Ecosystems and Communities

Sec. 4-1
The Role of Climate

What Is Climate?

- In the atmosphere, temperature, precipitation, and other environmental factors combine to produce weather and climate.
- **Weather** – is the day-to-day condition of Earth's atmosphere at a particular time and place.
- **Climate** refers to the average, year-to-year conditions of temperature and precipitation in a particular region.

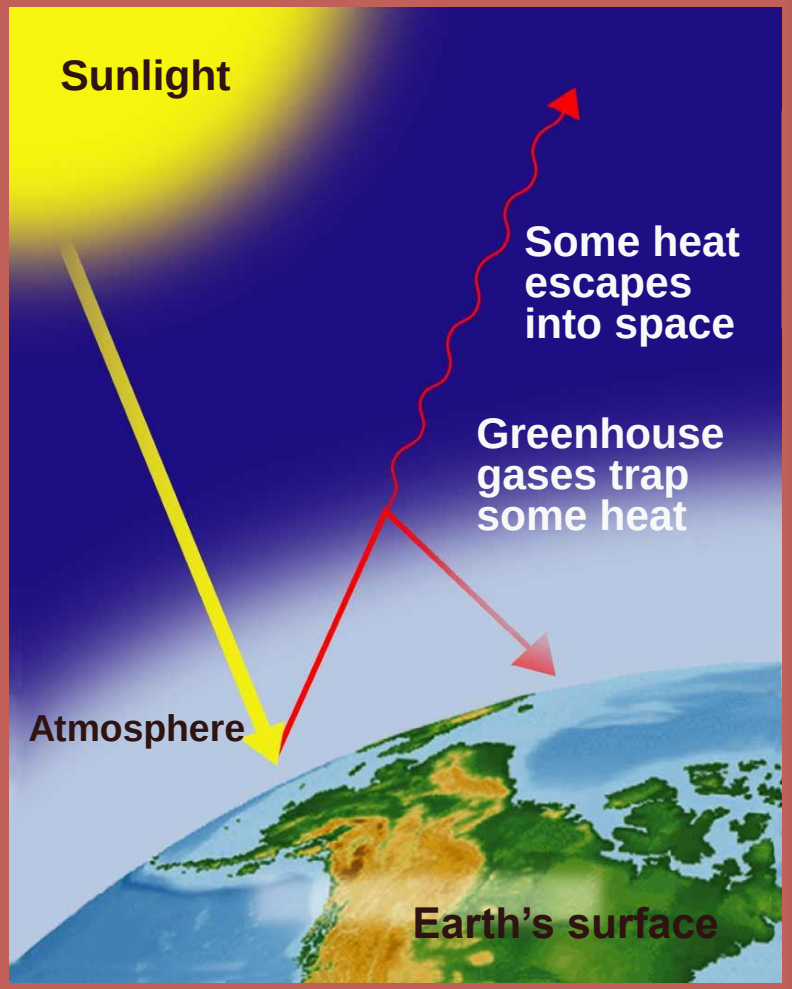
- Climate is caused by:
  - the trapping of heat by the atmosphere
  - the latitude
  - the transport of heat by winds and ocean currents
  - the amount of precipitation
  - the shape and elevation of land masses
- The energy of incoming sunlight drives Earth's weather and helps determine climate.

The Greenhouse Effect

- The atmosphere is a natural insulating blanket, keeping Earth's temperatures within a livable range.
- CO_2, methane,H_2O vapor and a few other atmospheric gases trap heat energy.
- The gases trap heat energy of sunlight inside the Earth's atmosphere.
- If these gases were not present, the Earth would be 30 C^o cooler.

The Greenhouse Effect

- The greenhouse effect is when a layer of greenhouse gases retains heat.
- Solar energy enters the atmosphere, converts to heat energy, radiates back and the gases trap the heat inside.

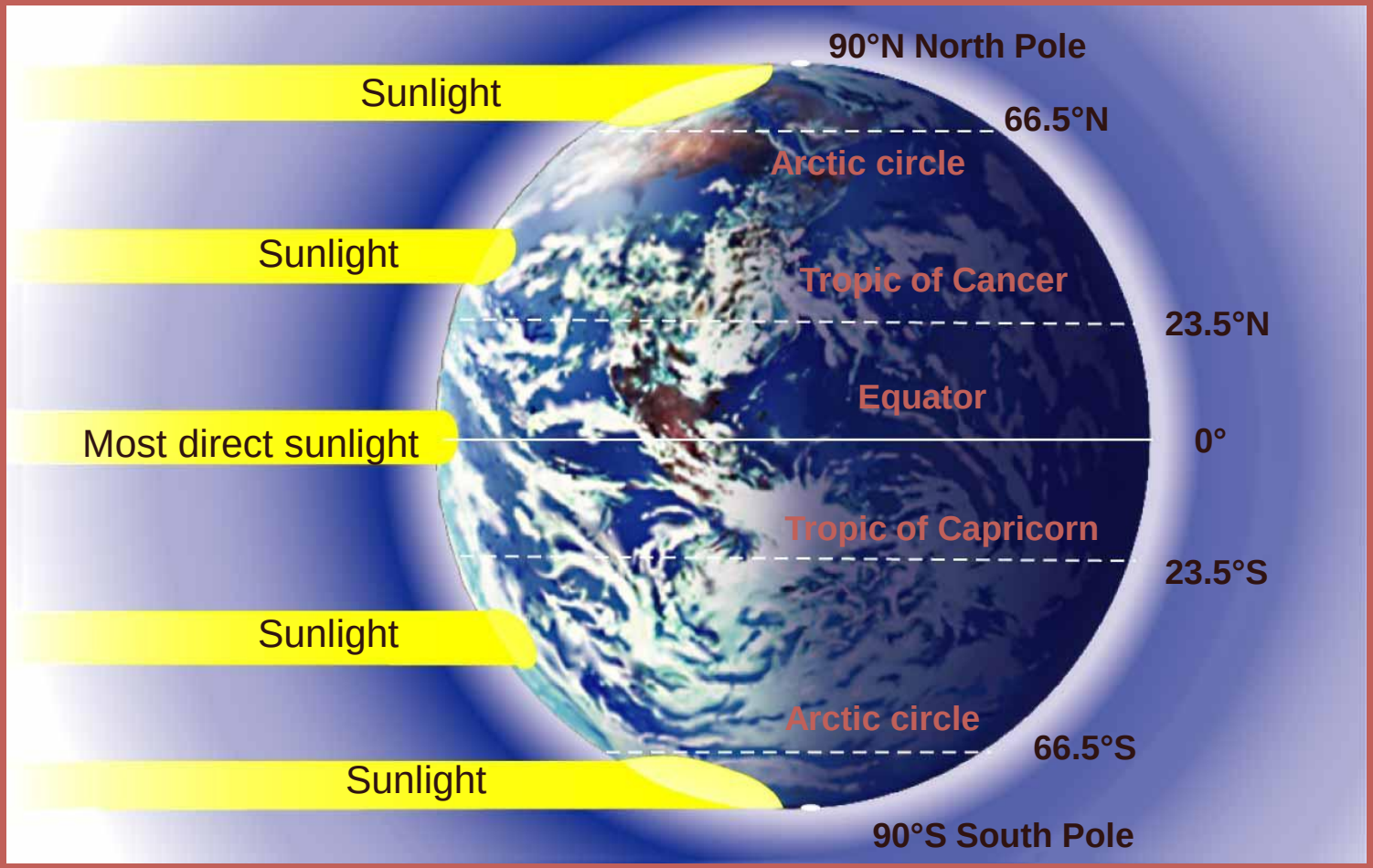


The Effect of Latitude on Climate

- Due to the Earth being tilted, solar radiation strikes the Earth's surface at an angle that varies throughout the year.
- At the equator, the sun is almost directly overhead.
- At the North and South poles, the sun is much lower in the sky for months at a time.

- There are three main climate zones:
  - Polar Zones are cold areas where the sun's rays strike Earth at a very low angle.
    - located between 66.5° and 90° North and South latitudes
  - Temperate Zones sit between the polar zones and the tropics.
    - temperatures range from hot to cold
  - Tropical Zones receive direct or nearly direct sunlight and are always warm.
    - located between 23.5° N and 23.5° S

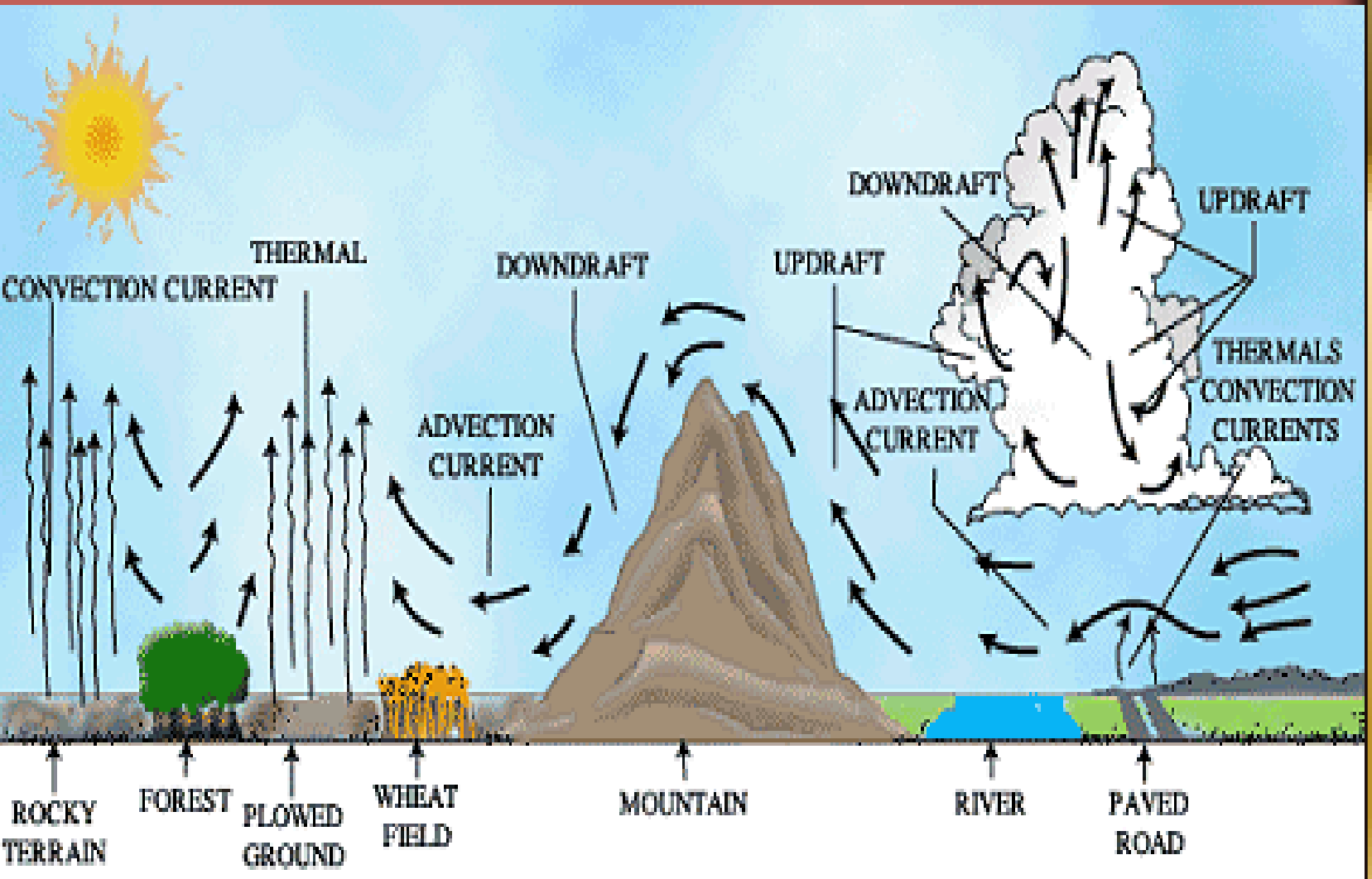
Different Latitudes



Heat Transport in the Biosphere

- Unequal heating of Earth's surface drives wind and ocean currents which transport heat throughout the biosphere.
  - Winds form because warm air rises (the equator) and cool air sinks (the poles).
- The upward and downward movement creates air currents or winds that move heat in the atmosphere.

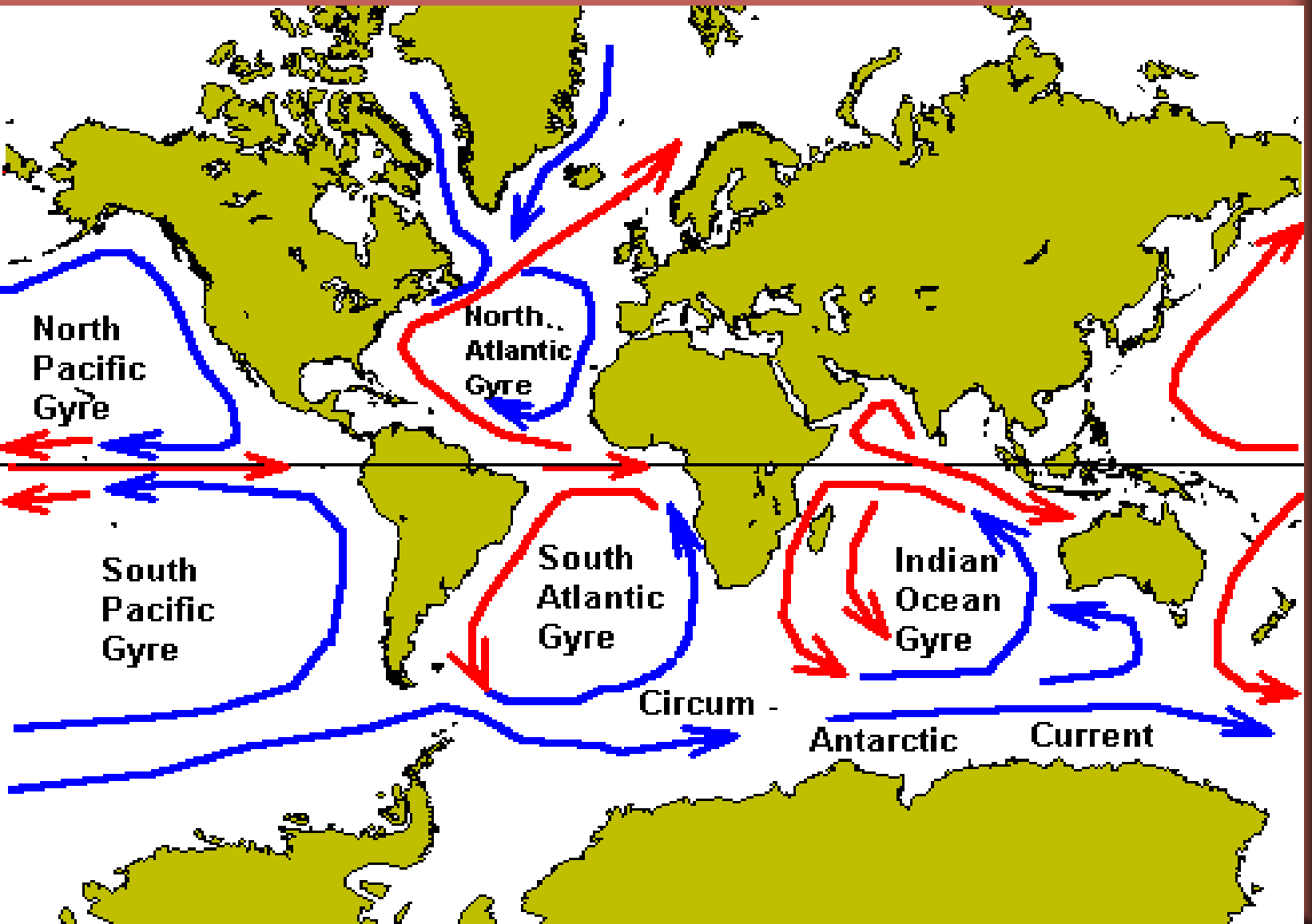
Air Currents



Air currents effect on local air circulation.

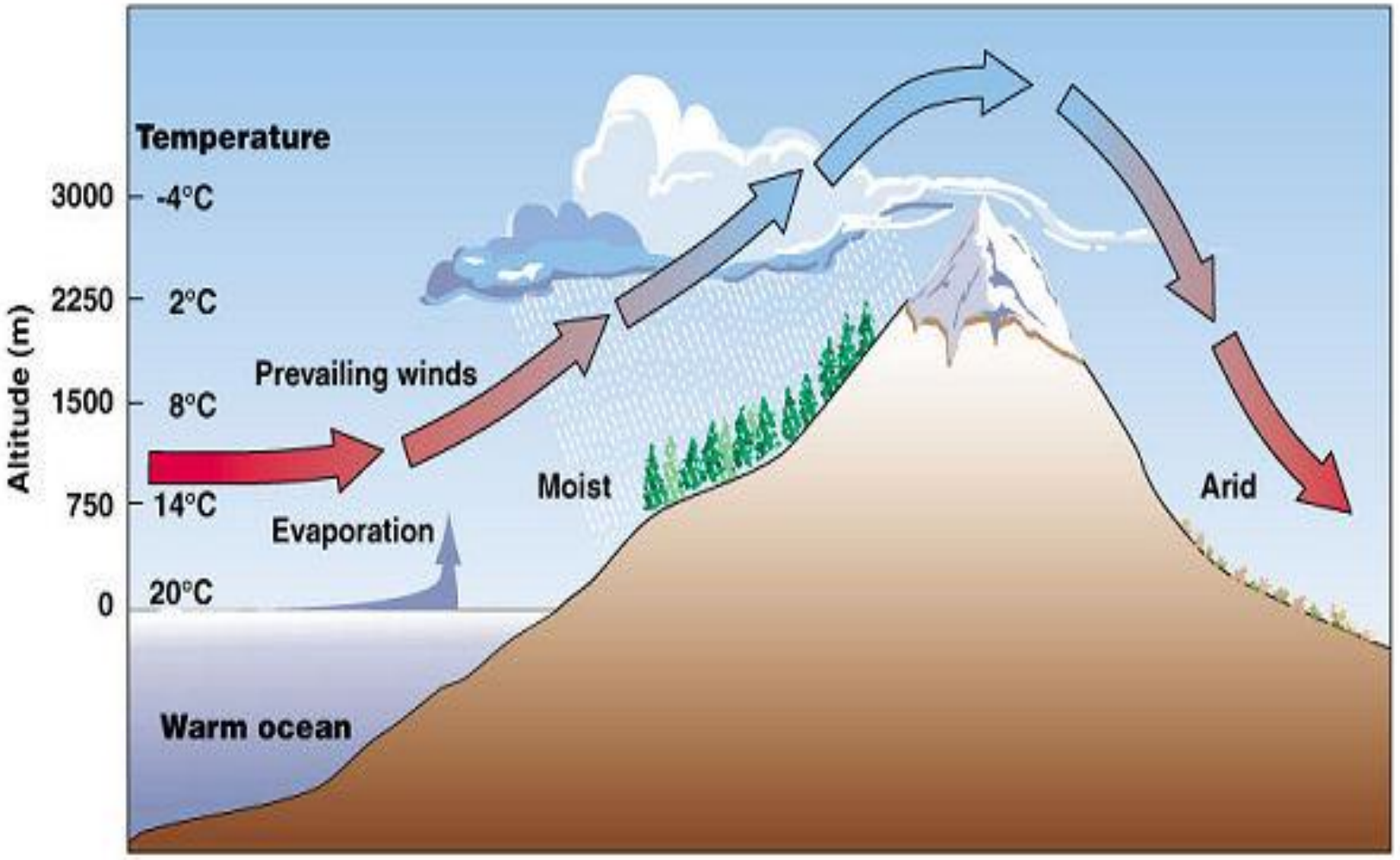
- Oceans operate the same way with cold water at the poles sinking and flowing along the ocean bottom; rising again in warmer regions.
- Surface water is moved by winds.
- Water flow creates currents, which transport heat energy.
- Surface ocean currents warm or cool the air above them affecting the weather and climate of nearby landmasses.

Ocean Currents



- Landmasses can interfere with the movement of air masses.
- A mountain range causes a moist air mass to rise, and as this happens, the air mass cools and moisture condenses, forming clouds that bring precipitation.
- Once the air mass reaches the far side of the mountains, it has lost much of its moisture resulting in a rain shadow – an area with a dry climate – on the far side of the mountain.

Rain Shadow

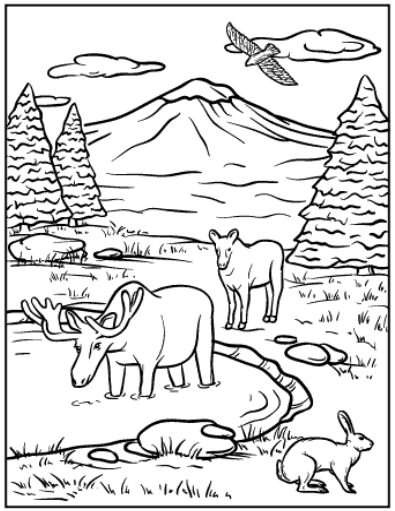


What Shapes an Ecosystem
Section 4-2

Biotic and Abiotic Factors

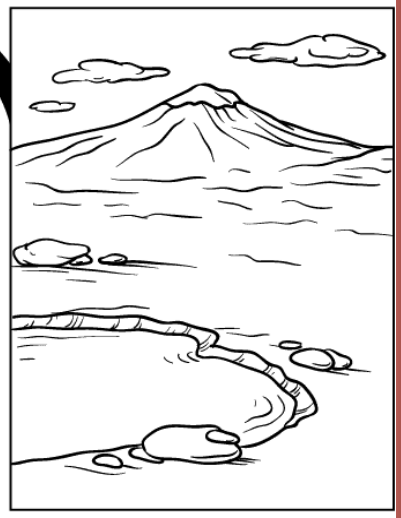
- Ecosystems are influenced by a combination of biological and physical factors.
- **Biotic factors** are the biological influences on an organism.
  - entire living cast with which an organism might interact.
- **Abiotic factors** are the physical, or nonliving factors that shape ecosystems.
  - the climate (temperature, precipitation, humidity)
  - wind, nutrient availability, soil type, and sunlight

Biotic Factors



ECOSYSTEM

Abiotic Factors

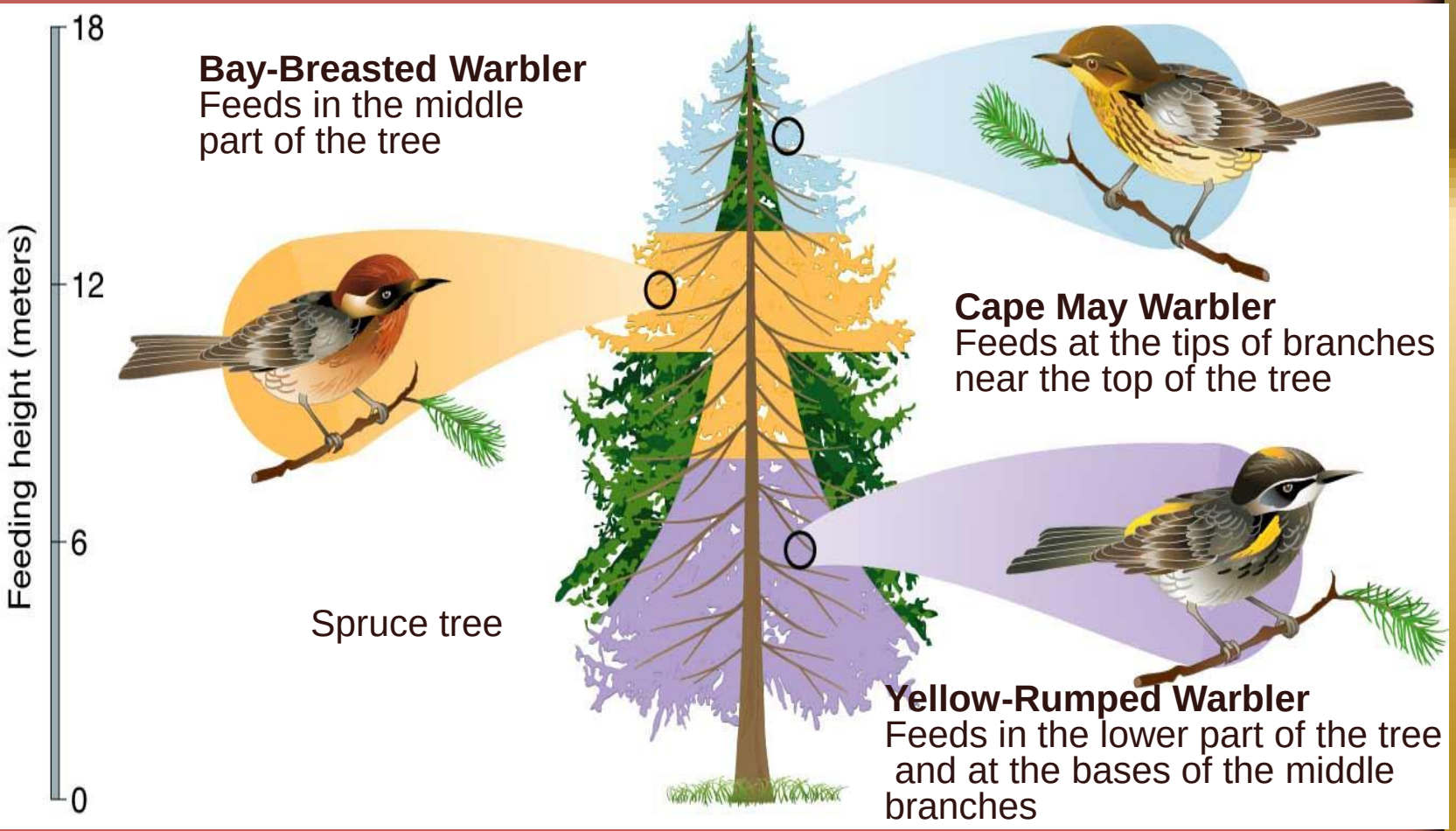


- **Habitat** is the area where an organism lives.
  - Includes both biotic and abiotic factors.

The Niche

- An organism's habitat is its address and its niche is its occupation.
- A **niche** is the full range of physical and biological conditions in which an organism lives and the way in which the organism uses those conditions.
  - **Includes its place in the food web**
  - **range of temperatures that the organism needs to survive**
  - **type of food that the organism eats**
  - **how an organism obtains food**
  - **which species use the organism for food**
  - **physical conditions required for survival**
  - **when and how an organism reproduces**

❖No two species can share the same niche in the same habitat



❖**Different species can occupy niches that are very similar**

Community Interaction

- Community interactions, such as competition, predation, and various forms of symbiosis can powerfully affect an ecosystem.

Competition

- Competition occurs when organisms of the same or different species attempt to use an ecological resource in the same place at the same time.
- A **resource** refers to any necessity of life, such as water, nutrients, light, food, or space.
- Direct competition often results in a winner and a loser-with the losing organism failing to survive.

- Broad-leaved trees may compete for sunlight by growing tall, spreading their leaves, and blocking the sunlight for shorter trees.

- Two species of lizards in a desert might compete by attempting to eat the same type of insect.

The **competitive exclusion principle** states that no two species can occupy the same niche in the same habitat at the same time.

Predation

- **Predation** is an interaction in which one organism captures and feeds on another organism.
- The organism that does the killing is called the predator.
- The food organism is the prey.

Symbiosis

- **Symbiosis** is any relationship in which two species live closely together.
- There are three main classes of symbiotic relationships in nature:
  - Mutualism
  - Commensalism
  - Parasitism

- In **mutualism**, both species benefit from the relationship.
  - Many flowers depend on insects to pollinate them. The flowers provide the insects with food in the form of nectar or pollen and the insects help the flowers reproduce.

- In **commensalism**, one member of the association benefits and the other is neither helped nor harmed.
  - Barnacles, small marine animals attach themselves to a whale's skin. The barnacles perform no known service to the whale but they benefit from the constant movement of water that carries food particles.

- In **parasitism**, one organism lives on or inside another organism and harms it.
- The parasite obtains all or part of its food from the other organism, called the host.
- Parasites weaken but do not kill their host, which is usually larger than the parasite.
  - Tapeworms are parasites that live in the intestines of mammals.
  - Fleas, ticks and lice live on the bodies of mammals.




Ecological Succession

- Ecosystems and communities are always changing in response to natural and human disturbances.
- As an ecosystem changes, older organisms die out and new organisms move in further changing the community.
- **Ecological succession** is a series of predictable changes that occurs in a community over time.
  - slow changes in physical environment
  - sudden natural disturbance
  - human activities (clearing a forest)

Primary Succession

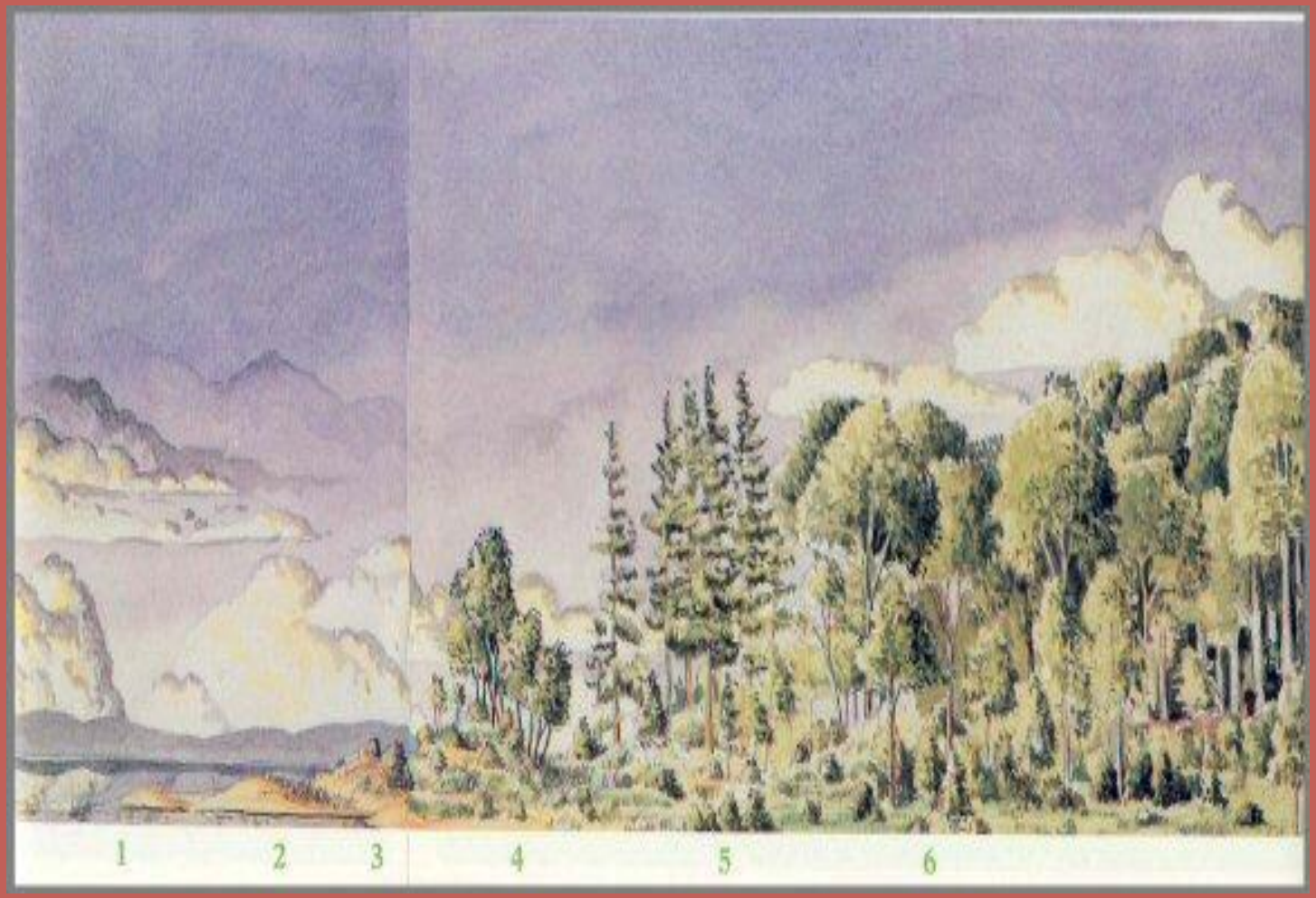
- **Primary succession** is succession that occurs on surfaces where NO soil exists.
  - bare rock exposed when glaciers melt
  - volcanic eruptions build new islands or cover land with lava rock or volcanic ash
- **Pioneer species** are the first species to populate an area.
  - Lichens (fungus and algae) can grow on bare rock
  - As lichens grow, they break up the rocks.
  - When they die, their organic material helps form soil in which plants grow

Secondary Succession

- **Secondary succession** occurs on a surface where an ecosystem has previously existed.
  - disturbed or disrupted by humans or animals
  - natural processes such as storms, floods, and earthquakes
  - cleared and plowed abandoned farmland

- The process of succession in a given area is always proceeded in certain specific and predictable stages and ended with a mature, stable community that did not undergo further succession, a "climax community".
  - This process may take 100 years.

Old Field Succession



Sand Dunes

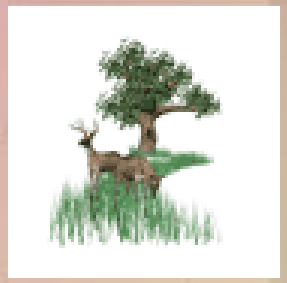
Grass

Shrubs

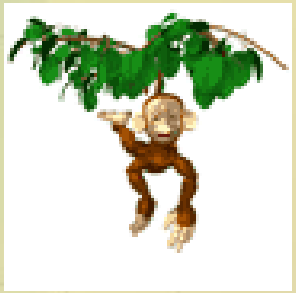
Cottonwood

Jack Pine

Oak Forest



Biomes Section 4-3

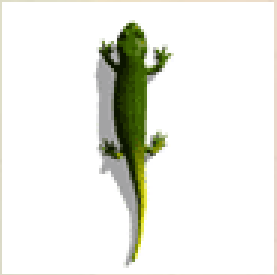


- A biome is a complex of terrestrial communities that covers a large area and is characterized by certain soil and climate conditions and particular assemblages of plants and animals.
- Species vary in their adaptations different conditions.

- An adaptation is an inherited characteristic that increases an organism's ability to survive and reproduce
  - spines on a cactus minimize water loss
  - desert rodents have adaptations in their kidneys that help conserve water

- Plants and animals also exhibit variations in tolerance.

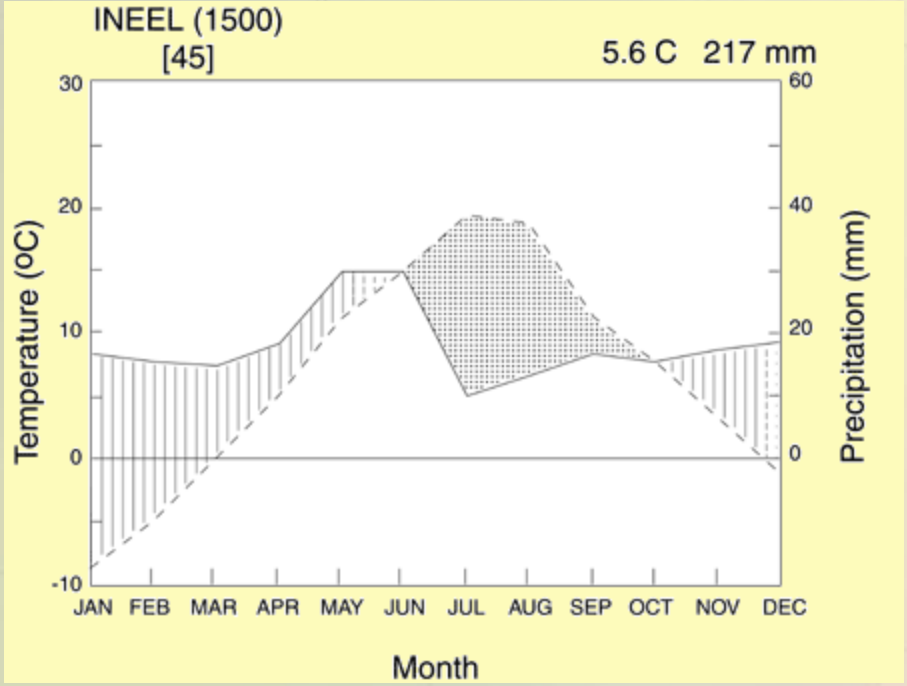
- Tolerance is the ability to survive and reproduce under conditions that differ from their optimal conditions.
  - Plants and animals in the desert can tolerate temperatures that range from blistering hot to below freezing.



Biomes and Climate

- The climate of a region is an important factor in determining which organisms can survive there.
- A microclimate is the climate in a small area that differs from the climate around it.
  - Certain streets in San Francisco are often blanketed in a fog while the sun shines brightly just a few blocks away.

- Two main components of climate – temperature and precipitation – can be summarized in a graph called a climate diagram.

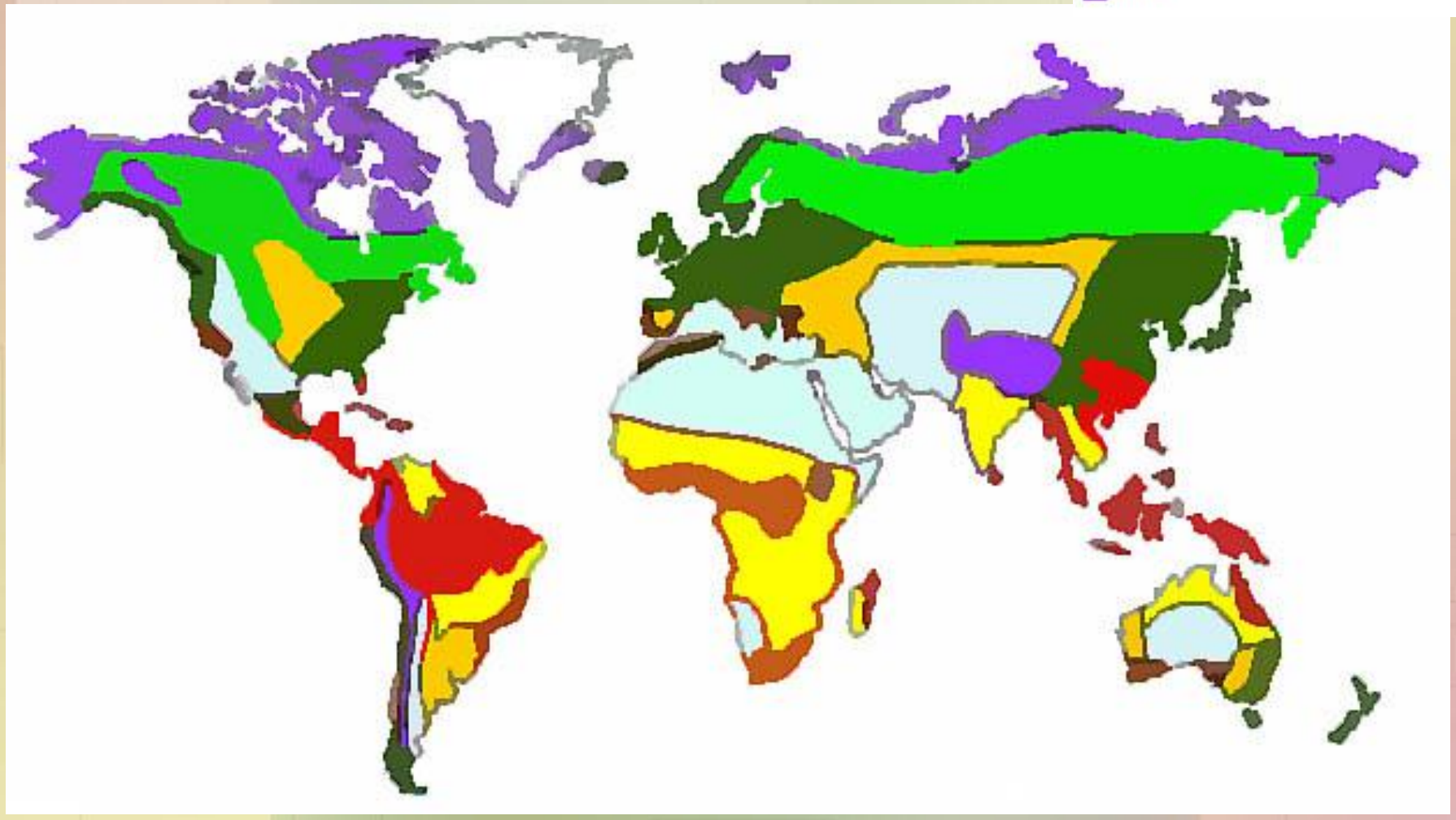


The Major Biomes

- Ecologists recognize at least 10 different biomes.
  - Tropical rain forest
  - Tropical dry forest
  - Tropical savanna
  - Desert
  - Temperate grassland
  - Temperate woodland and shrubland
  - Temperate forest
  - Northwestern coniferous forest
  - Boreal forest
  - Tundra
- Each of the biomes is defined by a unique set of abiotic factors - particularly climate - and a characteristic assemblage of plants and animals.

- There is often ecological variation within a biome.
  - Changes in microclimate caused by differences in exposure or elevation above sea level.
  - Local soil conditions or the presence of rock outcroppings.
- Boundaries between biomes on a map appear to be sharp, there are often transitional areas in which one biome's plants and animals become more common.
- The characteristics and locations of biomes relate to the patterns of global winds and ocean currents.

World Biomes



Other Land Areas

Mountain Ranges

- Mountain ranges can be found on all continents.
- Abiotic and biotic conditions vary with elevation.
- Plants and animals change as you move up the mountain.
  - Grasslands on the bottom, open woodland pines, forest of spruce and conifers, wildflowers and stunted vegetation resembling the tundra, ice fields occur at the peaks

Polar Ice Caps

- Icy polar regions border the tundra are cold year round.
- Mosses and lichens are the limited vegetation there.
- In the north polar region, polar bears, seals, insects and mites are the dominant animals.

- In the south polar region, the dominant wildlife includes penguins and marine animals.

Aquatic Ecosystems

Section 4-4

- Nearly 75% of the Earth's surface is covered with water.
- Aquatic ecosystems are determined by:
  1. depth
  2. flow
  3. temperature
  4. chemistry of the overlying water

- Aquatic ecosystems are grouped according to the abiotic factors that affect them.
  - Depth of the water, or distance from shore determines amount of light that organisms receive
  - Water chemistry refers to the amount of dissolved chemicals-salts, nutrients, and oxygen.
  - Latitude determines temperature-polar, temperate and tropical regions.

Freshwater Ecosystems

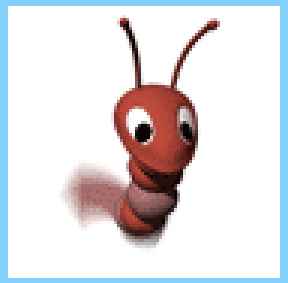
- Only 3% of the surface water is fresh water.
- Freshwater ecosystems are divided into two main types:
  1. flowing-water ecosystems
     - rivers, streams, creeks and brooks all flow over land
  2. standing-water ecosystems
     - lakes and ponds

Flowing-Water Ecosystems

- A river originates in the mountains or hills, often springing from an underground water source.
- Near the source, water has plenty of dissolved oxygen but little plant life.
- As water flows downhill, sediments build up and enable plants to establish themselves.
- Downstream, the water moves more slowly through flat areas, where turtles, beavers or river otters make their homes.

Standing-Water Ecosystem

- Water not only circulates in and out but also within them.
- Circulation helps to distribute heat, oxygen, and nutrients.
- Plankton is a general term for the tiny, free-floating or weakly swimming organisms that live in both fresh and salt-water environments.
- Phytoplankton or single celled algae are supported by nutrients in the water and form the base of many aquatic food webs.
- Zooplankton are planktonic animals that feed on the phytoplankton.



Freshwater Wetlands

- A wetland is an ecosystem in which water either covers the soil or is present at or near the surface of the soil for at least part of the year.
- Water may be flowing or standing and fresh, salty, or brackish (mixture of fresh and salt water).
- Three main types:
  - Bogs, form in depressions where water collects.
    - Dominated by sphagnum moss and very acidic

- Marshes are shallow wetlands along rivers and may be underwater part of the year.
  - dominated by cattails, rushes, and other grasslike plants
- Swamps are wet all year round and resemble flooded forests
  - presence of trees and shrubs is what distinguishes a swamp from a marsh!

Marsh

Swamp

Estuaries

- Estuaries are wetlands formed where rivers meet the sea.
- Contain a mixture of fresh and salt water, and are affected by the rise and fall of ocean tides.
- Estuary food webs differ from other aquatic ecosystems because primary production is not consumed by herbivores.
- Detritus is tiny pieces of organic material that provide food for organisms at the base of the food web, clams, worms, and sponges.

- Estuaries support a large amount of biomass but contain fewer species than freshwater or marine ecosystems.
- Commercially important fish and shellfish such as shrimp and crabs spawn and develop here.

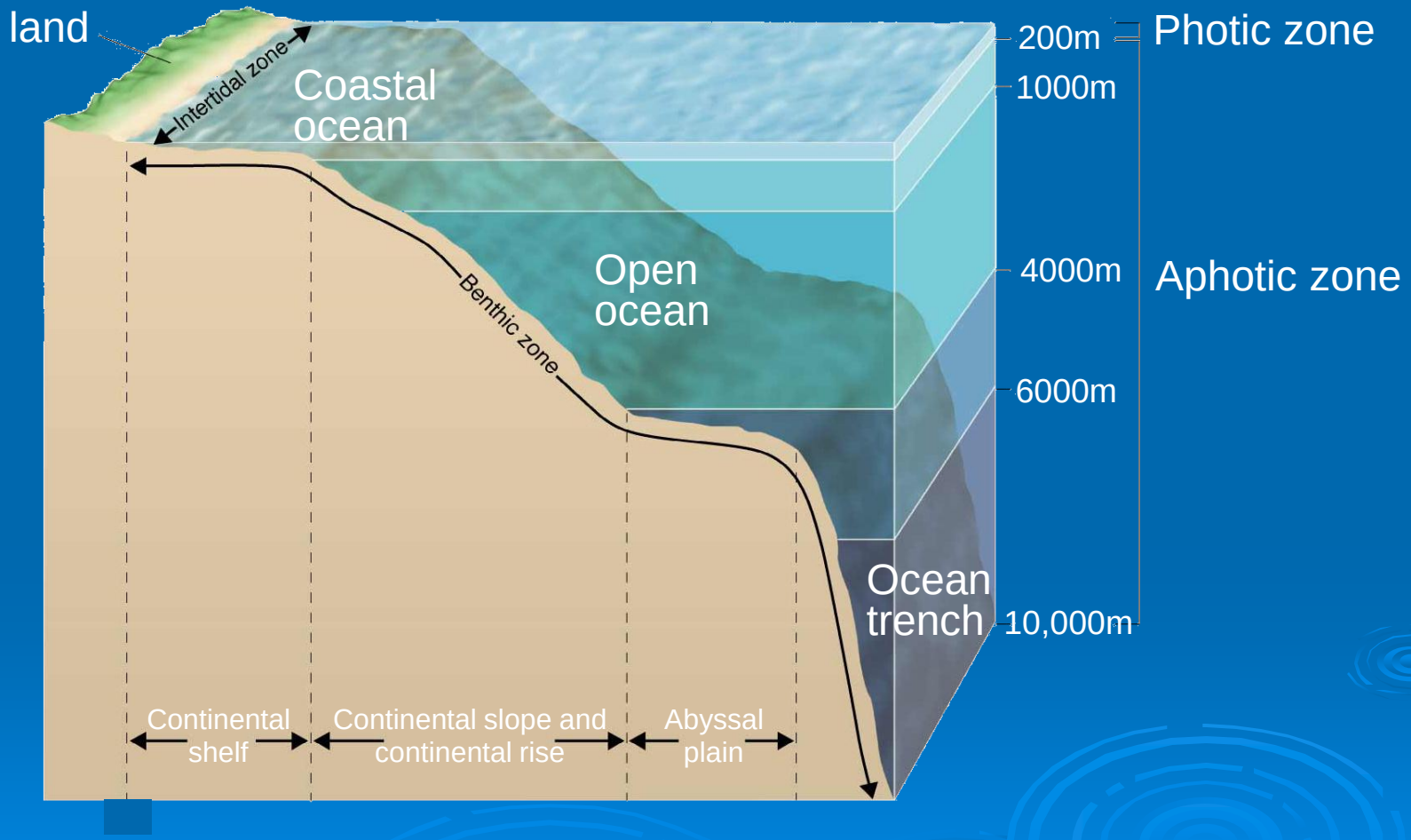
- Salt marshes are temperate-zone estuaries dominated by salt tolerant grasses above the low-tide line and by seagrasses under the water.
- Salt marshes are found along the eastern seaboard of North America from Maine to Georgia.
- One of the largest surrounds the Chesapeake Bay estuary in Maryland.

- Mangrove swamps are coastal wetlands that spread across tropical regions including southern Florida and Hawaii.
- The dominant plants are salt-tolerant trees called mangroves which provide a valuable nursery for fish and shellfish.
- The largest mangrove area in the continental U.S. is within Florida's Everglades National Park.

Marine Ecosystems

- Sunlight penetrates only a relatively short distance through the surface of the water.
- The photic zone is a relatively thin surface layer - about 200 meters.
  - Photosynthesis is limited to this layer.
- The aphotic zone, which is below the photic zone, is permanently dark.
  - Chemoautotrophs are the only producers that survive.

Zones of a Marine Ecosystem

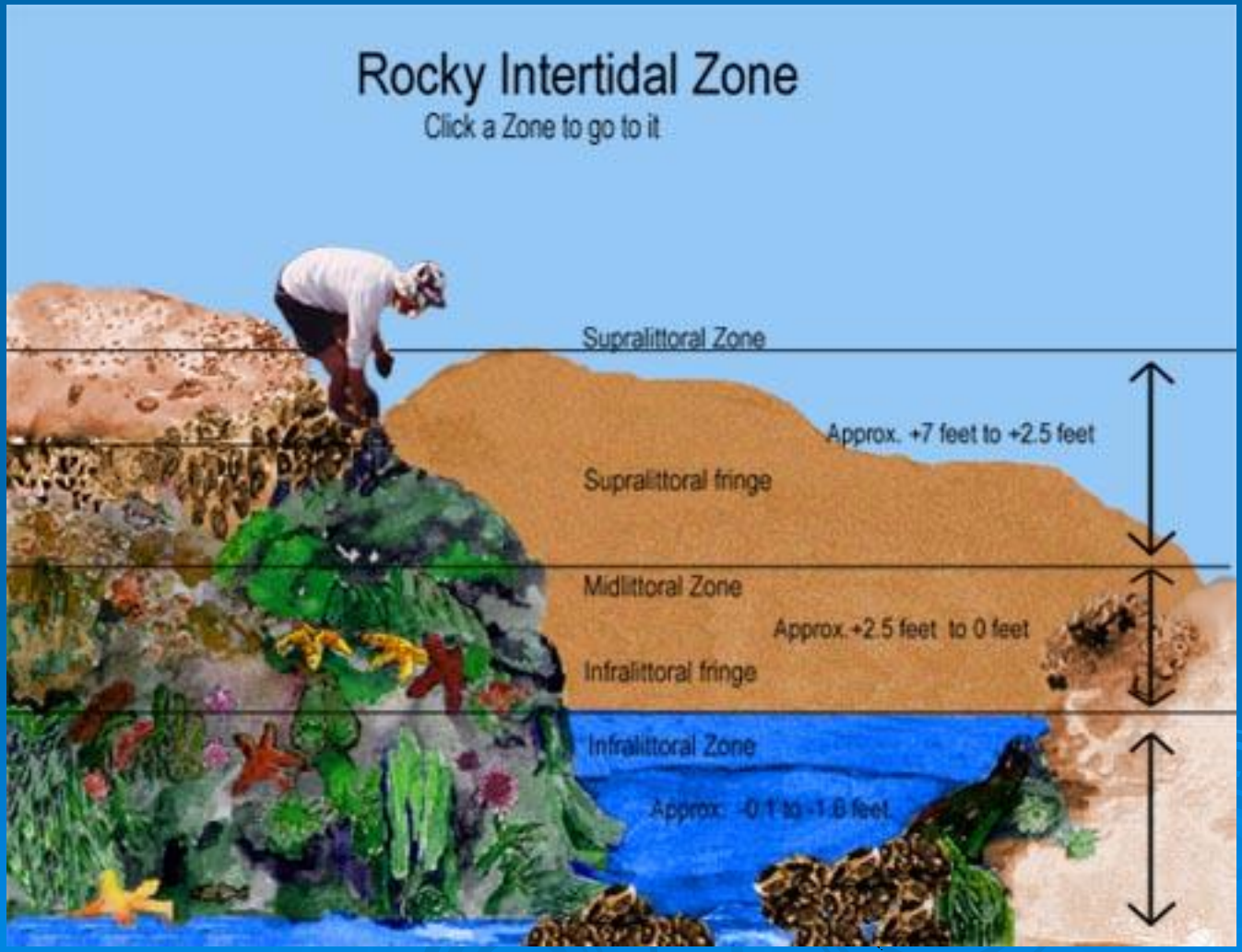


- The ocean is divided into zones based on depth and distance from shore:
  - intertidal zone
  - coastal zone
  - open ocean
- The benthic zone covers the ocean floor and is, therefore, not exclusive to any of the other marine zones.

Intertidal Zone

- Once or twice a day, organisms are submerged by sea water.
- Remainder of the time, they are exposed to air, sunlight, and temperature changes.
- Organisms are battered by waves and strong currents.

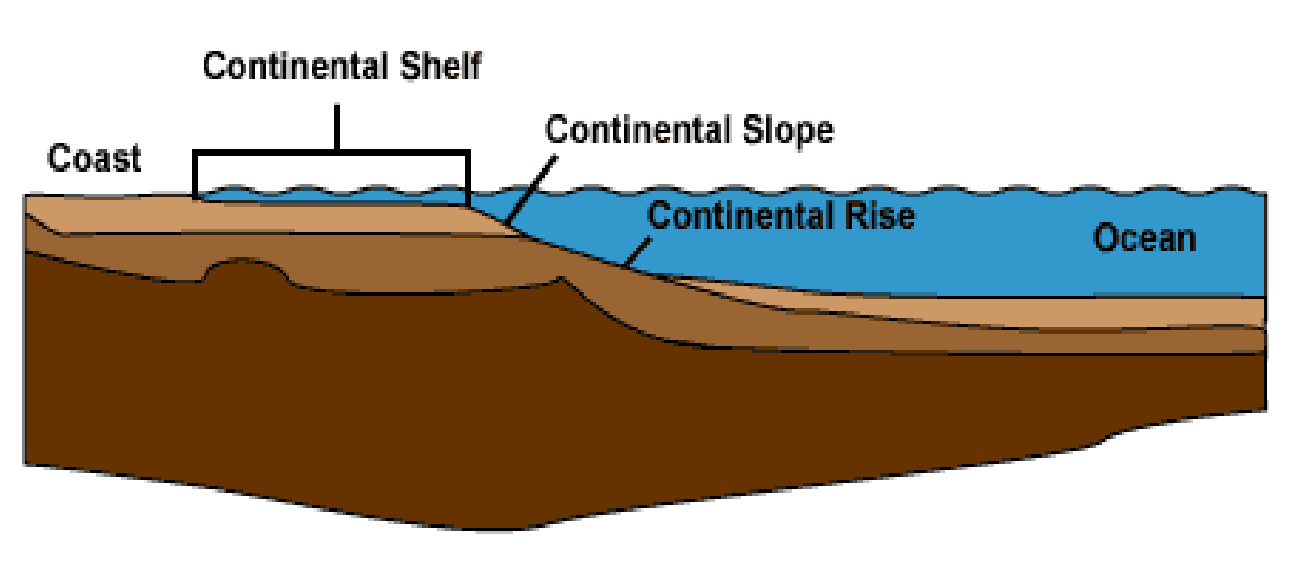
Zonation is the prominent horizontal banding of organisms that live in a particular habitat.



- Each band can be distinguished by difference in color or shape of the major organisms.
  - A band of black algae might grow at the highest hightide line----followed by encrusting barnacles---clusters of blue mussels might stick out amid clumps of green algae.
- This zonation is similar to the pattern that you might observe as you climb up a mountain.

Coastal Ocean

- The coastal ocean extends from the low-tide mark to the outer edge of the continental shelf.

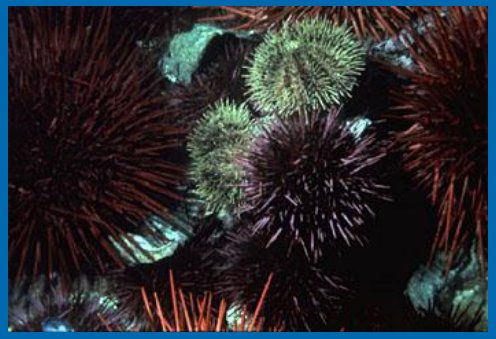


- Coastal ocean is rich in plankton because it is entirely within the photic zone.
- One of the most productive coastal communties is the kelp forest.

Kelp forests are named for their dominant organism: a giant brown alga that can grow as much as 50 cm/day.

- Found in cold-temperate seas along the coast of California and the Pacific Northwest.

- Support a complex food web that includes:



Sea Urchins

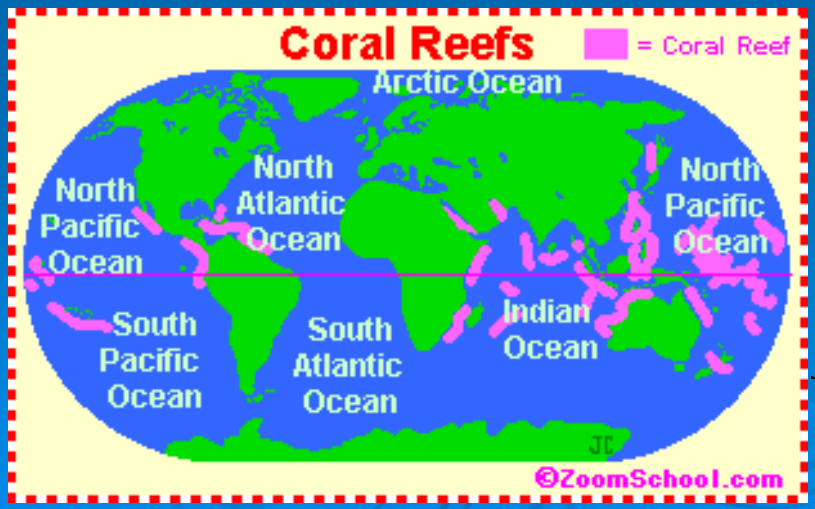
Sea Otters

Invertebrates

- Also, fishes, seals and whales.

Coral Reefs

- Coral reefs are found in the warm, shallow water of tropical coastal oceans.
- Coral reefs are named for the coral animals whose hard, calcium carbonate skeletons make up their primary structure.



- Coral animals are the size of your fingernail, or even smaller.

These animals use their tentacles to capture and eat microscopic creatures that float by.

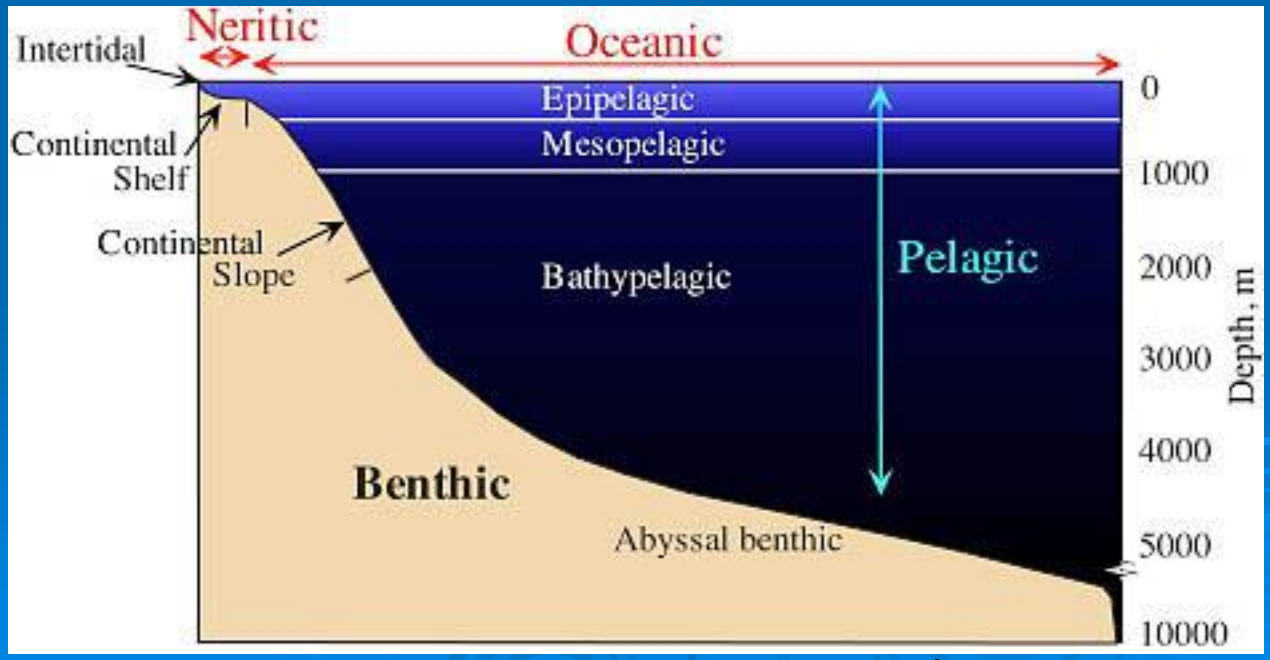
- Coral animals cannot grow in cold water or water that is low in salt.
- Corals grow with the help of algae that live symbiotically within their tissues.

Open Oceans

- The open ocean begins at the edge of the continental shelf and extends outward.
- It is the largest marine zone, covering more than 90% of the surface area o fthe world's oceans.
- Depth ranges from 500 meters to more than 11,000 meters at the deepest ocean trench.
- Organisms are exposed to high pressure, frigid temperatures, and total darkness.

Bentic Zone

- The benthic zone extends horizontally along the ocean floor from the coastal ocean through the open ocean.



- Benthos are organisms that live attached to or near the bottom such as sea stars, anemones, and marine worms.



- Benthic ecosystems often depend on food from organisms that grow in the photic zone and drift down from the surface.