Ecology Unit Notes

Sections 3.1-3.4, 4.2-4.5, 5.1-5.2, 4.1, 6.2-6.4

Ecology – the scientific study of interactions among/between organisms and their environment.

- Levels of ecological organization (from smallest to largest):
  - Species – group of similar organisms that breed and produce fertile offspring.
  - Population – group of individuals that belong to the same species and live in the same area.
  - Community – different populations living together in a defined area.
  - Ecosystem – all the organisms that live in a place together with their physical environment.
  - Biome – group of ecosystems that share similar climates and typical organisms.
  - Biosphere – all life on Earth and all parts of Earth in which life exists.

Components of ecosystems

- Biotic factors – any living part of an environment with which an organism might interact.
  - Ex. Animals, plants, mushrooms, bacteria, etc.
- Abiotic factors – nonliving part of the environment that influence the organism.
  - Ex. Sunlight, heat, precipitation, humidity, wind, water current, soil type, etc.

Producers

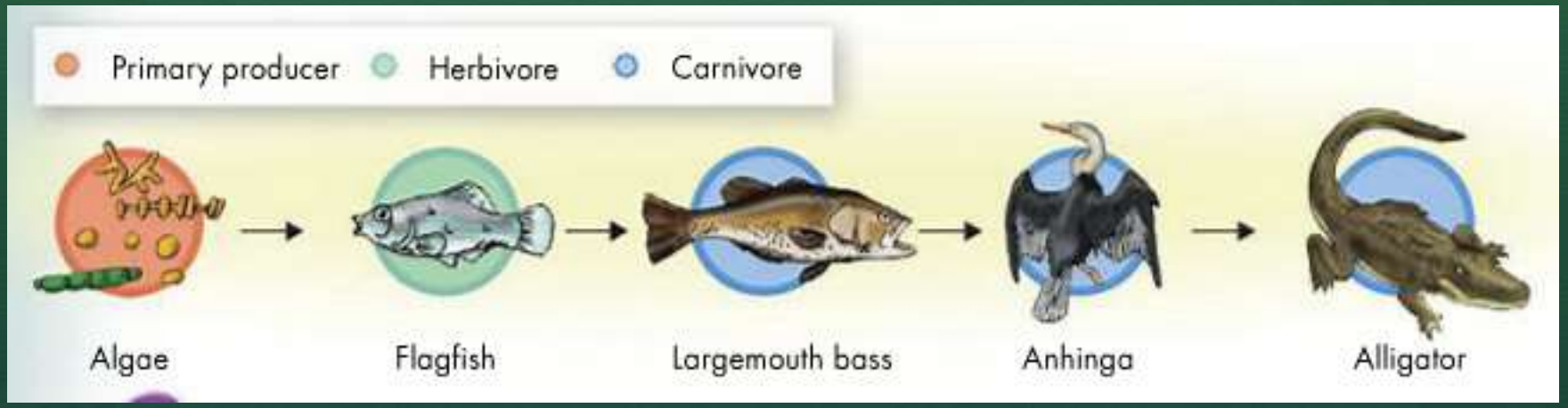
- Autotrophs – organisms that capture energy from sunlight or chemicals and convert it into forms living cells can use.
- Producers – make their own food.
- Primary producers – the first producers of energy-rich compounds that are later used by other organisms.
  - Autotrophs are primary producers!
  - Most engage in the process of photosynthesis.
  - Chemosynthesis – chemical energy is used to produce carbohydrates in dark conditions (like the deep oceans).

Consumers

- Heterotrophs – can not make their own food; acquire energy from other organisms by ingesting them.
- Consumers – organisms that rely on other organisms for energy and nutrients.
  - Carnivores – kill and eat other animals.
  - Scavengers – consume the carcasses of dead animals.
  - Decomposers – chemically break down organic matter (bacteria and fungi are examples).
  - Herbivores – eat plants.
  - Omnivores – diets include both plant and animal matter.
  - Detritivores – feed on detritus (small pieces of decaying matter) by grinding them into smaller pieces (earthworms and snails are examples). Often digest the decomposers living on the detritus.

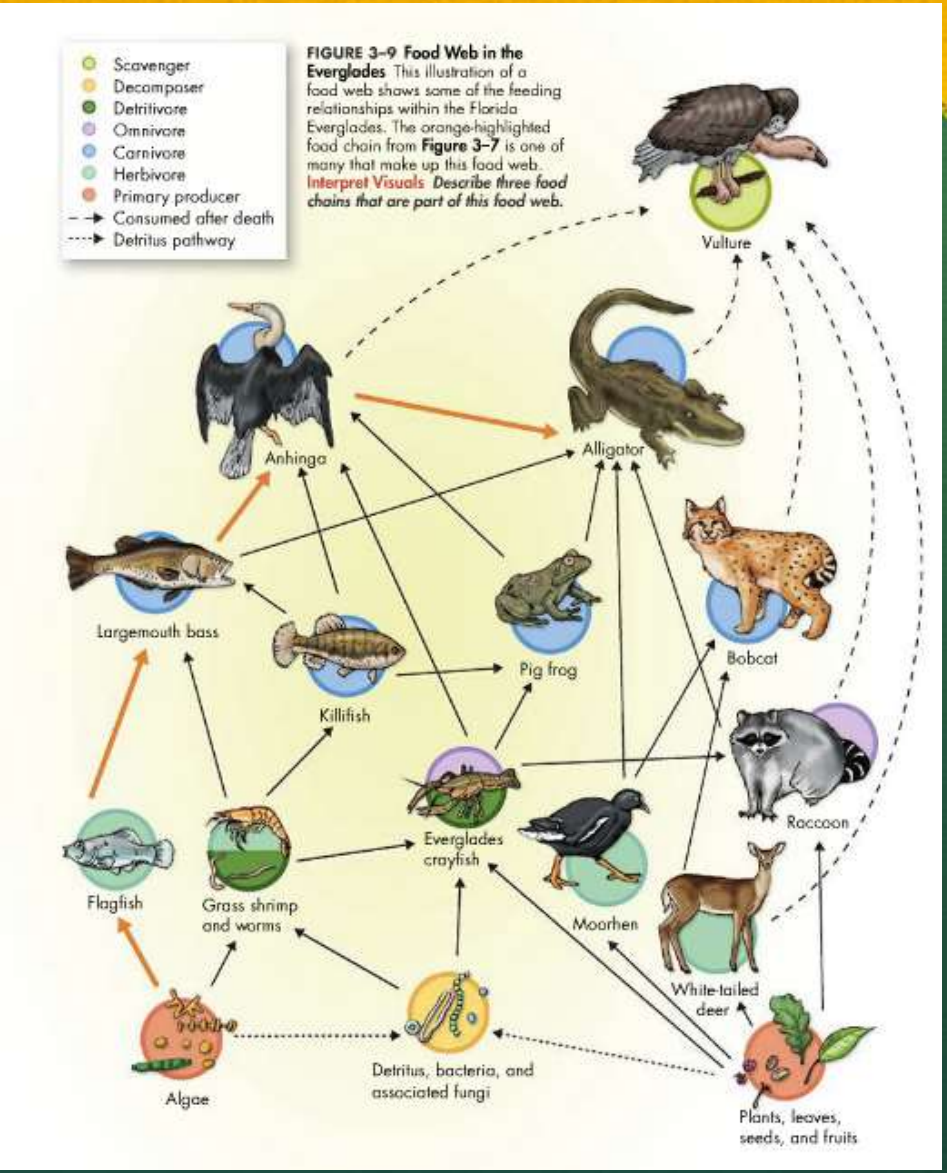
Energy flows in ecosystems

- Remember: energy flows through an ecosystem in one direction, from primary producers to consumers!
- Food chain – series of steps in which organisms transfer energy by eating and being eaten.



Energy flows in ecosystems

- Food web – Networks of feeding interactions involving multiple producers, herbivores, producers, and consumers.



Trophic levels

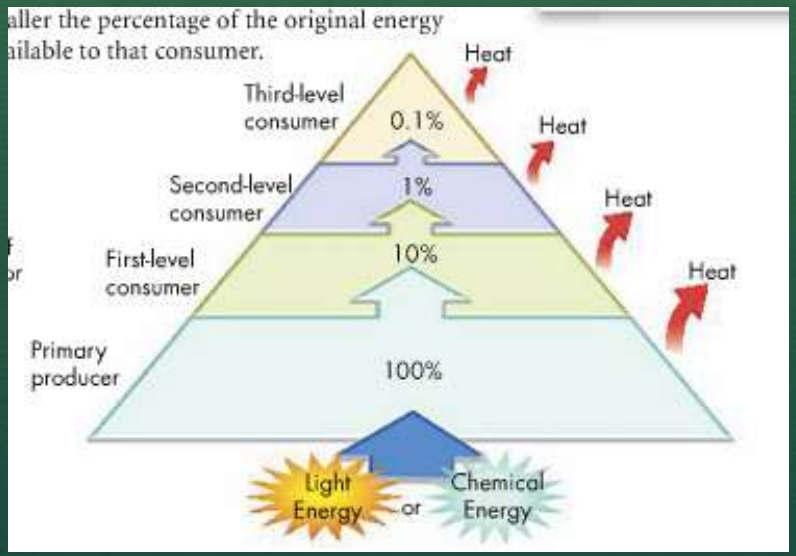
- Trophic level – each step in a food chain or food web.
  - Primary producers are always the first level; consumers occupy the other levels.
  - Trophic levels are illustrated by drawing ecological pyramids.

Ecological pyramids

- Ecological pyramid – shows the relative amount of energy or matter contained within each trophic level.
  - Three types:
    - Pyramids of energy
    - Pyramids of biomass
    - Pyramids of numbers

Pyramids of energy

- Pyramids of energy – show relative amount of energy available at each trophic level.
  - ***On average, only 10 percent of energy available in one trophic level is transferred to the next level! The rest is given off as heat!***



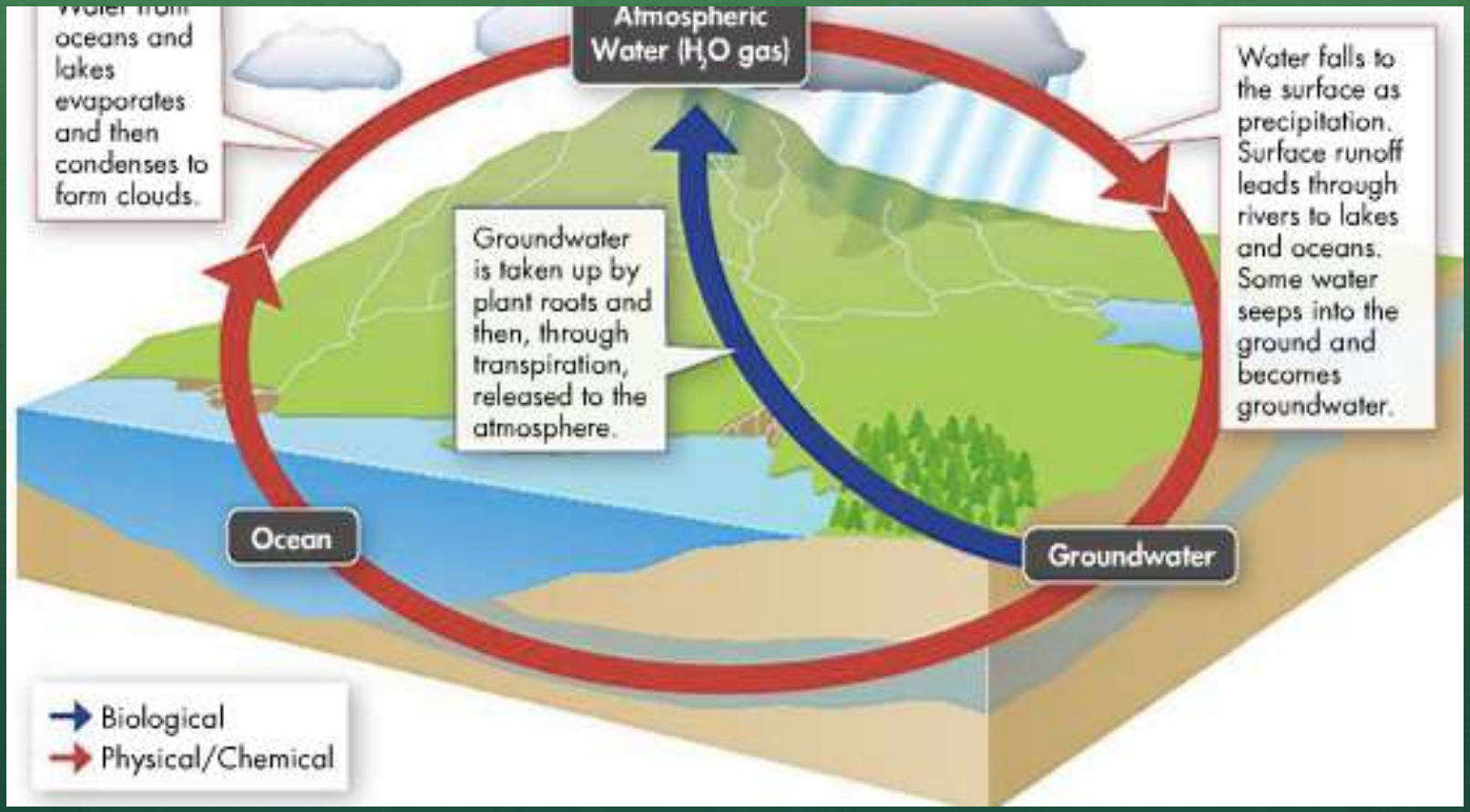
Pyramids of energy

- Biomass – the total amount of living tissue within a given trophic level.
- Pyramids of biomass – illustrates the relative amount of living organic matter in each trophic level of an ecosystem.
- Pyramid of the numbers – shows relative number of individual organisms at each trophic level of an ecosystem.

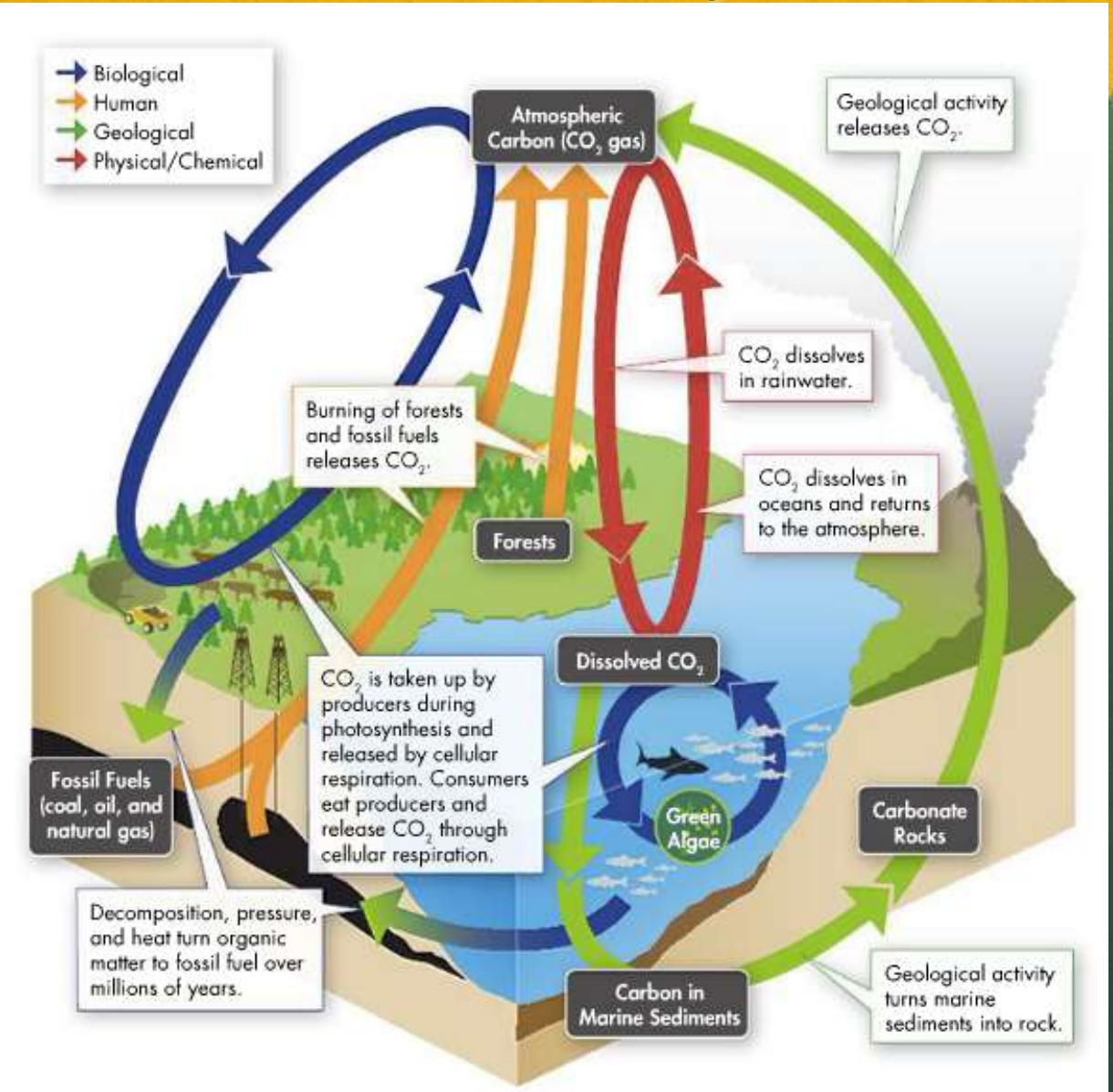
Cycles of matter

- Most living organisms are made of oxygen, carbon, hydrogen, nitrogen, sulfur, and phosphorus.
  - These make up life's important compounds like water, carbohydrates, lipids, nucleic acids, and proteins.
- Matter is recycled within and between ecosystems!
- Biogeochemical cycles – loops through which elements pass as they are recycled in ecosystems.
  - Are powered by the flow of energy.
- Nutrients – needed by organisms to build tissues and carry out life functions. Pass through organisms and environments through biogeochemical cycles.
  - Limiting nutrient – nutrient whose supply limits the productivity of an ecosystem.

Water cycle

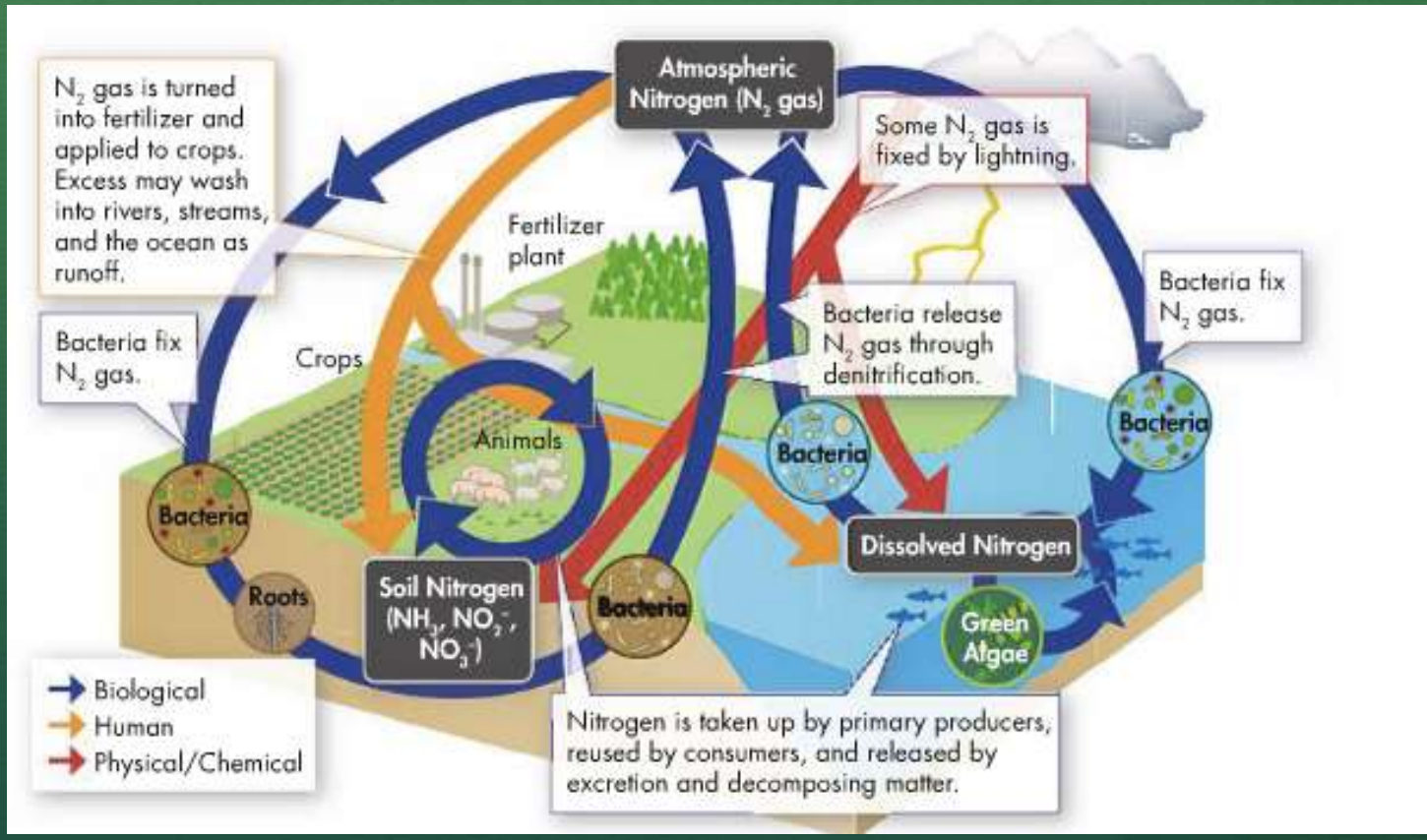

oceans and lakes evaporates and then condenses to form clouds.
Atmospheric Water (H_2O gas)
Water falls to the surface as precipitation. Surface runoff leads through rivers to lakes and oceans. Some water seeps into the ground and becomes groundwater.
Groundwater is taken up by plant roots and then, through transpiration, released to the atmosphere.
Ocean
Groundwater
Biological
Physical/Chemical

Carbon cycle

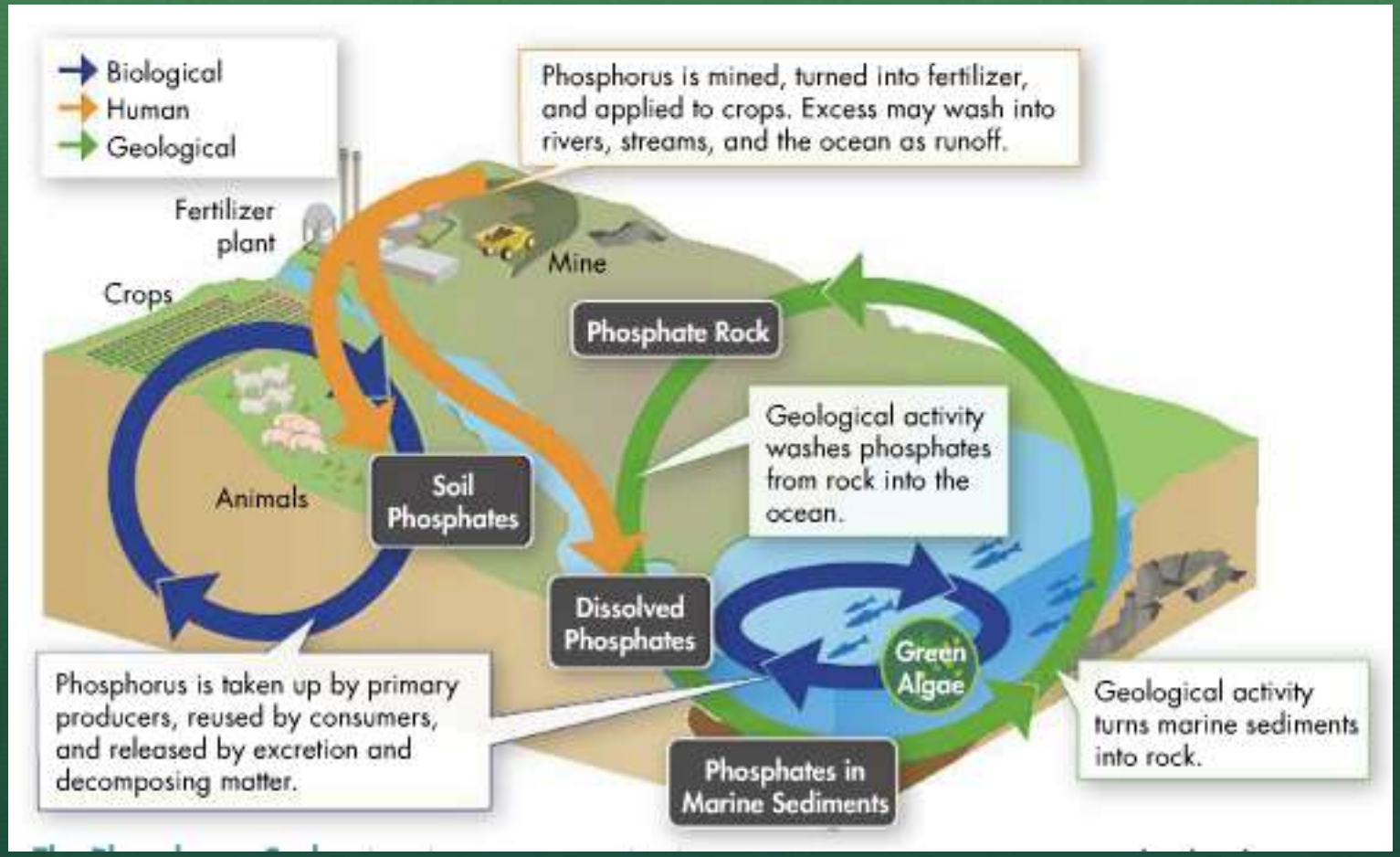


Nitrogen cycle

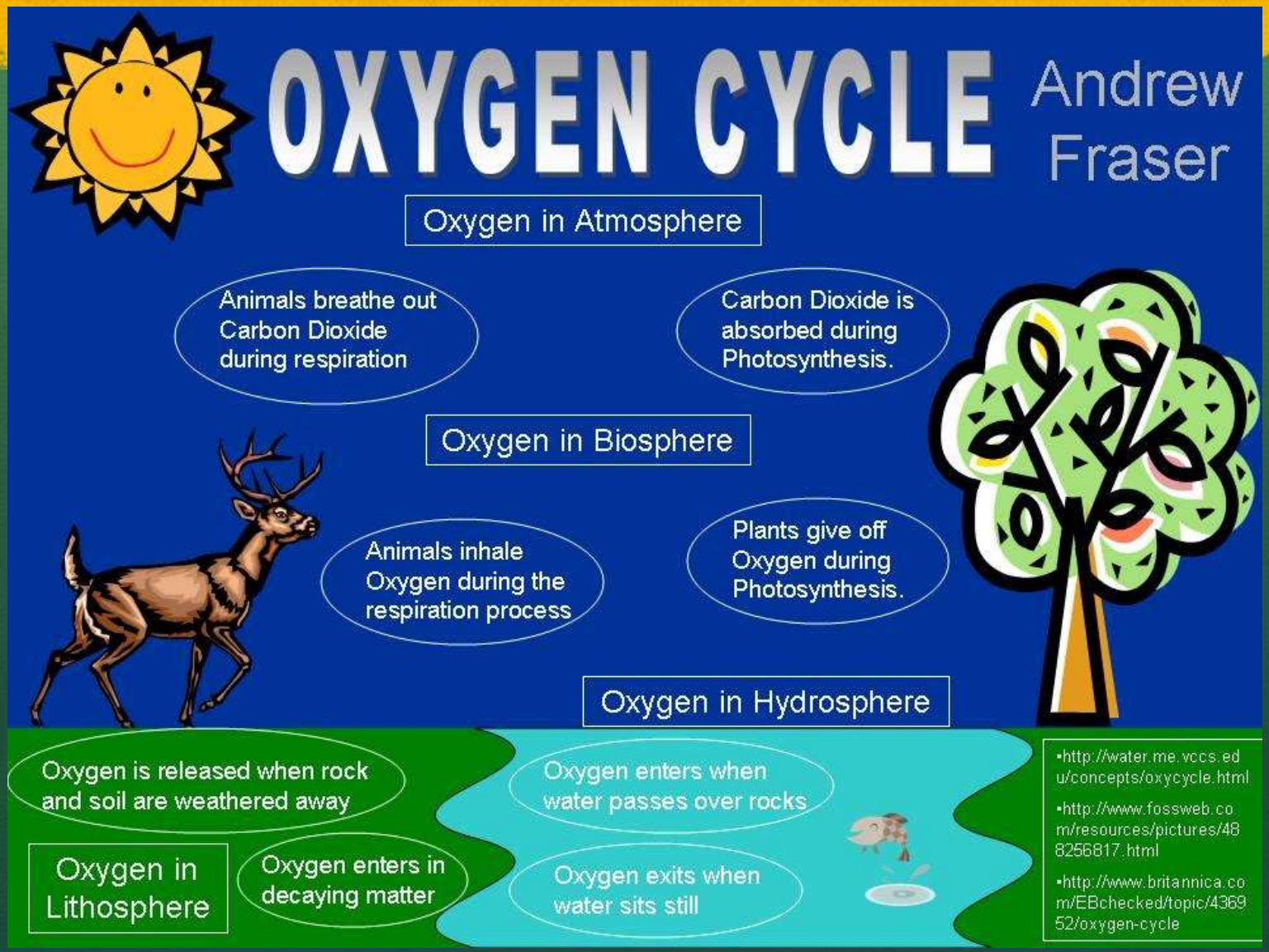
- Nitrogen fixation – process where bacteria (living in soil or on roots of legumes) convert nitrogen gas into ammonia.
- Denitrification – process where bacteria convert nitrates into nitrogen gas.



Phosphorus cycle



Oxygen cycle

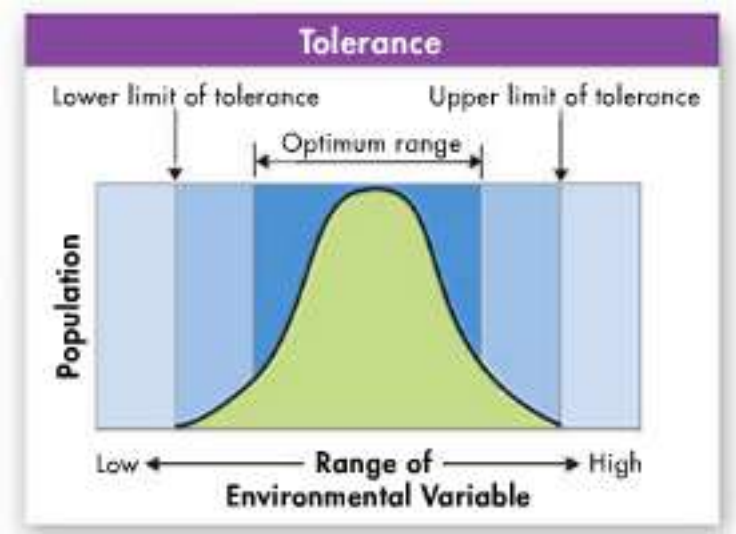


Niches and community interactions

- Niche – the range of physical and biological conditions in which a species lives and the way the species obtains what it needs to survive and reproduce.
  - Sometimes said to be the combination of the organism's habitat and "profession" in the ecosystem.
  - Niche's contain three aspects:
    - Resources – necessities of life.
    - Physical aspects – abiotic factors required for survival.
    - Biological aspects – biotic factors required for survival

Niches and community interactions

- Tolerance – the ability of a species to survive and reproduce under a range of environmental conditions.



- Habitat – general place where an organism lives.

Competition

- Intraspecific competition – competition for limited ecological resources between members of the same species.
- Interspecific competition – competition for limited ecological resources between members of different species.
- Competitive exclusion principle – states that no two species can occupy the same niche in exactly the same habitat at exactly the same time.
  - If two species attempt to, one will be better at competing for limiting resources and will eventually exclude the other species.
  - Species usually don't compete for similar resources, they usually divide them – this is called resource sharing.
    - By causing species to divide resources, competition helps to determine the number and kinds of species in a community and the niche each species occupies.

- Mimicry – the similarity of one species to another which protects one or both.
    - Appearance, behavior, sound, scent, or location
- Secondary Plant Compounds – compounds made for defense/prevention of competition

Predation

- Predator – captures and feeds upon the prey.
  - Can affect the size of prey populations in a community and determine the places the prey can live and feed.
- Herbivory – occurs when herbivores feed on producers.
  - Herbivores can affect the size and distribution of plant populations in a community and determine the places that plants can survive and grow.
- Keystone species – single species that is not usually abundant in a community yet exerts strong control on the structure of the community.

Symbiosis – any relationship in which two species live closely together.

- Mutualism – type of symbiotic relationship in which both species benefit.
- Parasitism – type of symbiotic relationship in which one organism benefits and one is harmed.
- Commensalism – type of symbiotic relationship in which one organism benefits and the other is neither helped nor harmed.

Ecological succession – series of predictable changes that occur in a community over time.

- Ecosystems change over time – after disturbances, some species die out and others move in.
- Primary succession – succession beginning in an area with no remnants of an order community.
  - Ex. After a volcanic eruption.
  - Pioneer species – first species to colonize a barren area.
- Secondary succession – succession in an area that has been disturbed but not completely destroyed.
  - Faster than primary because soil has survived and vegetation can regrow rapidly.
  - Ex. After a wildfire or hurricane.

Ecological succession

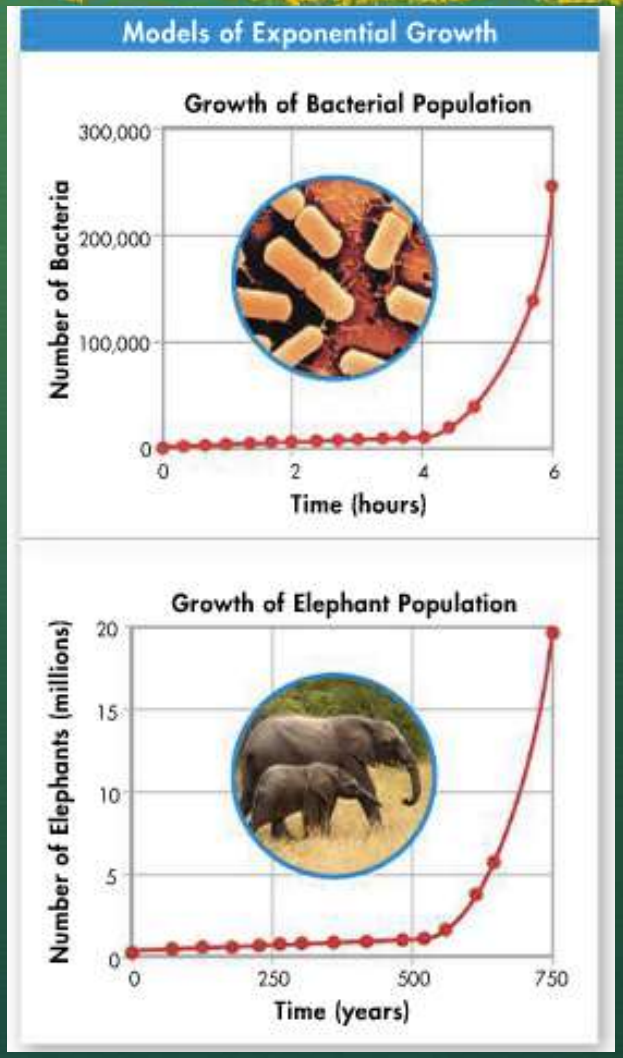
- Climax community – a biological community of plants, animals, and fungi which, through the process of ecological succession, have reached a steady state.
  - Following natural disturbances, secondary succession in healthy ecosystems often reproduces the original climax community.
  - Following human-caused disturbances, ecosystems may or may not recover a climax community.

Population growth

- Factors can affect population size:
  1. Birthrate – populations grow when more individuals are born than die in any period of time.
  2. Death rate – populations shrink when the death rate is greater than the growth rate.
  3. Immigration – populations grow if individuals move into its range from elsewhere.
  4. Emmigration – populations may decrease in size if individuals move out of the population's range.

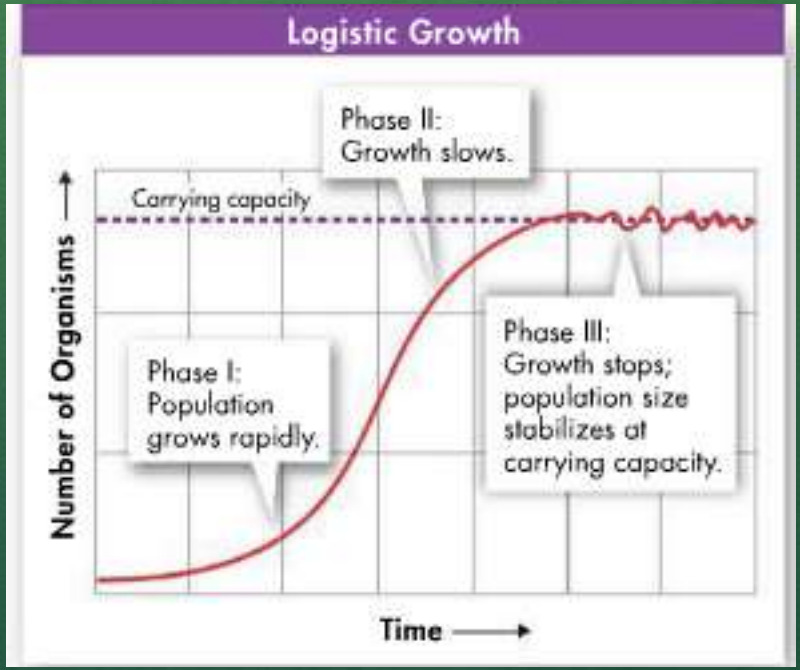
Population growth

- Exponential growth – occurs under ideal conditions with unlimited resources.



Population growth

- Logistic growth – occurs when a population's growth slows and then stops, following a period of exponential growth.
  - Carrying capacity – maximum number of individuals of a particular species that a particular environment can support.



Limits to growth

- Limiting factor – factor that controls the growth of a population.
  - Limiting factors determine the carrying capacity of an environment for a species.
  - Density dependent limiting factors – operate only when population density reaches a certain level.
    - Ex. Competition, predation, herbivory, parasitism, disease, stress from over-crowding.
  - Density independent limiting factors – affect all populations in similar ways, regardless of population size or density.
    - Ex. Natural disasters.

Climate

- Climate – defined by a region's year after year patterns of temperature and precipitation.
  - Microclimates – environmental conditions vary over small distances.

- Three factors influence global climate:
  1. Solar energy and the greenhouse effect – greenhouse gases trap heat in the atmosphere.
  2. Latitude and solar energy – climate zones are produced by an unequal distribution of the sun's heat on the Earth's surface.
  3. Heat transport in the biosphere – the unequal distribution of heat across the globe creates wind and ocean currents, which transport heat and moisture.

Earth's resources

- Soil erosion – when soil is washed away and eroded, carrying away organic matter and minerals that make it fertile.
  - Desertification – occurs when farming, overgrazing, and drought can turn farmland into desert.
  - Deforestation – when trees are removed reducing the quality of soil due to erosion.

Earth's resources

- Air pollution – occurs when the quality of Earth's atmosphere is reduced leading to respiratory illnesses and global climate pattern changes.
  - Forms of air pollution include:
    1. Smog – haze formed by chemical reactions among the pollutants released into the air by industry and vehicle exhaust. Ozone is produced.
    2. Acid rain – occurs when fossil fuels are burned releasing nitrogen and sulfur compounds into the air which combine with water vapor in the air.
    3. Greenhouse gasses – burning fossil fuels releases carbon into the atmosphere – accumulations contribute to global warming and climate change.
    4. Particulates – microscopic particles of dust and ash released by industry.

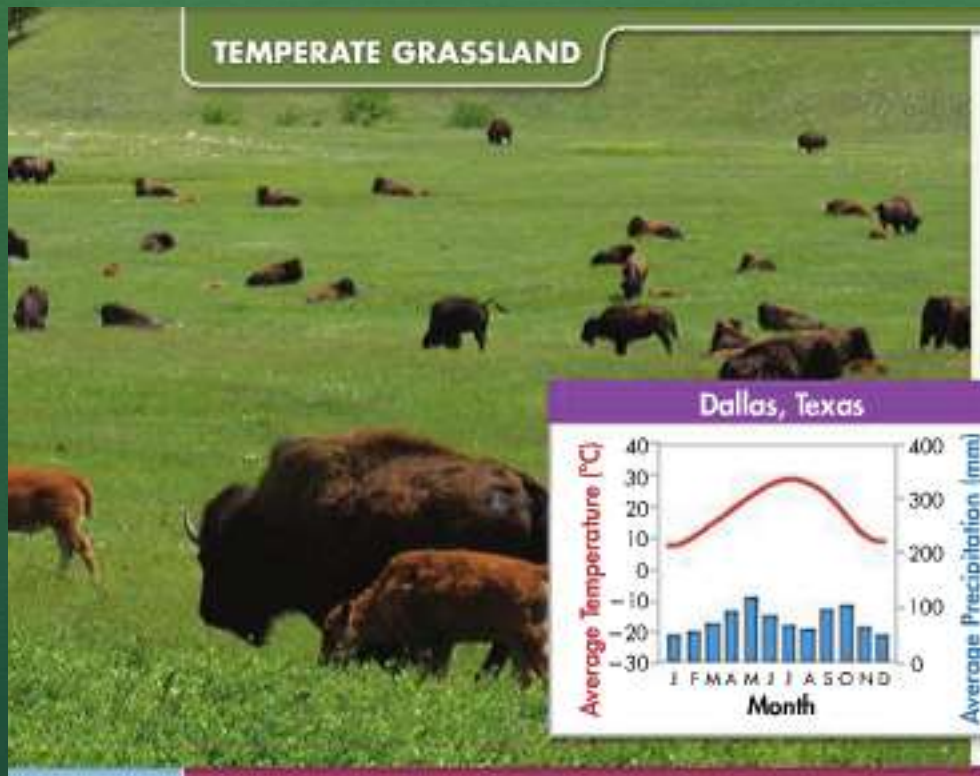
Biodiversity

- Biodiversity – the total of all the genetically based variation in all organisms in the biosphere.
  - Occurs on the ecosystem, species, and genetic levels.
  - Humans threaten biodiversity by: altering habitats, hunting, introducing invasive species, releasing pollution into food webs, and contributing to climate change.

Ecological challenges

- Ecological footprint – the total area of functioning land and water ecosystems needed both to provide the resources an individual or population uses and to absorb and make harmless the wastes an individual or population generates.
  - Take into account the need to provide resources (energy, food, water, shelter) and to absorb wastes (sewage, greenhouse gases).
  - Are used by ecologists to estimate the biosphere's carrying capacity for humans.

Biomes and ecosystems



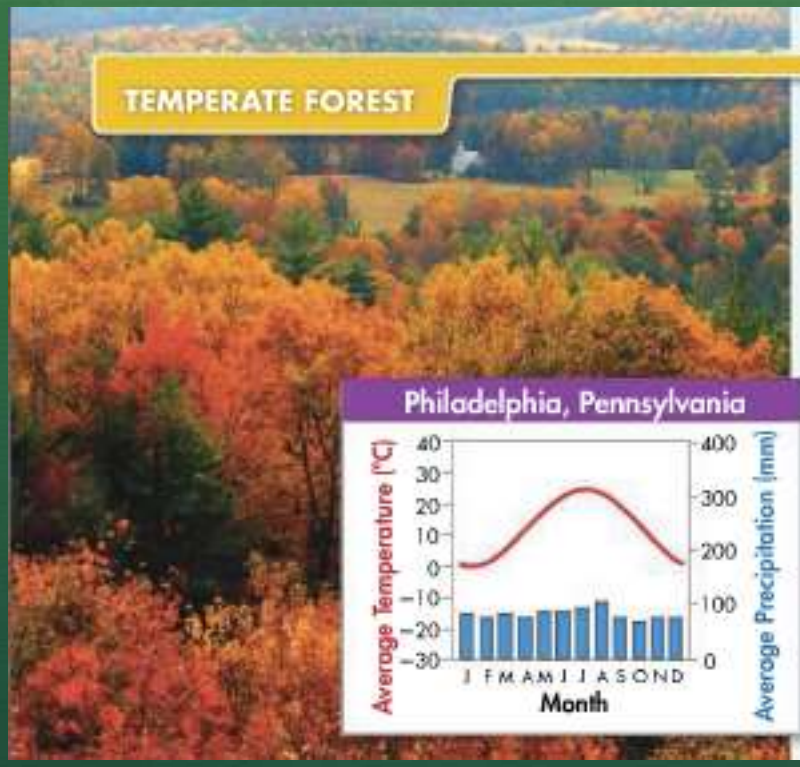
Plains and prairies, underlain by fertile soils, once covered vast areas of the midwestern and central United States. Periodic fires and heavy grazing by herbivores maintained plant communities dominated by grasses. Today, most have been converted for agriculture because their soil is so rich in nutrients and is ideal for growing crops.

- **Abiotic factors** warm to hot summers; cold winters; moderate seasonal precipitation; fertile soils; occasional fires
- **Biotic factors**

Plant life: Grassland plants—especially grasses, which grow from their base—are resistant to grazing and fire. Dispersal of seeds by wind is common in this open environment. The root structure and growth habit of native grassland plants helps establish and retain deep, rich, fertile topsoil.

Animal life: Because temperate grasslands are such open, exposed environments, predation is a constant threat for smaller animals. Camouflage and burrowing are two common protective adaptations.

Biomes and ecosystems



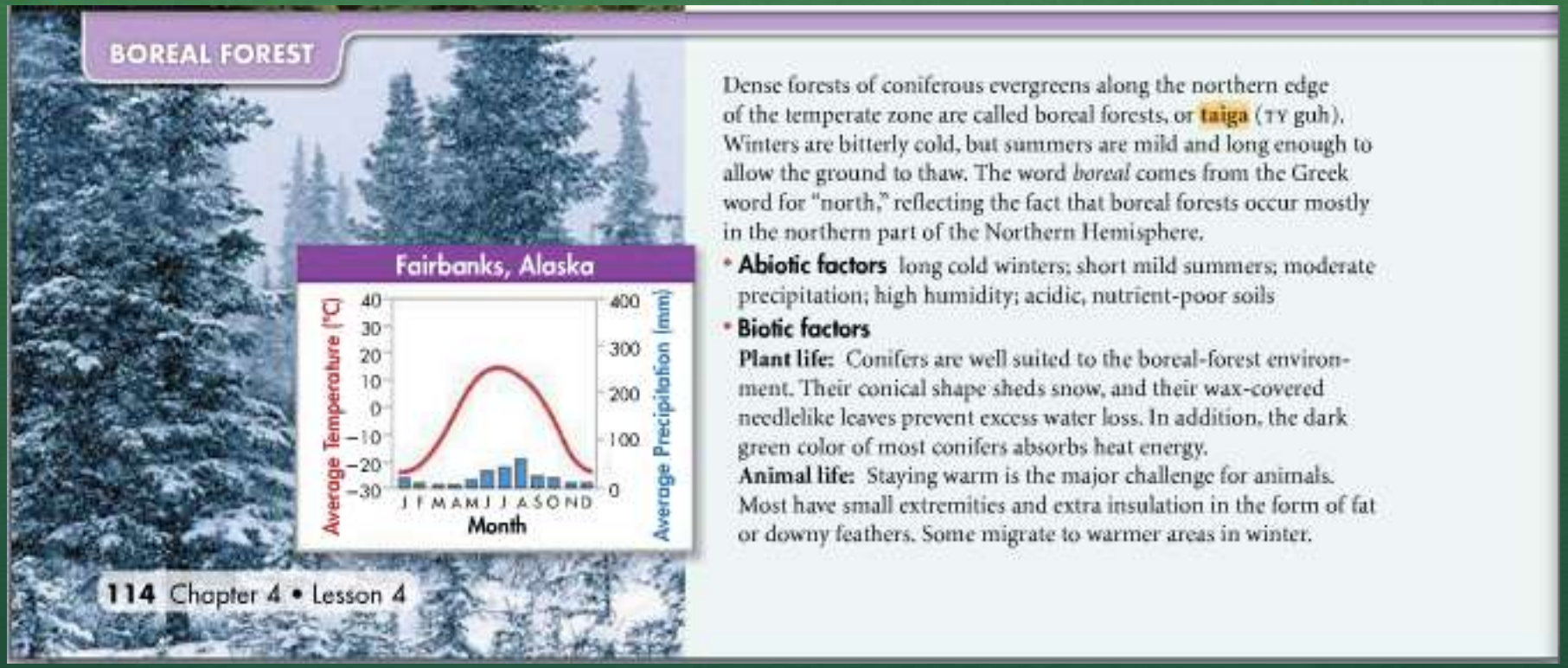
Temperate forests are mostly made up of deciduous and evergreen coniferous (koh NIF ur us) trees. **Coniferous** trees, or conifers, produce seed-bearing cones, and most have leaves shaped like needles, which are coated in a waxy substance that helps reduce water loss. These forests have cold winters. In autumn, deciduous trees shed their leaves. In the spring, small plants burst from the ground and flower. Fertile soils are often rich in **humus**, a material formed from decaying leaves and other organic matter.

- **Abiotic factors** cold to moderate winters; warm summers; year-round precipitation; fertile soils
- **Biotic factors**

  Plant life: Deciduous trees drop their leaves and go into a state of dormancy in winter. Conifers have needlelike leaves that minimize water loss in dry winter air.

  Animal life: Animals must cope with changing weather. Some hibernate; others migrate to warmer climates. Animals that do not hibernate or migrate may be camouflaged to escape predation in the winter when bare trees leave them more exposed.

Biomes and ecosystems



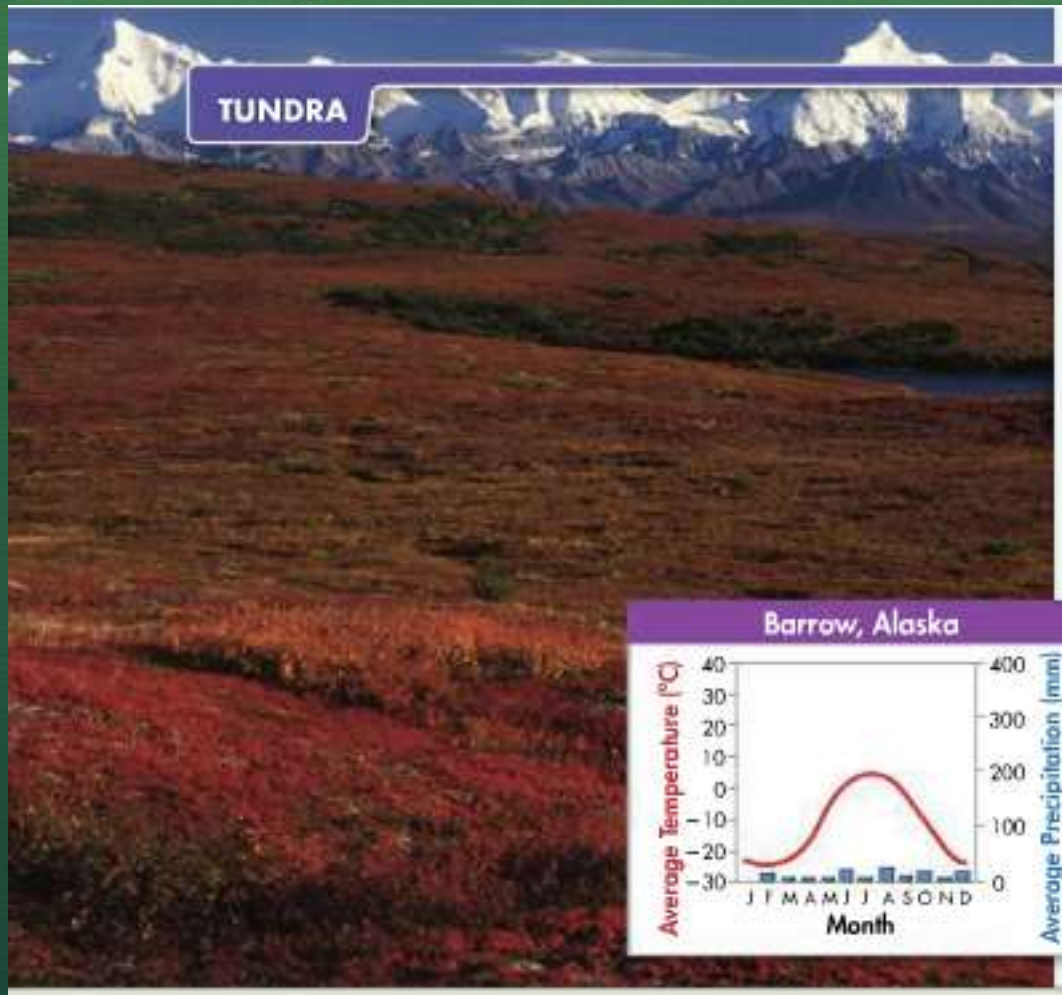
Dense forests of coniferous evergreens along the northern edge of the temperate zone are called boreal forests, or **taiga** (TY guh). Winters are bitterly cold, but summers are mild and long enough to allow the ground to thaw. The word *boreal* comes from the Greek word for "north," reflecting the fact that boreal forests occur mostly in the northern part of the Northern Hemisphere.

- **Abiotic factors** long cold winters; short mild summers; moderate precipitation; high humidity; acidic, nutrient-poor soils
- **Biotic factors**

Plant life: Conifers are well suited to the boreal-forest environment. Their conical shape sheds snow, and their wax-covered needlelike leaves prevent excess water loss. In addition, the dark green color of most conifers absorbs heat energy.

Animal life: Staying warm is the major challenge for animals. Most have small extremities and extra insulation in the form of fat or downy feathers. Some migrate to warmer areas in winter.

Biomes and ecosystems



The tundra is characterized by **permafrost**, a layer of permanently frozen subsoil. During the short cool summer, the ground thaws to a depth of a few centimeters and becomes soggy. In winter, the top layer of soil freezes again. This cycle of thawing and freezing, which rips and crushes plant roots, is one reason that tundra plants are small and stunted. Cold temperatures, high winds, a short growing season, and humus-poor soils also limit plant height.

- **Abiotic factors** strong winds; low precipitation; short and soggy summers; long, cold, dark winters; poorly developed soils; permafrost
- **Biotic factors**

Plant life: By hugging the ground, mosses and other low-growing plants avoid damage from frequent strong winds. Seed dispersal by wind is common. Many plants have adaptated to growth in poor soil. Legumes, for example, have nitrogen-fixing bacteria on their roots.

Animal life: Many animals migrate to avoid long harsh winters. Animals that live in the tundra year-round display adaptations, among them natural antifreeze, small extremities that limit heat loss, and a varied diet.

Biomes and ecosystems

- Freshwater ecosystems:
  1. Rivers/streams – water has dissolved oxygen near the source but little plant life. Downstream, sediments build up and plants flourish. Animals here depend on terrestrial plants and animals that live along their banks for food.
  2. Lakes/ponds – plankton, algae, and plants occur. Water flows in and out and circulates heat, oxygen, and nutrients.
  3. Freshwater wetlands – water covers the nutrient rich, highly productive soil. Purify water by filtering pollutants . Include freshwater bogs, freshwater marshes, and freshwater swamps.

Biomes and ecosystems

- Estuaries – special wetlands formed where a river meets the sea.
  - Serve as spawning and nursery grounds for many species.
  - Are shallow and allow plants to conduct photosynthesis.
  - Contain a large amount of biomass – examples include mangroves like the Florida Everglades.

Biomes and ecosystems

- Marine – ocean is divided into zones based on depth and distance from the shore.
  - Intertidal zone – organisms are in sea water at high tide and exposed to air and sun at low tide. Ex. Barnacles, seaweed.
  - Coastal ocean – from low tide mark to shallow border that surrounds the continent. Water is brightly lit and supplied with nutrients from freshwater runoff. Ex. Coral reefs, kelp forests.
  - Open ocean – 90% of the world's ocean. Some receives sunlight and has low nutrient level while other portion is dark and cold.