

Unit 6: Ecology

Content Outline: Ecosystem Dynamics (6.4) – Part 1

- I. **Ecosystems** – Refers to *all* the interacting communities within a given area *plus* the abiotic factors affecting it.
- A. Abiotic factors mainly deal with energy flow, nutrient cycling, temperature, and water.
- II. **Trophic levels** (*feeding* relationships) within an ecosystem and energy flow
- A. **Primary Producers** (Organisms that *can perform photosynthesis or chemosynthesis*.)
(A.K.A. **Autotrophes** – “Auto” means “self”; “Trophe” means “feeding”)
1. These organisms take the inorganic and *convert* it into organic energy storing molecules. These molecules will then be available to other organisms through the food chains.
- B. **Consumers** (A.K.A. **Heterotrophes** – “hetero” means “different”)
1. Different levels can occur such as: 1’(primary), 2’(secondary), 3’(tertiary), 4’(quaternary), etc.
2. Primary consumers (1’) feed upon producers. Secondary consumers feed upon primary consumers. Tertiary feed upon secondary and so forth upon the chain.
- C. **Decomposers** (A.K.A. **Detritivores**) – These organisms feed on *dead organic material* - which is called **detritus**.
1. They take dead decaying organic material (detritus) and *convert it back* to the inorganic state for *recycling and use* by the primary consumers.
- D. **Law of Conservation of Energy (E) and Second Law of Thermodynamics**
1. Energy is neither created nor destroyed... just transformed or transferred. (Law of Conservation)
2. All E proceeds toward a state of **entropy** (disorder) with each transfer. (Law of Thermodynamics)
- a. All E enters Earth as Sunlight. (This is *high quality E* with a low degree of entropy. It is highly organized and *can* perform work such as powering photosynthesis or splitting water.)
- b. All E leaves as heat. (This is *low quality E* with a high degree of entropy and *can not* perform work.)
3. The **10% rule** applies from trophic level to trophic level. The 10% rule states that only 10% of the energy from one trophic level will be available to fuel the next trophic level in the food chain. 90% is lost in the actual keeping alive of the organism (80%) and also waste (10%). The energy that was used to keep the organism alive was ultimately converted to heat energy and released to the environment.
- E. Nutrients are recycled in ecosystems. (This is the **Law of Conservation of Matter**.)
1. Matter is neither created nor destroyed...just transformed or transferred. This will be seen in the Biogeochemical cycles in the next section.
- III. **Primary Production** –Refers to the *total amount* of Solar E converted to Chemical E by photosynthesis by producers.
- A. **Global E budget** - This refers to the amount of E that the earth uses for the process of photosynthesis.
1. ONLY 1 % of Solar E is used to power photosynthesis, but *it makes 170 BILLION tons of sugar/year*.
2. 99% of solar E is *absorbed by water or reflected back into space/atmosphere* by water/ice.
3. This reflected E contributes to the Greenhouse effect and helping the temperature of Earth rise.
4. The absorbed E by water will be released at night to help keep the unlighted side of Earth warm.

Please make sure students understand that Energy is a one-way flow and that matter is recycled. These are major testing concepts.

Ecosystem Dynamics (6.4) – Part 2

I. **Biogeochemical Cycles** (“Bio” means “life”; “geo” means “earth”) These refer to the *cycling* of matter.

- A. **Water cycle** – Water vapor is created by the sun causing evaporation of the bodies of water such as oceans and lakes. This water vapor is carried by the winds to almost the whole world. It condenses in the air to make rain or snow (referred to as precipitation) and is returned to the land or ocean. Eventually the water that lands on land, makes its way to plants or rivers and streams that lead back to the oceans. Plants take in the water and use it for photosynthesis but also can lose it in the form of transpiration to the air.
- A. **Carbon Cycle** - CO₂ is removed from the air by photosynthesizing organisms such as plants, phytoplankton and bacteria. They use the CO₂ to aid in the development of sugars during photosynthesis. These sugars, which contain the carbon (C₆H₁₂O₆) are then passed from organism to organism through the food chain. All organisms then release the carbon, in the form of CO₂, by performing the process of cellular respiration in their cells. The burning of plant materials, natural gas and fossil fuels, which are the remains of dead life forms such as dinosaurs and pre-historic forests, puts CO₂ back into the air as well.
- B. **Nitrogen Cycle** - The majority of nitrogen is removed from the air by water. Remember, water is the *universal solvent*, so the gas is *dissolved* in the rain or snow. The nitrogen in the water mainly is consumed by **Nitrogen Fixing bacteria**, in the soil, that *convert it* into ammonium (NH₄). This process is referred to as **Nitrogen Fixation**. The ammonium can then be absorbed by plants to help make proteins and DNA or RNA. Some ammonium (NH₄) in the soil is also consumed by **Nitrifying Bacteria**, and converted to Nitrite (NO₂) first and then ultimately into Nitrate (NO₃). This process is called **Nitrification**. The nitrates are also absorbed by the plants, just as was the ammonium. (The plants *ate* the nitrates **and ammonium**, but not the nitrites.) Some other bacteria in the soil can also eat the nitrates. These are called **Denitrifying Bacteria**. They consume the nitrates and break it down into Oxygen gas (O₂) and Nitrogen gas (N₂) and both are returned to the air to be used again. This process is called **Denitrification**. As plants are eaten by animals, the nitrogen travels through the food chain. When all life forms die, the bodies decompose and create ammonia (NH₃), which is why they stink. The ammonia is converted by bacteria into ammonium to be used again by plants and bacteria. This conversion is called **Ammonification**. Some nitrogen is also released by animals in their urine. It too undergoes ammonification.
- C. **Phosphorus Cycle**- The phosphorus is initially a component of rock. As the rock breaks down over time, called **weathering**, the phosphorus is released into the soil. Some *dissolves* into the water as the rains pass through the soil. This phosphorus makes its way into bodies of water, such as lakes and oceans, and is available for producers (phytoplankton) to use to help make organic compounds such as phospholipids and DNA or RNA. Plants (also producers) can also retrieve the phosphorus from the soil and use it to make organic compounds too. When organisms die, decomposers break down the bodies and return the phosphorus back to the soil to be reused.
- E. Temperature affects the cycling rates
1. High Temperature cause faster recycling of the chemicals. (Such as in the Tropical Rain Forest.)
 2. Low Temperature causes slower recycling of the chemicals. (Such as in the Tundra.)

Please make sure students understand the cycles. Please remind them that C, N, P are needed to make the macromolecules – sugars, lipids, proteins, nucleic acids and also ATP. Help students “see” the terms in the N cycle.

Ecosystem Dynamics (6.4) – Part 3

I. Human Impact on Ecosystems

A. Agriculture

1. Harvesting (Promotes a *loss* of nutrients from that area.)
 - a. Fertilizers (Good in that it replaces or Bad in that it could hurt the environment.)
 - b. **Critical Load** (Refers to the *maximum amount of nutrients that plants can absorb.*)
(The *extra* fertilizer damages the ecosystem.)

B. Fossil Fuels

1. Burning these can cause **Acid Precipitation** (It is Rain/snow/sleet/ice with a pH of < 5.6.)
 - a. Sulfur and Nitrogen oxides are the main causes (They are released by burning fossil fuels.)
 - b. Effects? It kills plants and **leaches** (nutrients moved away from the roots) the soil.

C. **Biological Magnification** - the *buildup of poisons* and heavy metals in organisms. The higher up the food chain you get, the poisons get more and more concentrated, which causes health and reproductive problems.

Please help make sure students understand how the magnification occurs. That higher trophic levels eat *more* organisms in the tropic levels below them. So the poison accumulates in the higher trophic organism over time.

1. DDT and PCB, to name a couple, use has lead to organism extinct, health issues, and polluted water.
2. The book *Silent Spring* by Rachel Carson discusses these in depth.
 - a. This book led to the eventual banning of DDT in the U.S. in 1971.
 - b. The DDT was used to kill mosquitoes, but it was going up the food chain and killing the Bald Eagle population. The DDT caused the bird's eggs shells to be paper-thin. So when the mother goes to sit on the eggs to keep them warm; she ended up crushing them instead.

D. Rising Atmospheric CO₂ levels

1. Deforestation and Fossil Fuels (No trees to pull CO₂ out of the air and fossil fuels releasing it.)

E. The Greenhouse Effect and Greenhouse Gases increasing will help *raise the Earth's average temperature.*

F. Ozone Depletion and CFC's (Chloro-fluro-carbons are propellants found in aerosol cans and refrigerants.)

1. *Each CFC can destroy up to 100,000 Ozone molecules* (It is a chain reaction.)
2. Ozone helps block out harmful radiation from the sun, so we don't burn up.
2. Ozone holes in Antarctica and Northeastern Canada exist. These holes are causing ice to melt faster and also causing more health related issues, such as skin cancers.