

ECOLOGY: The Study of Ecosystems

Ecology (from the Greek oikos meaning "house" or "dwelling", and logos meaning "discourse") is the study of the interactions of organisms with each other and their environment. The hierarchy. Define each of the following.

species ~ population ~ community ~ ecosystem ~ biosphere

Ecology is a SCIENCE, not a sociopolitical movement (e.g., environmentalism).

The Ecologist engages in the hypothetico-deductive method to pose questions and devise testable hypotheses about ecosystems. Often, this involves the generation of complex mathematical models to simulate ecosystems. These models represent idealized systems to which real systems can be compared for their predictive value. Sometimes, when a very large scale project is logistically impossible to perform, a computer model is used to predict expected results.

An ecosystem consists of

- * **biotic components** - the living organisms
- * **abiotic components** - non-living factors, such as light, temperature, water, nutrients, topography, etc.

Evolution by natural selection is driven by ecological interactions.

Levels of Ecological Study

ORGANISMAL ECOLOGY - the study of individual organisms' behavior, physiology, morphology, etc. in response to environmental challenges.

POPULATION ECOLOGY - the study of factors that affect and change the size and genetic composition of populations of organisms.

COMMUNITY ECOLOGY - the study of how community structure and organization are changed by interactions among living organisms

ECOSYSTEM ECOLOGY - the study of entire ecosystems, including the responses and changes in the community in response to the abiotic components of the ecosystem. This field is concerned with such large-scale topics as energy and nutrient cycling.

LANDSCAPE ECOLOGY – study of the exchanges of energy, materials, organisms and other products of between ecosystems.

GLOBAL ECOLOGY - the study of the effects of regional change in energy and matter exchange on the function and distribution of organisms across the biosphere.

One of the most important figures in the application of ecological principles to modern awareness of our role in the biosphere was **Rachel Carson**, author of *Silent Spring* (1962). In this work, she warned that the widespread, unregulated use of pesticides (e.g., DDT, now banned in the U.S., but not banned everywhere) would lead to environmental disaster.

COMPONENTS OF THE BIOSPHERE

The plant community of a particular region depends on the CLIMATE--the combination of temperature, water, light, and wind. And the flora directly affects the composition of the fauna.

ABIOTIC COMPONENTS OF ECOSYSTEMS

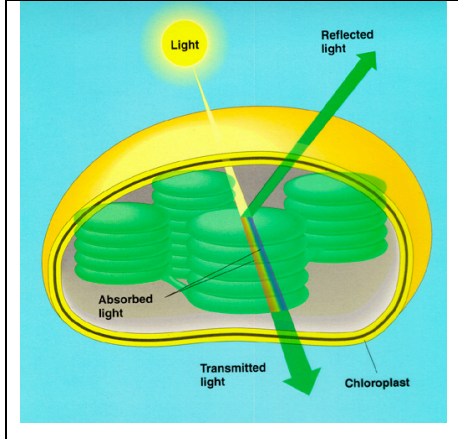
Temperature

- * contributes to erosion & creation of soil
- * different organisms have different cellular tolerances for cold and heat
- * organism classification based on temperature source and regulation:
 - > **ectotherm** - obtains heat primarily from the environment
 - > **endotherm** - obtains heat primarily from metabolic reactions
 - > **poikilotherm** - temperature regulated primarily by environment
 - > **homeotherm** - temperature regulated primarily by internal metabolism

Water

- * important component in erosion & creation of soils
- * terrestrial and freshwater environments require animals and plants to conserve water and evolve ways to maintain water/salt balance.
- * animals that have secondarily returned to marine environments face water/salt balance challenges, since the ocean is now saltier than when their ancestors left it.

Sunlight

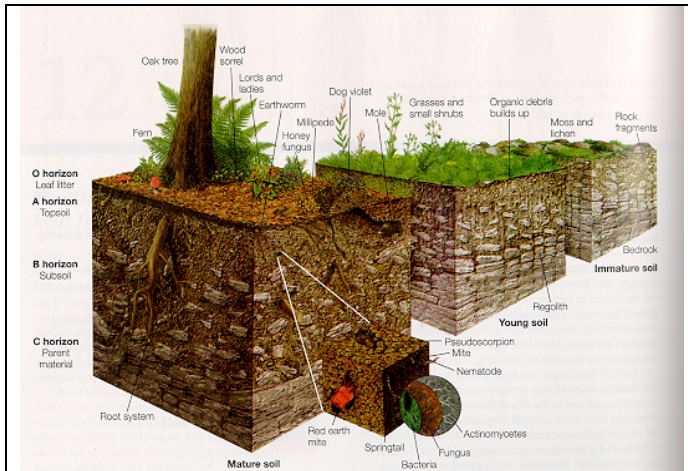


- * intensity affects living things
- * daily duration affects living things
- * angle of incidence of the sun (seasonal changes) affects climate
- * photoperiodicity can be diurnal, seasonal, etc. (Circadian rhythms)
- * competition for light is an important factor in many environments
- * plants use blue & red light for photosynthesis under foliage and underwater habitats have varying levels of these wavelengths, with red light being screened out first, and blue light last

Wind

- * contributes to erosion
- * affects perceived temperature via evaporation & convection
- * affects desiccation (drying out) rate of animals and plants
- * affects growth form of plants
- * affects the rate of photosynthesis

Rocks and Soil



- * topography (hills, valleys, caves, etc.) creates habitat
- * mineral (inorganic nutrient) content of rock affects flora
- * pH (acid/base level, on the scale of 0 to 14) of rock/soil affects flora
- * substrate composition affects any water in contact with that substrate

Soil is classified in layers. From bottom to top:

Bedrock – Solid base layer that gives rise to the upper layers.

C Horizon (parent material) – large rocks and gravel

B horizon (subsoil) – smaller rocks, more gravel, sand

A Horizon (topsoil) – sand, some gravel, organic material

O Horizon (leaf litter and other organic DETRITUS) – dead, decaying organic matter

NOTE: Organic vs. Inorganic

ORGANIC substances are those that have been produced by living things. (Chemically, these are composed of a “backbone” of carbon and hydrogen)

INORGANIC substances are not produced by living things, and are abiotic. (Chemically, these substances do NOT have a carbon-hydrogen “backbone”)

Major Environmental Disturbances

- * fire
- * severe storms (hurricanes, tornadoes, etc.)
- * volcanic activity
- * oh, heck. Comets, too. Choose your own disaster, and fill in here.

GLOBAL PATTERNS OF CLIMATE

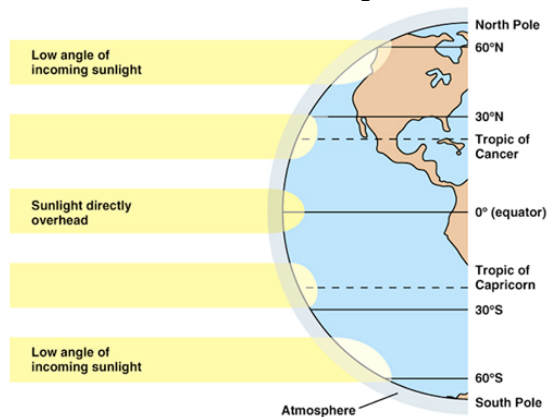
The ultimate source of climate is the sun, which provides not only most of earth's energy, but also creates climatic events when its energy interacts with the earth.

Less than half of the solar radiation striking the earth's atmosphere successfully penetrates the atmosphere to reach earth.

Terrestrial irradiance (i.e., solar radiation incident on the earth's surface) ranges from approximately 250nm (ultraviolet) to 1500nm (near infrared). Shorter and longer wavelengths are absorbed or reflected by atmospheric ozone, water vapor. (NOTE: "nm" stands for nanometer, which is a very small distance: 10^{-9} meters, which means 0.000000001 meters! Microscopic!)

When the sun is directly overhead in a cloudless sky, irradiance is most intense and peaks near 540nm ("green").

Environmental conditions and angle of incidence affect both intensity and spectral distribution of incident sunlight.



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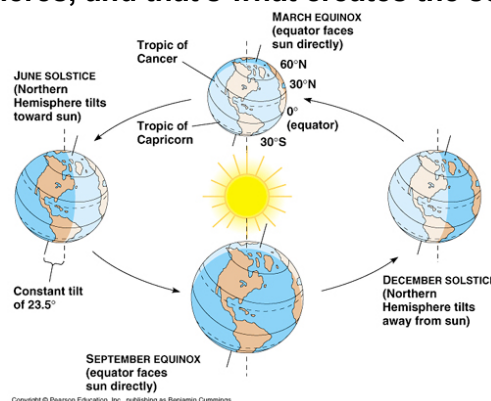
The **TROPICS** lie between the Tropic of Cancer (23.5° N) and the Tropic of Capricorn (23.5° S). These receive the highest annual input of solar energy, and are the only place on earth that the sun ever shines directly overhead (on the equinoxes, March 21 and September 21).

The **SUBTROPICS** lie between the Tropic of Cancer and 30° N in the northern hemisphere, and between the Tropic of Capricorn and 30° S in the southern hemisphere. (Miami is in the subtropics)

The **TEMPERATE** regions lie between 30° N and 60° N in the Northern Hemisphere and between 30° S and 60° S in the Southern Hemisphere.

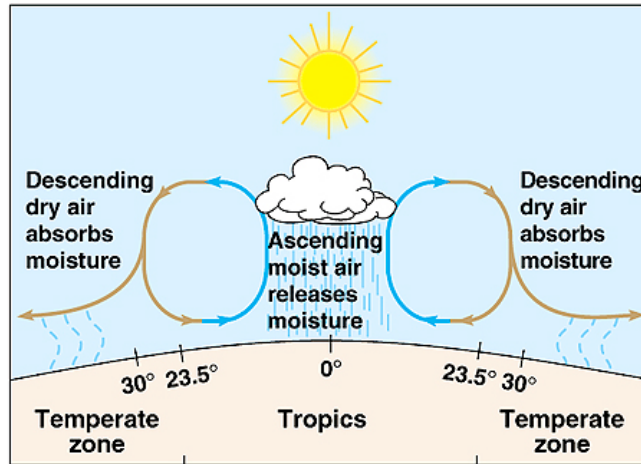
The **POLAR REGIONS** lie above 60° N and S

Flora (plants) and fauna (animals) are profoundly affected by environmental and seasonal changes in solar intensity and spectral distribution. **Note also that because the earth is tilted 23.5° on its axis (defining those tropical latitudes), there are seasonal changes solar irradiation in both hemispheres, and that's what creates the seasons.**



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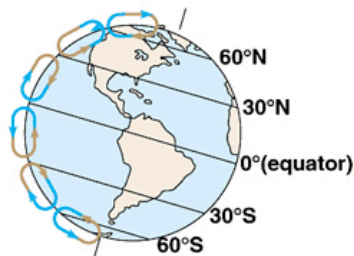
Solar warming of earth creates global air and water vapor movement



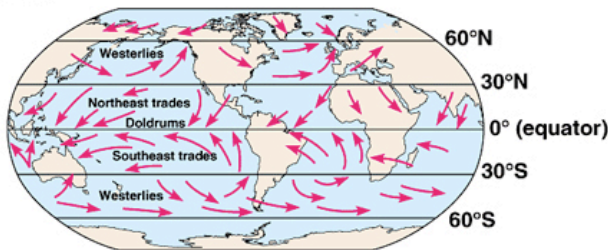
(a) Air circulation and precipitation near the equator

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And this results in global air cells of rising wet, warm air and falling cool, dry air at the latitudes shown here:



(b) Global air circulation



(c) Global wind patterns

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The interaction of the rising and falling "tubes" of air surrounding the earth interact with land masses, water masses and the forces that turn the earth, resulting in a complex web of prevailing winds, as shown above.

- * Warm, high levels of precipitation: Tropics
- * Relatively warm, arid: subtropics and temperate regions
- * Cool, high levels of precipitation: just below polar area; coniferous forests dominate
- * Cold, arid: polar regions (Arctic and Antarctic)

Local climate can be affected locally by proximity to ocean, lakes, rivers and topography. This creates smaller, localized ecosystems within biomes.

NOTE: Unlike most matter, **WATER can absorb a HUGE amount of energy without changing its temperature.** Thus, bodies of water are tremendous energy "sinks" that can absorb large amounts of solar energy without heating up as much as a similar area of land would. Solar radiation striking water is absorbed with far less temperature increase than solar radiation striking land.

During the day, land warms and the air over it rises.

If there is a body of water nearby, cooler air from over the water is pulled over the land.

In the evening, the opposite occurs, warming the land with dry air from offshore.