Chapter 1
Energy Transfer in the Biosphere

Chapter 6
Energy Transfer in the Biosphere
• 1.1 How Energy Enters the Biosphere
• 1.2 How Energy is Transferred in the Biosphere

1.1 How Energy Enters the Biosphere
In this section you will:
• Explain how energy enters the biosphere through the process of photosynthesis and chemosynthesis
• Describe how energy is transferred in the biosphere through the activity of producers and consumers
• Perform an investigation to demonstrate the storage of light energy in the form of the chemical energy of starch in green plants

What is Ecology?
• Study of interactions between organisms and their physical environment
• Includes both living and non-living components of the physical environment
Need for Energy

• Need energy to stay alive
• Two main processes to release energy:
  • Cellular Respiration
  • Photosynthesis

Overview

Cellular Respiration

• Occurs in:

• Represented by the following equation:

Photosynthesis

• Occurs in:

• Represented by the following equation:

The Basis of Life
Obtaining Energy

- **Producers (autotrophs):** self-feeders — Produce their own food from the sun’s energy
  - Synthesizes organic molecules from inorganic molecules
- **Consumers (heterotrophs):** other-feeders — Cannot make their own energy rich food.
  - Must obtain molecules by consuming other organisms.
    - Obtains organic molecules

Radiant Energy

- **Sun** is the source of energy
  - $10^{22}$ J (Joules) of Sun’s radiant energy reaches Earth each day.

- **Outcome of radiant energy**
  - 30% reflected from clouds, dust particles in atmosphere, and water at Earth’s surface
  - **Albedo:** describe amount of reflected energy
  - 19% absorbed by atmosphere and clouds
  - 51% absorbed at Earth’s surface

Producers

- Only 1-2% of radiant energy **captured** by producers on land and in the ocean

- What about producers that don’t use the sun’s energy?
  - **Chemosynthetic producers:** Use chemicals to make energy
    - Ex. Bacteria within tissue of tube worms split hydrogen sulfide capturing energy from chemical bonds

Consumers

- **Primary** consumers (Herbivores) — Eaters of plants and other producers
- **Secondary** consumers (Carnivores) — Eat other animals, mainly herbivores
- **Tertiary** consumers (Carnivores) — Eat other carnivores
- **Decomposers** — Eating or absorbing leftover waste matter
  - Feces and dead organisms
  - **IMPORTANT:** Return organic and inorganic matter to soil, air, and water.
  - Recyclers of biosphere
Decomposers

- F.B.I
  - Fungi
  - Bacteria
  - Insects
- E
  - Earthworms

Laws of Thermodynamics

- 1st Law- Energy cannot be created or destroyed, only transferred from one object to another.
  - Ex. Radiant energy from sun converted into chemical energy stored in carbohydrates
- Energy transformation is inefficient
- 2nd Law- Each conversion of energy offers less energy available for work.
  - Energy is lost as unusable heat in the environment
1.2 How Energy is Transferred in the Biosphere

- In this section you will:
  - Explain the structure of trophic levels in ecosystems
  - Explain what happens to energy as it is transferred from one trophic level to another through the biosphere
  - Describe and illustrate the transfer of energy using models such as food chains and food webs
  - Gather and analyze data and information to assess the effect of organisms diversity on an endangered ecosystem

Ecosystems

- **Ecosystem** - Biological community interacting with organisms and their physical environment
- **Biotic/Abiotic**
  - Living/non-living

Feeding Relationships

- Organisms can be identified by how they obtain their food and the kind of food they eat.
  - Ex. Producers, herbivores, carnivores, and decomposers
- Identified by type of food-maker or food-consumer
  - Ex. Producer, primary consumer, secondary consumer, tertiary

- **Trophic Level** - Feeding level through which energy and matter are transferred
**Food Chains/Food Webs**

- **Food Chain**: Model shows linear path through which food is transferred to higher trophic levels
  - 3-6 trophic levels
  - Limits due to thermodynamics

- **Food Web**: Model of food (energy) transfer in an ecosystem that shows the connections among food chains
Energy Transfer

- Amount of energy transferred varies among different organisms
- 5-20%
- 80-95% chemical energy that is available at each trophic level is not transferred
- Ecologists assume **10% of energy is transferred**
  - Ex. 35000kJ energy captured by grain plants
  - 350kJ of the energy to the cow
- **Rule of 10**

Pyramids of Numbers

- Fewer animals higher in trophic levels
  - Ex. Fewer secondary consumers than primary consumers
- Pattern: Pyramids of Numbers
  - Each bar of pyramid of numbers represents different trophic level
- **Width** represents relative number of organisms
- **Limitation**: Does not consider size of individual organism

Pyramid of Biomass

- Organisms tend to be larger than food they eat
  - Ex. Birds tend to be larger than seeds
- **Biomass**: Dry mass of living, or once-living, organisms per unit area
- Excellent indicator of amount of energy present in living tissue
- **g/m²** (grams per square meter)

Pyramids of Energy

- Total amount of energy transferred through each trophic level
- Always upright
Biomagnification

- Pollutants, etc. increase in concentration higher in trophic levels

Review

- Crash Course: [https://www.youtube.com/watch?v=v6ubvEJ3KGc](https://www.youtube.com/watch?v=v6ubvEJ3KGc)

Thought Lab

- Pg. 20 #1-3
- Work with a partner
- #4 will be completed as a class

Biomagnification: A Fish Story

- Pg. 28 ALL
- Hand it questions 1-5