pyramid shows the amount of biomass. A pyramid of numbers shows the numbers of organisms in each trophic level.*

### **Biogeochemical Cycles:**

1. Compare and contrast the movement of energy and matter in ecosystems.

*Energy flows and must be constantly replenished by the sun. Matter cycles.*

2. List the steps of the water cycle. Which steps add water to the atmosphere? Which steps remove it?

*Evaporation and transpiration add water to the atmosphere. Precipitation removes water from the atmosphere. Water exists on the ground as runoff, groundwater, and in bodies of water.*



3. List the steps of the carbon cycle. Which steps add carbon to the atmosphere? Which steps remove it?

*Carbon enters the atmosphere through burning of fossil fuels, diffusion out of oceans, and respiration. Carbon leaves the atmosphere through the creation of fossil fuels, diffusion into oceans, and photosynthesis.*

4. How is the carbon cycle related to climate change?

*Climate change is caused by an accumulation of greenhouse gases, such as carbon dioxide. The acceleration of carbon releasing activities without a balancing quantity of carbon absorbing activities can accelerate climate change.*

5. List the steps of the nitrogen cycle. What makes nitrogen available to living things?

*Nitrogen is removed from the atmosphere through nitrogen fixation, which includes nitrification and ammonification. Nitrogen fixation can also occur atmospherically, through lightening. Denitrifying bacteria return nitrogen to the atmosphere. Nitrogen must be fixed by bacteria in order to be made available to living things.*

6. Describe the phosphorus cycle.

*Phosphorus does not enter the atmosphere, but moves through the other portions of the Earth. Phosphorus weathers from rocks and minerals and is washed into bodies of water by runoff. It is also taken up by plants, which are eaten and incorporated into the bodies of animals. Decaying organic material returns phosphorus to the soil*

7. What is nutrient limitation?

*Organisms need particular nutrients to grow. A nutrient that is not present in sufficient amounts is said to be limiting, in that it limits the ability of the organism to grow.*

### **Climate and Climate Change:**

1. What factors influence global climate? Describe each.

*Angle of solar radiation- a more direct angle of solar radiation increases the amount of energy absorbed. Therefore, areas of the Earth near the equator receive much more solar radiation than the poles.*

*Wind – redistributes heat from solar radiation across the globe. Warm air rises and holds more moisture. Cool air falls and is drier. This creates Hadley cells, which produce predictable strips of biomes across the globe.*

*Ocean currents – also redistribute solar radiation. Can have a large modifying effect on the landmasses by which they pass.*

2. How do climate and weather differ?

*Climate – long-term averages*

*Weather – day to day temperature and precipitation*

3. What is the greenhouse effect? Why is it so vital to life on Earth?

*The Earth's atmosphere consists largely of greenhouse gases. As solar radiation strikes Earth, it is reflected back into space. Greenhouse gases bounce the reflected radiation back to Earth,*

*allowing the Earth to warm. Without the greenhouse effect, Earth would not be warm enough to sustain life.*

4. What are the possible natural causes of global climate change?

*Altering patterns of solar irradiance.*

5. What are the possible human causes of global climate change?

*Increased emissions of greenhouse gases, clearing of the land for human activities*

6. What is the evidence for global climate change?

*Ice cores, global temperature data, satellite imagery, increase in sea temperatures, rising sea levels, retreat of arctic ice, shrinking ice sheets, glacial retreat, ocean acidification, increase in extreme weather events*

7. What are the potential impacts of climate change?

*Rising sea levels, significantly altered climate (not just hotter, but an alteration overall. Some areas are currently kept warmer than they would normally be due to ocean currents, which could be altered due to climate change), droughts, increase in extreme weather, increased disease, decreased availability of fresh water*

### **Ecosystems and Communities:**

1. What is a niche? What factors define a niche? How is it different from a habitat?

*The role and needs of an organism in an ecosystem. Physical and biological factors influence a niche. A habitat simply describes the needs of an organism, without addressing what the organism does within the community.*

2. What is competition? How does competition affect the niche of an organism?

*Organisms which have similar needs will often compete for resources. Two organisms cannot occupy the same niche within the same community. Therefore, organisms with the same needs and role may occupy different locations within the ecosystem or have other compensatory mechanisms to reduce competition.*

3. How do predation and herbivory affect prey/plant populations?

*They affect the population size and distribution of prey/plant species.*

4. What is a keystone species? Why is the elimination of keystone species of such concern?

*A species that has an effect on the environment disproportionate to its abundance. If the species is eliminated, it may cause the collapse of the community.*

5. List and describe the types of symbiotic interactions between organisms.

*Parasitism – one species benefits, the other is harmed*

*Commensalism – one species benefits, the other is unaffected*

*Mutualism – both species benefit*

6. What is succession? Describe the steps involved in both types of succession?

*Succession is the orderly process of restoration in a community after creation or new disturbance.*

*Primary succession – bare rock colonized by pioneer species, then grass, then shrubs, then trees, then climax community*

*Secondary succession – disturbance wipes out existing community, grass, shrubs, trees, climax community*

7. List the major biomes. What are the factors used to define a biome?

*Desert, tundra, taiga, tropical forest, temperate forest, boreal forest, savanna, temperature grassland. Temperature, precipitation, species present.*

### **Population Growth:**

1. Describe the different factors used to study populations.

*Geographic range, density, distribution, growth rate, age structure*

2. What four factors affect the size of a population? Which increase it? Which decrease it?

*Increase: immigration, birth*

*Decrease: emigration, death*

3. Compare and contrast exponential and logistic growth.

*Exponential – starts out slowly, then rapidly increases without end*

*Logistic – increases to a point, then levels off*

*Both start with a similar pattern.*

4. What is a limiting factor? Compare and contrast density-dependent and density-independent limiting factors.

*Something needed by an organism which is not present in sufficient amounts, limiting the growth of that organism. Density-dependent factors depend on the amount of organisms living in an area, density-independent factors do not.*

5. What is carrying capacity? How is carrying capacity related to limiting factors?

*The number of organisms which can be supported by an ecosystem. Limiting factors determine the carrying capacity of an area, as running out of a limiting factor will cause a group to reach carrying capacity.*

6. If a limiting factor was increased, what would happen to the population over time? Why?

*It would begin to increase in size again, as the item limiting its growth was no longer in short supply.*