**Ecosystems Outline**

The Nature of Ecology

A. Ecology is the study of connections in the natural world. Ecologists try to understand interactions among organisms, populations, communities, ecosystems, and the biosphere.

1. An organism is any form of life. The cell is the basic unit of life in organisms.

2. Organisms are classified as either eukaryotic or prokaryotic based on the presence or absence of a membrane-bound nucleus.

3. Organisms are classified into species, which group organisms similar to each other together.

4. Sexually reproducing organisms are classified as a species if, under natural conditions, they can potentially breed with one another and produce live, fertile offspring.

5. The tiny microbes rule the world; they are unseen by the naked eye but keep the natural world operating.

6. About 1.4 million species have been identified, but estimates of number of species range from 3.6 million to 100 million.

B. A population consists of a group of interacting individuals of the same species occupying a specific area. Genetic diversity explains why these individuals may not behave nor look exactly alike. The habitat is the place where a population or an individual usually lives. Its distribution or range is the area over which a species may be found.

C. A community represents populations of different species living and interacting in a specific area. A biological community consists of all the populations of different species interacting and living in a specific area; this is a network of plants, animals, and microorganisms.

1. An ecosystem is a community of different species interacting with each other and with their nonliving environment of matter and energy. All of the earth’s diverse ecosystems comprise the biosphere.

The Earth’s Life-Support Systems

A. Various interconnected spherical layers make up the earth’s life-support system.

B. The atmosphere is the thin membrane of air around the planet.

C. The troposphere is the air layer about 11 miles above sea level.

D. The stratosphere lies above the troposphere between 11–30 miles; it filters out the sun’s harmful radiation.

E. The hydrosphere consists of the earth’s water, found in liquid water, ice, and water vapor.

F. The lithosphere is the crust and upper mantle of the earth’s soil. It contains nonrenewable fossil fuels, minerals, and soil, and renewable soil chemicals needed for plant life.

G. The biosphere includes most of the hydrosphere, parts of the lower atmosphere, and upper lithosphere. All parts of the biosphere are interconnected.

H. Ecology’s goal is to understand the interactions in the earth’s global skin of air, water, soil, and organisms.

I. Sun cycles of matter and gravity sustain life on Earth.

1. The one-way flow of high-quality solar energy through materials and living things (as they eat) produces low-quality energy. Energy can’t be recycled.

2. Matter cycles through parts of the biosphere.

3. Gravity causes the downward movement of chemicals as matter cycles through the earth.

J. Solar energy just passes through the earth as electromagnetic waves; they warm the atmosphere, evaporate and recycle water, generate wind, and support plant growth.

K. As solar radiation interacts with the earth, infrared radiation is produced. Greenhouse gases trap the heat and warm the troposphere. This natural greenhouse effect makes the planet warm enough to support life. Energy from the sun supports photosynthesis.

1. The earth’s temperatures, distance from the sun, and size all produce a livable planet. Its liquid water, orbit from the sun, and its gravitational mass all contribute to sustaining life in this natural greenhouse.

Ecosystem Components

1. Terrestrial parts of the biosphere are classified as biomes, areas such as deserts, forests, and grasslands. Aquatic life zones describe the many different areas found in a water environment, such as freshwater or marine life zones (coral reefs, coastal estuaries, deep ocean).

B. The major components of ecosystems are abiotic (nonliving) water, air, nutrients, solar energy, and biotic (living) plants, animals, and microbes.

C. Ecosystem characteristics include a range of tolerance to physical and chemical environments by the ecosystem’s populations.

1. Law of tolerance: The distribution of a species in an ecosystem is determined by the levels of one or more physical or chemical factors being within the range tolerated by that species.

a. The limiting factor principle states that too much or too little of any abiotic factor can limit or prevent growth of a population, even if all other factors are at or near the optimum range of tolerance. An abiotic factor such as lack of water or poor soil can be understood here.

1. Aquatic life zones can be limited by the dissolved oxygen (DO) content in the water or by the salinity.
2. The major biological components of ecosystems are the producers/autotrophs that are self-feeders and the consumers/heterotrophs.
3. Autotrophs make their own food from compounds in the environment (organisms such as green plants and algae). A few specialized producers can convert simple compounds to more complex compounds without sunlight, a process called chemosynthesis.
4. Consumers, or heterotrophs, feed on other organisms or their remains.

a. Decomposers break down organic detritus (bacteria/fungi) into simpler inorganic compounds.

b. Omnivores feed on both plants and animals.

c. Carnivores feed on animals.

d. Detritivores feed on dead organic matter and break it down into smaller molecules

e. Herbivores feed on plants.

f. Natural ecosystems produce little waste or no waste. In nature, waste becomes food.

1. Glucose and other organic compounds are broken down and energy released by the process of aerobic respiration, the use of oxygen to convert organic matter back to carbon dioxide and water. This process is a net chemical change to that of photosynthesis.
2. Some decomposers are able to break down organic compounds without using oxygen. This process is called anaerobic respiration, or fermentation. The end products are compounds such as methane gas, ethyl alcohol, acetic acid, and hydrogen sulfide.
3. Matter is recycled; there is a one-way flow of energy.

E. Biodiversity is the amazing variety of earth’s genes, species, ecosystems, and ecosystem processes.

1. The kinds of biodiversity are: genetic diversity, species diversity, ecological diversity and functional diversity.
2. Human cultural diversity is included as part of the earth’s biodiversity by some people.
3. Biodiversity keeps us alive and supports our economies.
4. Biodiversity is a renewable resource as long as humans live off the income, not destroy the capital.

Energy Flow in Ecosystems

A. Food chains and food webs help us understand how eaters, the eaten, and the decomposed are interconnected in an ecosystem.

B. The sequence of organisms as they are eaten is a food chain.

1. Trophic levels are feeding levels for organisms within an ecosystem.

a. Producers belong to the first trophic level.

b. Primary consumers belong to the second trophic level.

1. Secondary consumers belong to the third trophic level.
2. Detritivores and decomposers process detritus from all trophic levels.

2. Food webs are complex networks of interconnected food chains. They are maps of life’s interdependence.

C. Energy flow in a food web/chain decreases at each succeeding organism in a chain or web.

D. The dry weight of all organic matter within the organisms of a food chain/web is called biomass. Ecological efficiency is the term that describes the percentage of usable energy transferred as biomass from one trophic level to another and ranges from 2%–40% with 10% being typical.

E. The greater number of trophic levels in a food chain, the greater loss of usable energy.

F. The pyramid of energy flow visualizes the loss of usable energy through a food chain. The lower levels of the trophic pyramid support more organisms. If people eat at a lower trophic level (fruits, vegetables, grains directly consumed), Earth can support more people. There is a large loss of energy between successive trophic levels.

Primary Productivity of Ecosystems

A. Production of biomass takes place at different rates among different ecosystems.

1. The rate of an ecosystem’s producers converting energy as biomass is the gross primary productivity (GPP).

1. Some of the biomass must be used for the producers’ own respiration. Net primary productivity (NPP) is the rate which producers use photosynthesis to store biomass minus the rate which they use energy for aerobic respiration. NPP measures how fast producers can provide biomass needed by consumers in an ecosystem.

3. Ecosystems and life zones differ in their NPP. The three most productive systems are swamps and marshes, tropical rain forests, and estuaries. The three least productive are tundra, desert scrub, and extreme desert.

1. The planet’s NPP limits the number of consumers who can survive on Earth.

1. The highly productive tropical rain forest cannot support agriculture as practiced in developed countries.

2. Marshes and swamps do not produce food that can be eaten directly by humans; they feed other aquatic species that humans consume (fish, shrimp, clams).

C. Humans are using, wasting, and destroying biomass faster than producers can make it.