AP Environmental Systems Ch. 3

**Ecosystems: What Are They and How Do They Work?**

**Core Case Study:** Tropical Rain Forests Are Disappearing

* Cover only about \_\_\_\_\_\_\_\_\_\_ of the earth’s land surface
* Contain about \_\_\_\_\_\_\_\_\_\_ of the world’s known plant and animal species
* Major harmful effects of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Reduces \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ global warming
  + Changes \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ weather patterns
* Natural Capital Degradation: The Loss of Tropical Rain Forest

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**3-1 How Does the Earth’s Life-Support System Work?**

* The four major \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the earth’s life-support system
  + The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (air), the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (water), the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (rock, soil, and sediment), and the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (living things)
* Life is sustained by the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of energy from the sun through the biosphere, the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of nutrients within the biosphere, and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

The Earth’s Life-Support System Has Four Major Components

* Atmosphere
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: where weather happens
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: contains ozone layer
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: water on the earth’s surface
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: the solid earth
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: life

Natural Capital: General Structure of the Earth

Three Factors \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Life on Earth

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ flow of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ energy:
  + Sun → plants → living things → environment as heat → radiation to space
* Cycling of nutrients through parts of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ holds the earth’s atmosphere

Greenhouse Earth

1.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

4.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

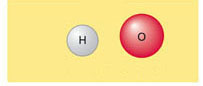
5.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**3-2 What Are the Major Components of an Ecosystem?**

* Some organisms produce the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ they need
* Others get their nutrients by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ other organisms
* Some \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ nutrients back to producers by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the wastes and remains of organisms

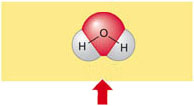
Ecosystems Have Several Important Components

* Ecology
  + Science of organism’s \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ with each other and their \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ environment
  + Ecologists study interactions within and among:
    - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_



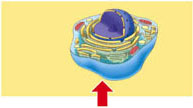
**Smallest unit of a chemical element that exhibits its chemical properties**

**Atom**



**Molecule**

**Chemical combination of two or more atoms of the same or different elements**



**Cell**

**The fundamental structural and functional unit of life**



**Organism**

**An individual living being**



**Population**

**A group of individuals of the same species living in a particular place**



**Community**

**Populations of different species living in a particular place, and potentially interacting with each other**

**Stepped Art**

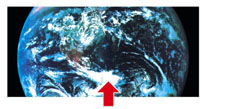
**Ecosystem**

**A community of different species interacting with one another and with their nonliving environment of matter and energy**



**Biosphere**

**Parts of the earth's air, water, and soil where life is found**



**Oxygen**

**Hydrogen**

**Water**

**Fig. 3-4 p. 55**

* Major Biotic and Abiotic Components of an Ecosystem

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* Producers (\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_)
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    - CO2 + H2O + sunlight → glucose + oxygen
* Consumers (\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_)
  + Primary consumers = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ consumers
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ consumers
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Consumers that release nutrients
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Feed on dead bodies of other organisms
* There is very little waste of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in nature
  + Detritivores and Decomposers

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Organisms Get Their Energy in Different Ways

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ respiration
  + Using oxygen to turn glucose back to carbon dioxide and water
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ respiration
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + End products are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ compounds such as methane or acetic acid
* The Components of an Ecosystem

**3-3 What Happens to Energy in an Ecosystem?**

* As energy flows through \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in food chains and webs, the amount of chemical energy \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to organisms at each successive feeding level \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Energy Flows Through Ecosystems in Food Chains and Food Webs

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Movement of energy and nutrients from one trophic level to the next
  + Photosynthesis → feeding → decomposition
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Network of interconnected food chains

Usable Energy \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ with Each Link in a Food Chain or Web

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Dry weight of all organic matter of a given trophic level in a food chain or food web
  + Decreases at each higher trophic level due to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of energy flow
  + \_\_\_\_\_\_\_\_\_\_ of energy lost with each transfer
  + Less chemical energy for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ trophic levels

Some Ecosystems Produce Plant Matter Faster Than Others Do

* Gross primary \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (GPP)
  + Rate at which an ecosystem’s producers convert solar energy to chemical energy and biomass
  + Kcal/m2/year
* Net primary \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (NPP)
  + Rate at which an ecosystem’s producers convert solar energy to chemical energy, minus the rate at which producers use energy for aerobic respiration
  + Ecosystems and life zones differ in their NPP

**3-4 What Happens to Matter in an Ecosystem?**

* Matter, in the form of nutrients, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ within and among ecosystems and the biosphere, and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ activities are altering these chemical cycles

Nutrients Cycle within and among Ecosystems

* Nutrient cycles
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Nutrients may remain in a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ for a period of time

The Water Cycle

* Three major processes
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the hydrologic cycle by humans
  + Withdrawal of large amounts of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ at rates faster than nature can replace it
  + Clearing \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Increased \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when wetlands are drained

Science Focus: Water’s Unique Properties

* Properties of water due to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ bonds between water molecules:
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ over large temperature range
  + Changes temperature \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ boiling point: 100˚C
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ as it freezes
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ out harmful UV

The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Cycle

* Based on \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ remove CO2 from the atmosphere
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ use CO2
* Some carbon takes a long time to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Humans altering carbon cycle by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ fossil fuels

The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Cycle: Bacteria in Action

* Nitrogen \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and cyanobacteria
    - Combine gaseous nitrogen with hydrogen to make ammonia (NH3) and ammonium ions (NH4+)
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Soil \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ change ammonia and ammonium ions to nitrate ions (NO3-)
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Nitrate ions back to nitrogen gas
* Humans are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ nitrogen from the atmosphere faster than it can be replaced

The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Cycle

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ through water, the earth’s crust, and living organisms
* Impact of human activities
  + Clearing \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Removing large amounts of phosphate from the earth to make \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ leaches phosphates into streams

The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Cycle

* Most sulfur found in rocks and deep under ocean \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* SO2 in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Released by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Human activities affect the sulfur cycle
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ sulfur-containing coal and oil
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ sulfur-containing petroleum
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ sulfur-containing metallic mineral ores

**3-5 How Do Scientists Study Ecosystems?**

* Scientists use both field research and laboratory research, as well as mathematical and other models, to learn about ecosystems

Some Scientists Study Nature \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ research
  + Observing and measuring in nature
* New technologies available
  + Remote sensors
  + Geographic information system (GIS) software
  + Digital satellite imaging

Some Scientists Study Ecosystems in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* Model ecosystems and populations under laboratory conditions
* Simplified systems
* Supported by field research

Some Scientists Use \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to Simulate Ecosystems

* Mathematical and other models
* Computer simulations and projections
* Field and laboratory research needed for baseline data

We Need to Learn More about the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the World’s Ecosystems

* We need to determine the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the world’s ecosystems
  + More \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ data needed

Three Big Ideas

* Life is sustained by:
  + The flow of energy from the sun through the biosphere
  + The cycling of nutrients within the biosphere
  + Gravity
* Organisms obtain energy in different ways
* Some organisms produce the nutrients they need
* Some organisms consume others
* Some organisms live on wastes and recycle nutrients
* Human activities are altering:
  + The flow of energy through food chains and webs
  + The cycling of nutrients within ecosystems and the biosphere

Tying It All Together: Tropical Rainforests and Sustainability

* Producers rely on solar energy
* Species depend on nutrient cycles
* Tropical rainforests contain a huge amount of the earth’s biodiversity