Chapter 24
Lecture Outline

See separate PowerPoint slides for all figures and tables pre-inserted into PowerPoint without notes.
Global Ecology and Human Interferences
Points to ponder

• What is an ecosystem and what are its biotic components?
• What are energy flow and chemical cycling in an ecosystem?
• What are the two major ecosystems on earth?
• Describe the three types of terrestrial ecosystems and the two types of aquatic ecosystems.
• Compare and contrast food webs and food pyramids.
• What is a biogeochemical cycle?
• What is a reservoir and an exchange pool?
Points to ponder

• Explain the water, carbon, nitrogen, and phosphorus cycles.
• What human activities interfere with these cycles?
• What problems are we creating by altering these pathways?
• What is biomagnification and why is mercury a concern?
The nature of ecosystems

• **Biosphere** – the regions of the Earth’s waters, crust, and atmosphere inhabited by living organisms

• **Ecosystem** – a place where organisms interact with each other and their environment
  – Terrestrial: several distinct types based on temperature and waterfall
  – Aquatic: freshwater and marine
24.1 The Nature of Ecosystems

Terrestrial ecosystems

- Forests – dominated by trees
  - Tropical rain forest
  - Coniferous forests (taiga)
  - Temperate deciduous forests

- Grasslands – dominated by grass
  - Tropical grasslands
  - Temperate grasslands (prairie)
24.1 The Nature of Ecosystems

Terrestrial ecosystems

- Deserts – characterized by lack of available moisture
  - Tundra
  - Deserts
24.1 The Nature of Ecosystems

Terrestrial ecosystems

Figure 24.1 The distribution of the major terrestrial biomes.

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Aquatic ecosystems

- Marine
  - Seashores
  - Oceans
  - Coral reefs
  - Estuaries

- Freshwater
  - Lakes
  - Ponds
  - Rivers
  - Streams
24.1 The Nature of Ecosystems

Aquatic ecosystems

Figure 24.2  Examples of freshwater and saltwater ecosystems.

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Components of an ecosystem

• Abiotic components – nonliving environment

• Biotic components - living components
  • Autotrophs – producers
  • Heterotrophs – consumers
    • Herbivores – feed on plants and algae
    • Carnivores – feed on other animals
    • Omnivores – eat both plants and animals
    • Detritus feeders – feed on decomposing organic matter
Components of an ecosystem

- **Niche** – the role an organism plays in an ecosystem such as how it gets its food, what it eats, and how it interacts with other organisms
Biotic components of an ecosystem

Figure 24.3 The biotic components of an ecosystem.
24.1 The Nature of Ecosystems

Energy flow and chemical cycling

• Energy flow
  • It begins and continues when producers absorb solar energy.
  • Energy flow occurs as nutrients pass from one population to another.
  • This energy is converted to heat that dissipates into the environment.
  • Only a portion of energy is passed to organisms as they consume one another.
Energy flow and chemical cycling

• Chemical cycling
  • Inorganic nutrients are returned to producers from the atmosphere or soil.
  • Chemicals recycle within and between ecosystems.
24.1 The Nature of Ecosystems

Energy flow and chemical cycling

Figure 24.4 Energy flow and chemical cycling in an ecosystem.
Figure 24.5  The fate of food energy taken in by an herbivore.
Energy flow

- Food web – describes who eats whom
  - Grazing food web
  - Detrital food web

- Trophic levels – composed of all organisms that feed at a particular link in the food chain
  - Producers, primary consumers, and secondary consumers
Energy flow

• Ecological pyramid – reflects the loss of energy from one trophic level to another

• Only about 10% of the energy of one trophic level is available to the next trophic level
Food webs illustrate ecological relationships.

**Figure 24.6** Food webs illustrate ecological relationships.
24.2 Energy Flow

An example of a food pyramid

Figure 24.7 The influence of trophic level on biomass.
Biogeochemical cycles

- Biogeochemical cycles are pathways by which chemicals circulate through an ecosystem.
  1. Water cycle
  2. Carbon cycle
  3. Nitrogen cycle
  4. Phosphorus cycle
Biogeochemical cycles

• **Reservoir** – fossil fuels, minerals in rocks, and sediments in oceans contain inorganic nutrients that are limited in availability

• **Exchange pools** – atmosphere, soil, and water are ready sources of inorganic nutrients
24.3 Global Biogeochemical Cycles

Biogeochemical cycles

Figure 24.8
The cycling of nutrients between biotic communities and biogeochemical reservoirs.
Water cycle

- Water evaporates from bodies of water, land, and plants, and returns when water falls on land to enter the ground, surface waters, or aquifers.
Water cycle

- Human activities that interfere
  - Withdrawing water from **aquifers**
  - Clearing vegetation from the land and building structures that prevent percolation and increase **runoff**
  - Adding pollutants to water such as sewage and chemicals
24.3 Global Biogeochemical Cycles

Water cycle

Figure 24.9 The hydrologic (water) cycle.
Carbon cycle

• $\text{CO}_2$ is exchanged between the atmosphere and living organisms.

• Plants incorporate atmospheric $\text{CO}_2$ into nutrients through photosynthesis, providing food for themselves and other organisms.

• $\text{CO}_2$ is returned to the atmosphere through respiration.
24.3 Global Biogeochemical Cycles

Carbon cycle

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Figure 24.10 The carbon cycle.
Human activities that interfere

- Burning of fossil fuels and the destruction of forests are adding CO$_2$ to the atmosphere faster than it is being removed.

- CO$_2$ and other gases (N$_2$O and CH$_4$) are being emitted due to human activities.

- These gases are called greenhouse gases because they trap heat; this contributes to global warming.
24.3 Global Biogeochemical Cycles

Global warming and climate change

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Figure 24.11  Global warming and climate change.
78% of the atmosphere is nitrogen gas (N₂) but plants cannot use this form.

Nitrogen-fixing bacteria convert nitrogen gas to ammonium (NH₄⁺), which can be used by plants.

Nitrifying bacteria convert ammonium to nitrate (NO₃⁻).

Bacteria convert nitrate back to nitrogen gas through a process called denitrification.
Figure 24.12 The nitrogen cycle.
24.3 Global Biogeochemical Cycles

Nitrogen cycle

- Human activities that interfere
  - We add nitrogen fertilizers that run off into lakes and streams, causing major fish kills by eutrophication.

- Burning of fossil fuels
  - It puts nitrogen oxides and sulfur dioxide into the atmosphere, where they combine with water vapor to form acids that return to earth as acid deposition.
  - It results in nitrogen oxides and hydrocarbons that react with one another to produce smog.
Thermal inversions and smog

- During a thermal inversion, pollutants are trapped near the Earth.
  - The air does not circulate, so pollutants can build up to dangerous levels.

Figure 24.14  Thermal inversions.
24.3 Global Biogeochemical Cycles

Nitrogen cycle

Figure 24.13  The effects of acid deposition.

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Figure 24.13  The effects of acid deposition.
Phosphorus cycle

- Phosphate ions become available to living organisms by the slow weathering of rocks.

- Phosphate is a limiting nutrient in ecosystems.

Figure 24.15 The phosphorus cycle.
Phosphorus cycle

• Human activities that interfere
  • Runoff of phosphate due to fertilizer and discharge from sewage treatment plants results in eutrophication.

• Sources of water pollution
  - Point sources are the easily identifiable sources.
  - Nonpoint sources cannot be specifically identified (e.g., runoff).
Biomagnification of mercury

- Emissions of mercury into the environment can lead to serious health effects for humans, fish, and wildlife.
- There is widespread mercury contamination in streams, wetlands, reservoirs, and lakes throughout most of the U.S.
- Bioaccumulation occurs when an organism accumulates a contaminant such as mercury faster than it can eliminate it.
- Mercury enters ecosystems at the base of the food chain and increases in concentration as it moves up higher trophic levels.
### Sources of Water Pollution

#### Leading to Cultural Eutrophication

<table>
<thead>
<tr>
<th>Source</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen-demanding waste</td>
<td>Biodegradable organic compounds (e.g., sewage, wastes from food-processing plants, paper mills, and tanneries)</td>
</tr>
<tr>
<td>Plant nutrients</td>
<td>Nitrates and phosphates from detergents, fertilizers, and sewage treatment plants</td>
</tr>
<tr>
<td>Sediments</td>
<td>Enriched soil in water due to soil erosion</td>
</tr>
<tr>
<td>Thermal discharges</td>
<td>Heated water from power plants</td>
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</tbody>
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#### Health Hazards

<table>
<thead>
<tr>
<th>Category</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disease-causing agents</td>
<td>Bacteria and viruses from sewage and barnyard waste (causing, for example, cholera, food poisoning, and hepatitis)</td>
</tr>
<tr>
<td>Synthetic organic compounds</td>
<td>Pesticides, industrial chemicals (e.g., PCBs)</td>
</tr>
<tr>
<td>Inorganic chemicals and minerals</td>
<td>Acids from mines and air pollution; dissolved salts; heavy metals (e.g., mercury) from industry</td>
</tr>
<tr>
<td>Radiation</td>
<td>Radioactive substances from nuclear power plants, medical and research facilities</td>
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</tbody>
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### Figure 24.16 Some sources of surface water pollution.