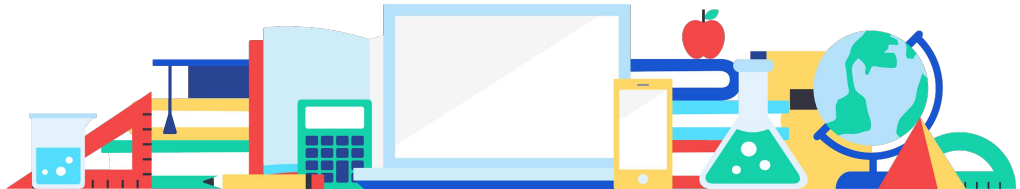
Environmental Science Concepts & Vocab

April 2023



Introduction to Environmental Science

Additional Resources:

Overview of Environmental Science (video)

Renewable and Nonrenewable Resources

Environmental Science: A branch of science that concentrates on the relationships between organisms and the environment, environmental issues, and human impacts on the environment.

Sustainability: Capacity of Earth's natural and human cultural systems to survive, flourish, and adapt to changing environmental conditions into the long-term future.

Sustainable Yield: Highest rate at which we can use a renewable resource without reducing the amount available.

Resource: Anything we can obtain from the environment to meet our needs.
- Some directly available for use (Ex: sunlight)
- Some indirectly available for use (Ex: petroleum)

Perpetual Resource: A resource that has a never-ending supply.
- Ex: solar energy, wind energy

Renewable Resource: A resource that takes several days to several hundreds of years to renew.
- Ex: fresh water, fertile soil

Nonrenewable Resources:
- Energy sources (fossil fuels, coal, gas)
- Metallic mineral resources (copper, iron ore, etc.)
- Nonmetallic mineral resources (timer, sand, clay)

Topics to Discuss

- Introduction to Environmental Science
- Earth Systems and Resources
- The Atmosphere
- Interdependence of Organisms
- Ecology
- Populations
- Land and Water Resources and Use
- Energy Resources and Consumption
- Natural Biogeochemical Cycles
- Pollution
- Impact on Human Health and Environment
- Global Change

Introduction to Environmental Science

- ➔ Ecological Footprint
- ➔ Principles of Sustainability
- ➔ Scientific Method
- ➔ Biodiversity
- ➔ Environmental Problems and their Causes

Principles of Sustainability, Ecological Footprint, and Environmental Problems

Additional Resources:

IPAT model explained (video)

Nature's Survival Strategies Follow Three Principles of Sustainability

1. Reliance on Solar Energy
2. Biodiversity
3. Chemical Cycling

Ecological Footprint: The environmental impact of a person or population measured through the area/amount of space of biologically productive land and water required to supply raw resources and dispose/recycle waste.

3 FACTORS:

- **Affluence:** Wealth of nations
- **Technology:** Amount of technology that either helps or harms the environment (Ex: polluting factories)
- **Population:** The larger the population, the more is needed to be produced.

IPAT Model: A model of a country's total ecological footprint, which is based on population, affluence, and technology.

4 Basic Causes of Environmental Problems

1. Population Growth
2. Wasteful and unsustainable resource use
3. Poverty
4. Failure to include the harmful environmental costs of goods and services in market prices

Laws of Thermodynamics

Additional Resources:

Laws of thermodynamics review

First Law of Thermodynamics:

- The total amount of energy in the universe is constant
- Energy cannot be created or destroyed, only converted from one form to another

Second Law of Thermodynamics:

- Every energy transfer or transformation increases the entropy of the universe.

Law of Conservation of Matter:

- Matter cannot be created or destroyed

GDP: Measure of a country's growth based on the annual market value of all goods and services produced by all businesses, foreign or domestic, operating within a country.

Per Capita GDP: Economic change per person where it is divided by total population.

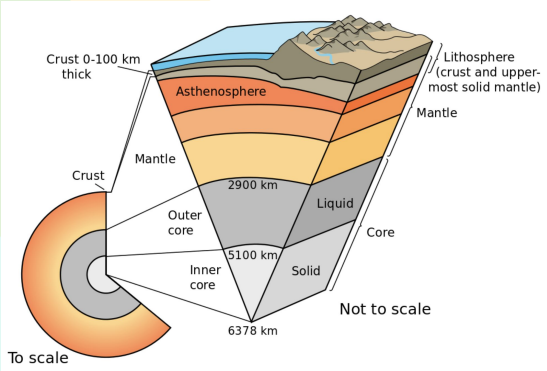
Two Phenomenons triggered the increase in population size:

- Agricultural Revolution
- Industrial Revolution

Earth Systems and Resources

- Earth’s Structure
- Plate Tectonics
- Soil Formation and Erosion
- The Rock Cycle
- Earthquakes, Tsunamis, and Volcanoes
- Earth’s Geography and Climate
- Solar Intensity

Earth's Structure



Sedimentary rock: Formed through the decomposition and sedimentation that was transported by ice, wind, and water.

Metamorphic rock: Rock that is altered by great heat or pressure. The forces generally occur deep underground, at temperatures lower than the rocks melting point, but high enough to change its appearance and physical properties.

Igneous rock: Rock that forms magma or lava cools.

Earth can be divided into three sections:

- **Biosphere**: All forms of life
- **Hydrosphere:** All forms of water
- **Internal structure:** crust, mantle, core

Crust:

- 2 main parts: granite-rich continental crust and basalt-rich oceanic crust
- Floats on top of the mantle
- Rocky and brittle

Mantle:

- Most of Earth's mass
- Mostly solid. A portion of the upper mantle called the **asthenosphere** contains especially soft rock, melted in some areas.
- Composed of iron, aluminum, magnesium, and silicon-oxygen composed.

Lithosphere:

- harder rock above the asthenosphere
- 3 main layers: core (inner layer), mantle (middle), and the crust (continents and ocean floor)
- Always moving very slowly. Movement = plate tectonics

Core:

- Consisting mostly of iron
- Very hot. Outer core is molten
- Inner core is under extreme pressure so it is solid

Additional Resources:

Video lessons for plate tectonics

Natural Disasters (article)

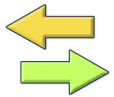
Richter Scales: Magnitude or strength of a earthquake based on amplitude of waves (logarithmic)

Severity	Richter Scale
Insignificant	<4.0
Minor	4.0-4.9
Damaging	5.0-5.9
Destructive	6.0-6.9
Major	7.0-7.9
Great	8.0-8.9
Extreme	>8.0

Plate Boundaries: A fundamental system that shapes Earth's physical geography and produces earthquakes.

Types of Boundaries

Transform boundaries:



- Plates slide past each other
- Frequently cause earthquakes

Divergent boundaries:

- Two plates slide apart from each other
- Can create massive fault zones and frequent oceanic earthquakes

Convergent boundaries:

- Two plates slide toward each other
- Form either a subduction zone or an orogenic belt
- Mountain ranges

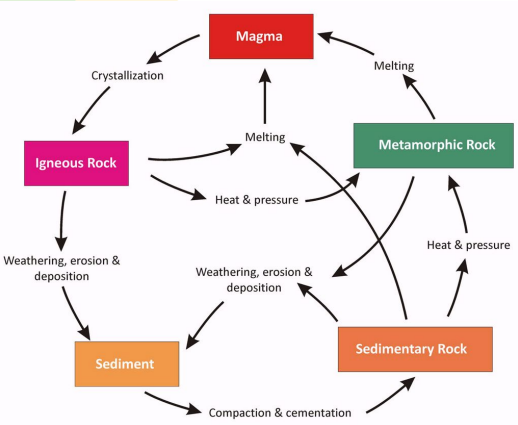
Earthquakes: Earth's release of energy. Result from movement at faults and plate boundaries.

Volcanoes: Arise from heating by magma at rifts, subduction zones, and hotspots.

Tsunamis: A series of huge waves created when large undersea earthquakes causes sudden drop or rise of ocean floor or a landslide caused by such an earthquake.

Additional Resources:

Soil Formation and Layers (Video)



The Rock Cycle

Humus: Dark organic material that forms in soil when plant and animal matter decays. Reduces erosion and stabilizes pH.

Soil Erosion: Movement of weathered soil from one place to another, which is caused by flowing wind, water, and various human activities. Damages agriculture, waterways, and infrastructures.

Soil: Thin layer on top of most of Earth's land surfaces. Basic natural resource, which greatly impacts every aspect of ecosystems

Soil Profile:

O HORIZON (surface litter)
- Leaves & partially decomposed organic debris
- Primarily made up of organic material, including the waste from organisms; the bodies of decomposing organisms; and live organisms. The dark, crumbly material that results from the decomposition of organic material forms humus.

A HORIZON (topsoil)
- Organic matter (humus), living organisms, inorganic minerals
- Plays an important role in plant growth

E HORIZON (zone of leaching)
- Dissolved and suspended materials move downward
- Only exists in biomes with high amounts of nutrients

B HORIZON (subsoil)
- Yellowish in color due to iron, aluminum, humic compounds and clay that leached down
- Rich in nutrients in areas where rainwater leached nutrients from topsoil
- Zone of illuviation: the movement of dissolved material from higher soil layers to lower soil layers due to the downward movement of water

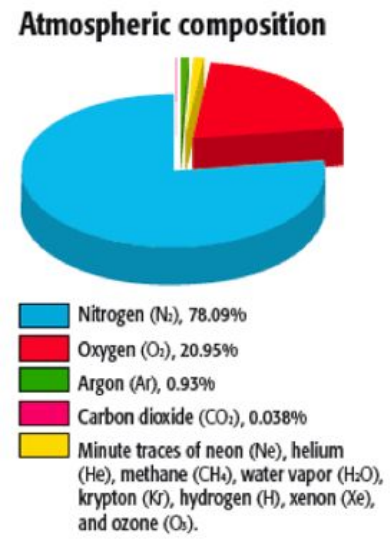
C HORIZON (weathered parent material)
- Partially broken-down inorganic materials
- Composed of larger pieces of rock that have not undergone much weathering

R HORIZON (bedrock)
- Lies below all the layers of soil.

The Atmosphere

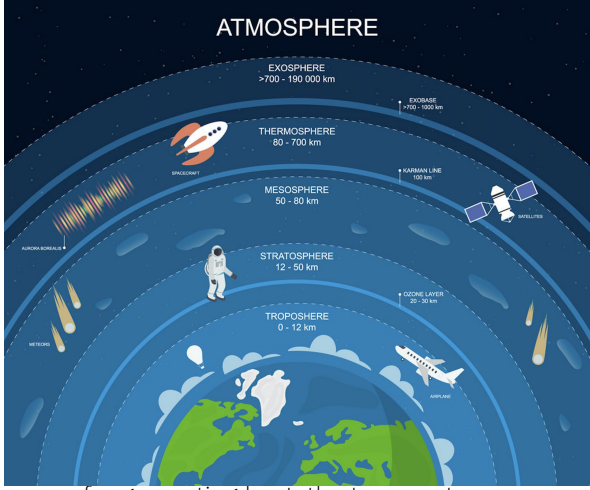
- ➔ Atmospheric Composition
- ➔ Structure
- ➔ Climate and Weather
- ➔ Atmospheric Circulation
- ➔ El Niño and La Niña - Southern Oscillation (ENSO)
- ➔ Hurricanes, Cyclones, and Tornadoes

Atmospheric Composition and Structure



Nitrogen: Fundamental nutrient for living organisms.

Atmospheric Layers:



Troposphere (Surface to 10 km)

- 75-80% of Earth's air mass.
- Rising and falling air currents: weather and climate.
- Tropopause (uppermost layer)

Stratosphere (10-50 km)

- 15% of total air mass.
- No weather, Temperature increases with altitude.
- O3, ozone layer, UV radiation-blocking ozone.

Mesosphere

- Coldest layer, Ice clouds.
- Meteors begin here.
- Mesosphere has negligible amounts of water vapor and ozone for generating heat, the temperature drops across this layer.

Thermosphere

- Blocks x-ray and UV radiation.
- The temperature increases with altitude.
- The high temperatures are the result of absorption of intense solar radiation by the last remaining oxygen molecules.

Ionosphere

- Reflects radio waves from the earth's surface, allowing long-distance radio communication
- Very hot, everything almost instantly vaporizes.
- The visual atmospheric phenomenon known as the northern lights (Aurora Borealis) also occurs in this region.

Exosphere

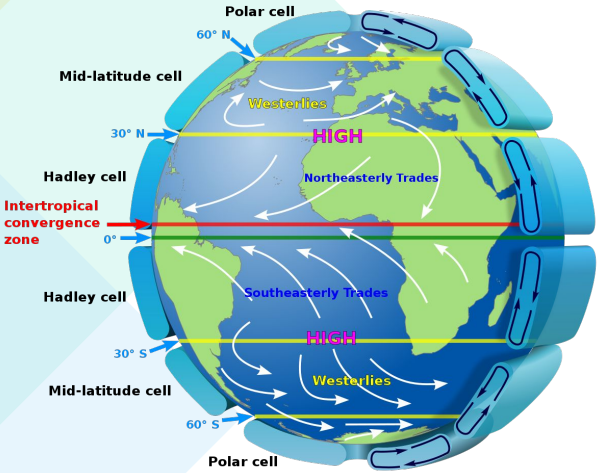
- Outer region of the atmosphere, represents the final transition between the atmosphere and interplanetary space.
- Contains mainly helium and hydrogen.
- Most satellites operate in this region.

Weather and Climate

Additional Resources:

[Difference between Climate and Weather (Article)]

Air Circulation Cells



Hadley cells: Characterized by heavy rains, high humidity, and high clouds
Ferrel cells: Severe winter and cool summers. Defined seasons.
Polar cells: Deserts. Amount of snowfall per year is extremely minimal. Low temperatures, severe winters, small amounts of rain, and short summers.

Weather: Describes what is CURRENTLY happening outdoors.

Climate: Describes weather patterns in a place over a period of time.

2 Main Indicators:
- Temperature
- Precipitation

3 Factors on Climate:
- Sun
- Atmosphere
- Oceans

Front: A boundary between air masses that differ in temperature, density, and moisture.
- **Warm front:** Warm air moves over cold air, which results in light rain from the moisture it contains.
- **Cold front:** Cold air moves under warm air which is less dense and pushes air up. Results in high surface winds, thunderstorms, or heavy rain.

Wind Patterns are Influenced by:
- Temperature
- Pressure differences
- Coriolis effect: Earth's rotation makes winds in the Northern Hemisphere curve to the right and winds in the Southern Hemisphere curve to the left.

Thermal Inversion: When a relatively warm layer of air at mid-altitude covers a layer of cold, dense air below. The warm inversion layer traps emissions that then accumulate beneath it. This increases the level of air pollution present.

Additional Resources:

El Niño and La Niña Explained (Article)

El Niño and La Niña Explained (Video)

Hurricanes, Tornadoes, and Cyclones (Article)

Hurricanes: Occur when winds rush into areas of low pressure. Warm, moist air over the tropical oceans rises.

Tornadoes: Swirling masses of air with high wind speeds that are produced from a single convection storm.

Cyclones: Comprised of many convection storms that are viewed as an oceanic phenomenon.

Upwelling:

- The upward movement of ocean water toward the surface as the result of *diverging currents*.
- Surface water is replaced with cool, nutrient-rich water, which contain high levels of phosphates and nitrates.
- Results in a Increase in biodiversity

Downwelling:

- Occurs when surface *currents converge*.
- Transports warm water rich in dissolved gases, which provides an influx of oxygen for deep water life.
- Results in a decrease in biodiversity.

EL NIÑO- SOUTHERN OSCILLATION (ENSO)

El Niño (Warm Phase):

- A systematic shift in atmospheric pressure, sea surface temperature, and ocean circulation in the tropical Pacific Ocean.
- Trade winds weaken
- Bringing of lots of warm humid water.
- Results in decrease in upwelling of nutrients

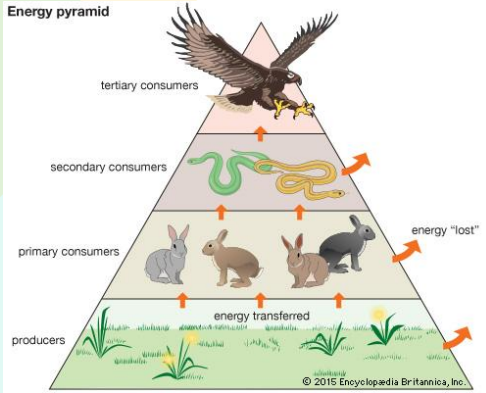
La Niña (Cool Phase):

- Trade winds are stronger than normal
- Increase in upwelling off of South America
- Cold water rises to the surface and extend westward in the equatorial Pacific

Interdependence Of Organisms

- ➔ Energy Flow in Ecosystems
- ➔ Trophic Levels
- ➔ Interactions between Species
- ➔ Species Diversity
- ➔ Stability in Ecosystems
- ➔ Food Chains and Food Webs
- ➔ Ecosystem Productivity

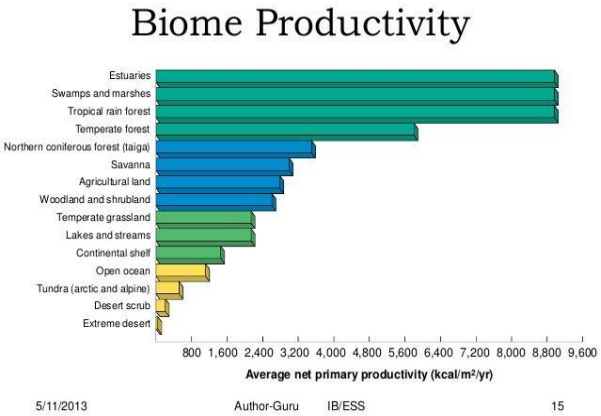
Energy Flow in Ecosystems



Autotrophs (Producer): Organisms that make their own food from compounds obtained from the environment. Capture energy from sunlight or chemicals and use that energy to produce food.
Primary Consumers (Herbivores): Organisms that feed on primary producers.
Secondary Consumers (Carnivores): Organisms that feed on primary consumers.
Tertiary Consumers: Organisms that feed on secondary consumers.
Decomposers: Organisms that break down wastes and return raw materials to the environment.

10% Rule: During the transfer of energy from one trophic level to the next, approximately 10% of energy is passed on while the rest is generally lost in the form of heat.

ECOSYSTEM PRODUCTIVITY:



Gross primary production (GPP): Rate at which plants capture and store a given amount of chemical energy as biomass in a given length of time.
Net primary production (NPP): Rate at which producers use photosynthesis to produce and store chemical energy minus the rate at which they use some of this stored chemical energy through aerobic respiration.

NPP = GPP - plant respiration

Interactions between Species

Types of Species Interactions:

- **Mutualism (+, +):** Two or more species benefit from their interaction.
- **Commensalism (+, 0):** One species benefits and the other is not harmed.
- **Parasitism (+, -):** A relationship in which one organism depends on another. A parasite lives on or within a host or when an organism lives on the organism that it consumes.
- **Amensalism (-, 0):** Interaction where one species causes harm to another organism while the other organism in unaffected.
- **Competition (-, -):** Species compete for the same resource.
- **Predation (+, -):** A consumer feeds on another consumer.
- **Neutralism (0, 0):** Neither population affects the other

Each species in an ecosystem has a specific role or way of life

- Factors that make an organism's niche: abiotic and biotic factors (Law of Tolerance)

Fundamental Niche: The full potential range of physical, chemical, and biological conditions and resources a species could theoretically use.
Realized Niche: The part of fundamental niche that an organism occupies as a result of limiting factors present in its habitat, such as competition.

Resource partitioning: Occurs when competing species coexist by using different resources or shared resources at different times.
Temporal resource partitioning: Occurs when two organisms use the same resource, but at different times of the day or year.
Spatial resource partitioning: Occurs when organisms use same space, but different parts of the area (Ex: Birds claim different parts of the tree)
Morphological resource partitioning: Occurs when different size or body shape allows species to use different parts of resource (Ex: Darwin's beak sizes)

<u>5 Major Roles of Species Within Ecosystems:</u>

1. **Native species**
2. **Nonnative species (invasive)**
3. **Indicator species:** Early warning of damage to an ecosystem
4. **Keystone species:** Considered of most importance in maintaining their ecosystem
5. **Foundation species:** Play a major role in shaping their communities by enhancing their habitats to benefit other species

Ecology

- Ecosystem Structure and Services
- Terrestrial and Aquatic Biomes
- Ecosystem Biodiversity
- Natural Ecosystem Change
- Ecological Succession

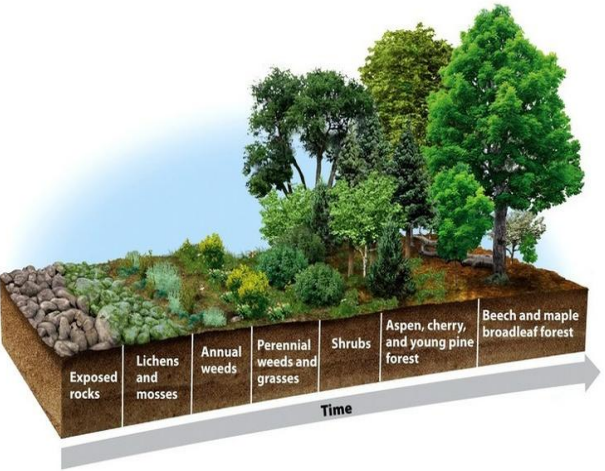
Ecosystem Stability

Additional Resources:

Ecological Succession (Video)

Ecosystem Structure (Article)

Ecosystem Services (Video)



Organisms → Species → Populations → Communities → Ecosystems → Biosphere

Population Dispersal Patterns

1. **Clumped:** Animals tend to "clump" together around crucial resources
2. **Random:** Habitats where environmental conditions and resources are consistent. Lack of strong interaction between species
3. **Uniform:** Distance between neighboring individuals is maximized, which can arise from competition

Ecosystem Services

- Production of food and water
- Control of climate and diseases
- Nutrient cycles and crop pollination
- Spiritual and recreational benefits

Ecological Succession: Gradual process of ecosystem development that follows a disturbance in community composition.

- **Primary succession:** Begins in an area where no biotic community or soil previously existed.
- **Secondary succession:** Succession following a disturbance that destroys a community without destroying the soil. Natural disaster occurs.

Pioneer species: First species to enter an area

Marine, Lakes, and Wetlands

WETLANDS:

- Plants are adapted to be very water tolerant
- Soil is saturated with water for all or most of the year
- High plant productivity supports a rich diversity of animal life

Major Types of Organisms in Aquatic Systems

1) **Plankton (top, free floating)**
   - Phytoplankton, zooplankton, single-celled to large invertebrates, ultraplankton
2) **Nekton (middle, open ocean)**
   - Strong swimmers: fish and turtles
3) **Benthos (Bottom)**
   - Bottom dwellers: crabs and clams
4) **Mostly Bacteria**

MARINE ZONES

- **Coastal Zone:** Warm, nutrient rich, shallow. Extends from the high tide mark on land to the edge of the continental shelf
- **Intertidal Zone:** Area of shoreline between low and high tide. Area where high and low tides occur.
- **Pelagic Zone:** Vast volume of the ocean after the continental shelf. High nutrient fluctuations and varied biodiversity.

Euphotic Zone (top, 0-200 m): Phytoplankton, nutrient levels low, and high levels of dissolved oxygen.

Bathyal Zone (middle, 200-1,500m): Dimly lit, Zooplankton, and smaller fish. Migrate to feed on the surface at night.

Abyssal Zone (bottom, 1,500 and below): Dark and cold, high levels of nutrients, little O2, deposit feeders, and filter feeders.

AS YOU GO FURTHER DOWN: CO2 increases, O2 decreases

LAKES

- **Littoral Zone:** Shallow, close to shore, rotted plants grow
- **Limnetic Zone:** Sunlit surface layer that extends to the depth penetrated by sunlight. Produces the food & oxygen that support most of the lake's consumers. Mai photosynthetic zone.
- **Profundal Zone:** Deep, too dark for photosynthesis to occur
- **Benthic Zone:** Bottom of the lake with decomposers and detritus feeders, dead matter, and low oxygen levels

TYPES OF LAKES

1) **Oligotrophic (young lake):** Water is clear, many cold water fish, high oxygen concentration, nutrient-poor.
2) **Mesotrophic (middle-aged):** Supports both cold and warm water fish, bottom is mostly sand.
3) **Eutrophic (old lake):** Shallow, warm, nutrient-rich, mostly nitrates and phosphates, and low oxygen levels.

Additional Important Biomes

***MUST know characteristics of all**

- Temperate coniferous forest
- Alpine tundras
- Savannas

Additional Resources:

[Terrestrial and Aquatic Biomes (Video)]

Biome	Defining Characteristics	Average Temperature	Precipitation	Soil/Vegetation
Tundra	Very cold, harsh, and long winters	Freezing (<0 °C)	Little precipitation	Small, close to the ground (moss), permafrost layers
Taiga (Boreal Forest)	Largest terrestrial biome, cold-tolerant evergreen conifers: pines & spruces, very cold and dry winters	-10 °C - 14 °C	About 20 inches per year	Soil is low in nutrients and acidic
Temperate Grasslands	Seasonal drought and occasional fires, hot summers, cold winters	Summers: over 38°C, winters as low as -40 °C	Moderate, 10-30 inches per year	Fertile soil, grasses are dominant vegetation
Tropical Rainforest	Greatest diversity of species, distinct seasonality: no winter, 2 seasons (rainy and dry)	Hot (25-30°C)	Very high precipitation, more than 80 inches per year	Nutrient-poor soil, heavy leaching
Deciduous Forest	Well defined seasons, trees have broad leaves that are lost annually,	-30 °C - 30 °C	Moderate, 30-60 inches per year	Fertile soil, enriched with decaying litter. Diversified understory vegetation
Chaparral	Droughts and fires are extremely common, dense spiky bushes	-1 °C- 38°C depends on season	Low, 10-17 inches per year	Dry soil, often very thin and low organic content
Desert	Spaced apart due to limiting factors, succulents and wildflowers, animals spend time underground, thick outer coverings, occasional fires	Daytime: average of 38°C Nighttime: average of -3.9 ° C	Low, less than 20 inches per year	Dry, clumpy vegetation, desert soils are called aridisols

Populations

- Survivorship Curves
- Population Ecology
- Age Structure Diagrams
- Human Population Dynamics
- Demographic Transition
- Population Growth

Population Ecology

Density-Independent control: Affect a population's size regardless of its density. (Ex: Natural disaster)
Density-dependent control: Factors that limit population growth and have a greater effect as a population's density increases. (Ex: Competition for resources)

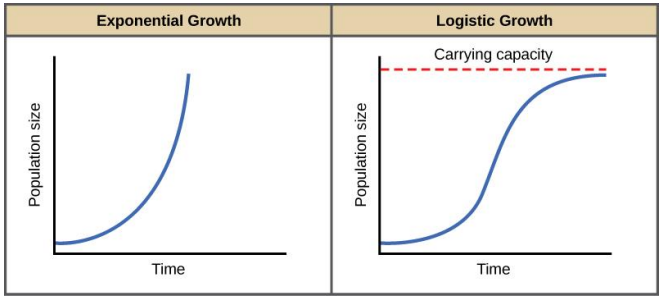
Reproductive Strategies

R-Strategists	K-Strategists
Mature rapidly	Mature slowly
Short-lived	Long-lived
Have many offspring	Have few offspring
Tend to be small	Tend to be larger
Type III survivorship curve	Type I or II survivorship curve
Low parental care	High parental care
Tend to be prey	Tend to be both predator and prey

Biotic potential: Maximum reproductive capacity of an organism under optimum environmental conditions. Full expression is restricted by environmental resistance.
Carrying capacity (K): Number of individuals that can be supported in a given area sustainably.
Overshoots: Goes above carrying capacity

<u>Regulating Factors</u>

- Space
- Oxygen levels in aquatic ecosystems
- Nutrient levels
- Amount of sunlight available
- Food availability



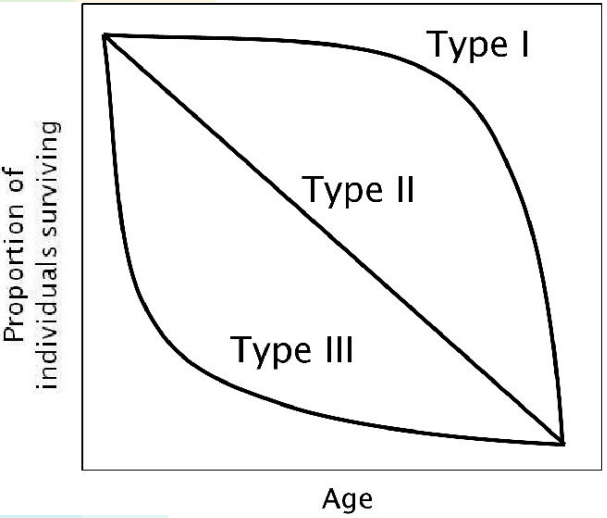
J-Curve (no carrying capacity)

S-Curve

Thomas Malthus: Predicted that exponential population growth would outpace linear food production leading to starvation.

- Actual population is kept in line with food supply by "positive checks" like disease and starvation, which increases the death rate.
- "Preventive checks" like postponement of marriage, which decreases the birth rate.
- Implied that actual population growth always has the ability to surpass the food supply available.

Survivorship



Rule of 70: Amount of time it takes for a population undergoing exponential growth to double in size at a constant growth rate.

$$dt = \frac{70}{r}$$

Where:

- r = growth rate (entered as whole number not as decimal)
- dt = change in time

Type I (Late Loss)

- Low infant mortality and long life spans
- Tend to be K-selected species
- Ex: humans and elephants

Type II (Constant Loss)

- Fairly uniform death rates among all ages
- Ex: rodents and songbirds

Type III (Early Loss)

- High infant mortality
- Death is prevalent for younger members of the species and declines with age
- Seen in most R-selected species
- Ex: fish, sea turtles, and insects

Fertility Rates:

- Infant mortality rates are a good indicator of comparative standards of living.
- Total fertility rate (TFR): Average number of children that a women has in her lifetime.
- Decline in fertility rates can be attributed to: Increase in number of women in the workforce, increase in female educational opportunities, and greater access to primary health care.

Population change = (crude birth rate + immigration) - (crude death rate + emigration)

$$\text{Actual growth rate (\%)} = \frac{\text{birth rate - death rate}}{10}$$

Demographic Transition

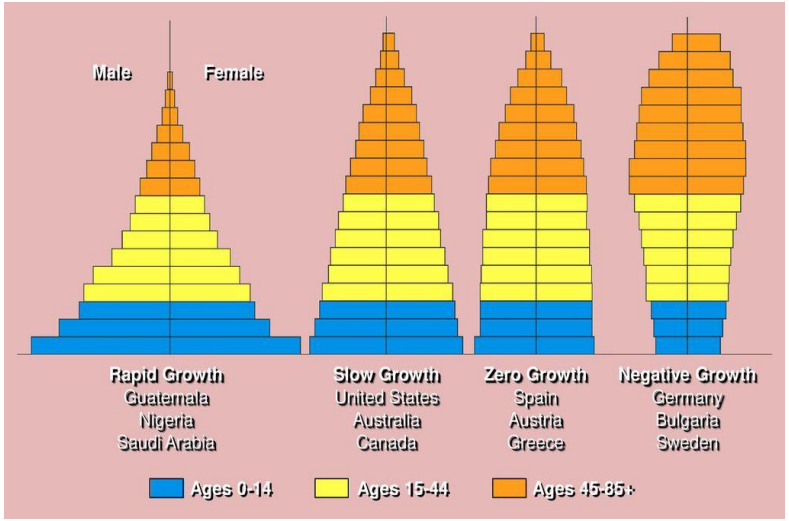
Pre-industrial stage (STAGE 1)
Characterized by high birth and death rates. Medical care is poor and food scarcity is evident

Transitional stage (STAGE 2)
Characterized by declining death rates (introduction of medicine and hygiene) but continued high birth rates (cultural lag).

Industrial stage (STAGE 3)
Characterized by falling birth rates that close the gap with falling death rates and reduce the rate of population growth. Educational and work opportunities for women decrease birth rates.

Post-industrial stage (STAGE 4)
Both birth and death rates are relatively low and remain stable there, and populations may even decline slightly. Zero population growth is achieved.

Age Structure Diagrams



Rapid growth: Population has high birth rates and a substantial amount of the population is in the reproductive age group.

Slow growth: Pre-reproductive and reproductive age groups are nearly equal. Post reproductive are the smallest due to mortality. Stable populations.

Zero growth: When a population is no longer increasing/decreasing.

Negative/Declining growth: Pre-reproductive is the smallest and post-reproductive is the largest. A result of birth rates falling below death rates.

Land and Water Resources and Use

- Tragedy of the Commons
- Types of Agriculture
- Sustainable Agriculture
- Pest-Control Methods
- Irrigation Methods
- Forestry
- Deforestation
- Urban Land Development
- Mining
- Fishing
- Green Revolution

Types of Agriculture

Alley Cropping: Method of planting crops in strips with rows of trees or shrubs on each side. Increases biodiversity.

Conservation Tillage: Reduces the amount of tillage and conserves soil by reducing soil erosion.

Crop Rotation: Planting a field with different crops from year to year to reduce soil nutrient depletion.

Intercropping: Growing more than one crop on the same field, which reduces wind erosion.

Monoculture: The cultivation of a single crop on a given field.

Polyculture: Different crops in the same space. Increases diversity.

Interplanting: Growing two different crops in a given area at the same time.

High-input Agriculture: Uses chemical fertilizers, mechanized equipment, and pesticides.

First Green Revolution (1950-1970)

- Planting monocultures
- Large amounts of fertilizers, pesticides, and artificial irrigation systems
- Increase in crop yield

Second Green Revolution (1970-Present)

- Growing genetically engineered crops.
- Spread industrialized farming to developing nations

CONTROLLING PESTS

Integrated Pest Management:

- GOAL: To reduce the number of pests to an economically tolerable level
- Reduces bioaccumulation and biomagnification of pesticides
- Methods include: polyculture, natural insect predators, intercropping, pest-repellent crops, and limited use of narrow-spectrum or natural pesticide.

FORESTRY:

Old-Growth forests: Have not been seriously impacted by human activities for hundreds of years. Rich in biodiversity.

Forest Fires

- **Crown fires:** Extremely hot, burn entire trees, increase soil erosion, and destroy structures.
- **Ground fires:** Occur underground, therefore, are difficult to detect. Burn partially decayed leaves.
- **Surface fires:** Burn undergrowth and leaf litter. May provide food in the form of vegetation that sprouts after fire. Reduce larger fires later

METHODS TO MANAGE AND HARVEST TREES: Clear-cutting, high grading, seed-tree cutting, selective cutting, shelterwood cutting, and strip cutting.

*MUST know characteristics of each

Additional Resources:

Land Use (Video)

Mining (Video)

Fishing (Video)

Forestry and Rangelands (Video)

MINING

4 Steps: *MUST know details

1. ***Site development***
2. ***Extraction***
   - **Surface mining:** Includes strip mining, open-pit mining, and mountaintop removal mining
   - **Underground mining**
   - ***In situ* leaching:** small holes are drilled into the site.
3. ***Processing:*** Intense chemical processing during smelting
4. ***Reclamation:*** Overburden remediation

FISHING

TYPES OF FISHING:

- **Bottom trawling:** Funnel-shaped net to drag the ocean bottom. Can lead to bycatch, which kills unwanted species.
- **Drift net:** Allows huge nets, which can stretch over multiple miles, to drift along the water and trap fish.
- **Longline:** A fishing line that has a ton of hooks on it is let out for a long distance and allowed to float and drift in the water. Can lead to bycatch, which kills unwanted species.
- **Purse seine:** Large nets are placed along the bottom of the ocean then drawn up and closed at the top to capture the fish, which allows for catching large amounts of fish at once.

Impacts of Overfishing

- Commercial extinction
- Invasive species are rapidly reproducing
- Disrupts food web, leading to a loss of other important marine organisms

“Tragedy of the Commons”: A situation in which individuals use a common resource for their own personal gain and degradation of the common resources results, leading to a decrease in yield for both the group and the individual.

- There exists no incentive to protect or replenish fish stocks because fish are in the open ocean and hence do not belong to any nation.

Energy Resources and Consumption

- Energy Sources
- Global Energy Consumption and Distribution
- Energy Use
- Renewable Energy Sources
- Energy Conservation Methods
- Transportation

Additional Resources:

Energy Consumption (Video)

Nuclear Energy (Video)

Fossil Fuels (Video)

Hydroelectric Power (Video)

Renewable Energy (Video)

Energy Reduction (Video)

We can cool houses by:

- Super Insulating them
- Taking advantages of breezes
- Shading them
- Having light colored or green roofs
- Using geothermal coolings

*MUST know all types of energy sources well

NONRENEWABLE ENERGY SOURCES: A source of energy that exits in limited quantities and, once used, cannot be replaced except over the course of millions of years.

- Fuels (coal, oil, and natural gas)
- Nuclear fuels

Nuclear fission: The process by which a large nucleus is split into smaller nuclei
Nuclear fusion: A nuclear reaction in which nuclei combine to form more massive nuclei with the simultaneous release of energy

RENEWABLE ENERGY SOURCES: A source that can be replaced when needed

- Solar, wind, geothermal, hydroelectric power, etc.

Passive Solar Heating: Passive solar heating system absorbs and stores heat from the sun directly within a structure without the need for pumps to distribute the heat.
Active Solar Energy Collection: Uses technology to focus, move, or store solar energy.
Flat plate solar collectors: Dark, colored heat absorbing metal plates mounted on rooftops.

Photovoltaic (PV) cells: Convert sunlight directly into electrical energy.
The photovoltaic (PV) photoelectric effect: Occurs when light hits the PV cell and hits a plate made of silicon.

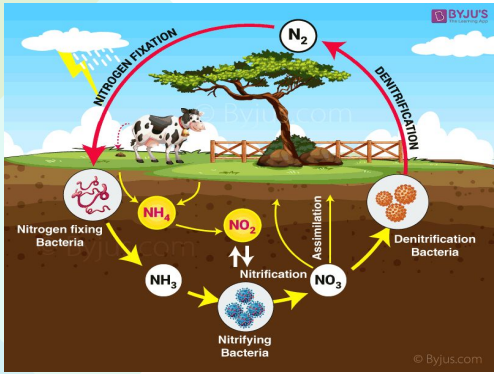
Natural Biogeochemical Cycles

- Water Cycle
- Sulfur Cycle
- Phosphorus Cycle
- Nitrogen Cycle
- Carbon Cycle
- Role of H2O, C, N, P, and S in the Human Body

*MUST know what each step consists of for each cycle

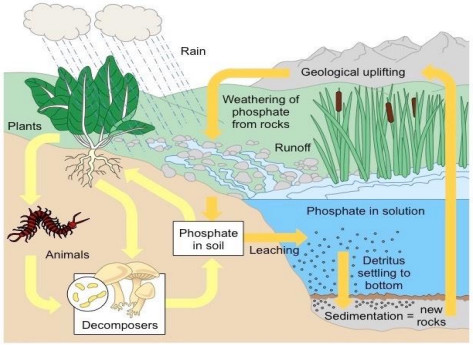
Nitrogen Cycle

- Major sink: Atmosphere
- Three ways nitrogen gets fixed: atmospheric fixation, industrial fixation, and biological fixation



Phosphorus Cycle

- Main sink: Sedimentary rock
- No gaseous phase, slower



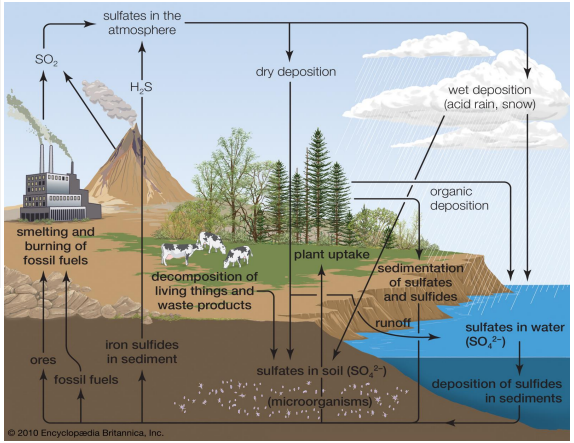
Additional Resources:

Biogeochemical Cycles (Article)

Chemical Composition of the Human Body (Article)

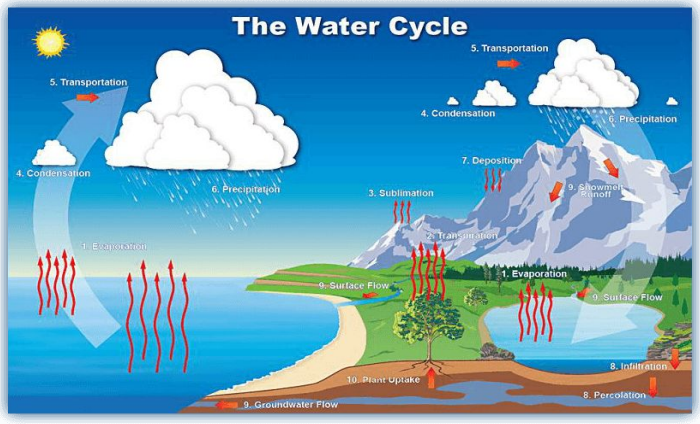
Water Cycle

- Powered by energy from the sun
- Processes include: evaporation, evapotranspiration, condensation, infiltration, runoff, and precipitation



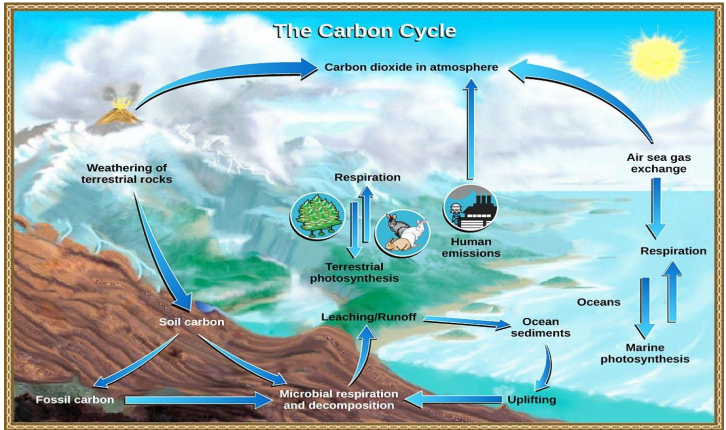
Carbon Cycle

- Main reservoirs: world's oceans, rocks, and fossil fuels
- Processes include: photosynthesis, respiration, exchange, sedimentation and burial, extraction, and combustion



Sulfur Cycle

- Main sink: terrestrial rock
- Human influences: burning of coal, refining of petroleum, and production of iron



Pollution

- Major Air Pollutants
- Air Pollution
- Methods to Reduce Air Pollutants
- Acid Decomposition
- Thermal Pollution
- Noise Pollution
- Water Pollution
- Groundwater Pollution
- Maintaining Water Quality
- Septic Systems
- Municipal Solid Waste
- Waste Reduction Methods
- Sources of Pollution

Additional Resources:

Air Pollutants, Acid Rain, Noise Pollution

Sources of Pollution

Water Pollution

Health Impacts of Pollution

Solid Waste

Major Air Pollutants

*MUST know in full detail

1. **Carbon Monoxide (CO)**
2. **Lead (Pb)**
3. **Sulfur Dioxide (SO_2)**
4. **Ozone (O_3)**
5. **Particulate Matter (PM)**
6. **Volatile Organic Compounds (VOCS)**
7. **Nitrogen Dioxide**

Point source pollution: A single identifiable source of pollution
Non-point source pollution: Pollution that comes from multiple different sources
Primary Pollutants:

- Emitted directly into the air
- Harmful substances released into the air through volcanoes, industry, combustion, etc.

Secondary Pollutants:

- Interaction of a primary pollutant with another substance in the air forming new chemical compounds

TYPES OF POLLUTION *MUST know in full detail

Air Pollution: Presence of chemicals in the troposphere and with high concentrations it causes harm and alters the climate

Water Pollution: The contamination of streams, rivers, lakes, oceans or groundwater with substances produced through human activities and that negatively affect organisms

- Runoff contributes to water pollution
- Water pollutants include excess nutrients, toxic waste, and organic waste

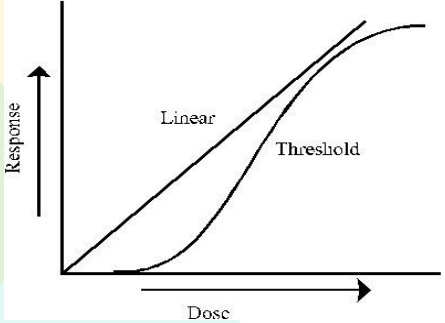
Thermal Pollution: When waste heat significantly changes the temperature of the environment

- Caused by heat absorbed by water used to cool unclean power plants, which in turn lowers oxygen levels and causes thermal shock

Noise Pollution: Any unwanted, disturbing, or harmful sounds that lead to damage, impairs, or interfere with hearing, cause stress, hamper concentration and work efficiency, or lead to various accidents.

Impact on Human Health and Environment

- ➔ Hazards to Human Health
- ➔ Dose-Response Relationship
- ➔ Biomagnification and Bioaccumulation
- ➔ Contaminated Sites
- ➔ Hazardous Chemicals in the Environment
- ➔ Pathogens and Infectious Diseases



LD_{50}: Dose of a pollutant or drug that kills 50% of the tested population and is an indicator of toxicity.

TD_{50}: Dose at which toxicity occurs in 50% of the cases

EC_{50}: Dose required for an individual to experience 50% of the maximum effect

ED_{50}: Dose required for 50% of population to obtain the therapeutic effect

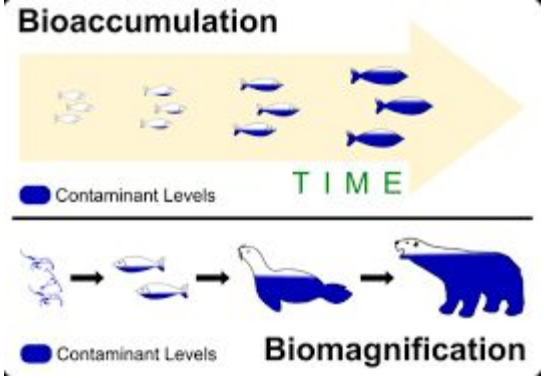
Lethal dose: A dose at which a given percentage of individuals will die

Hazardous Chemicals

- Corrosive (ex: battery acid)
- Discarded commercial products
- Ignitable
- Mutagens (ex: DNA)
- Radioactive
- Teratogens (ex: ethanol)
- Toxic (ex: lead)

Biomagnification: Increasing concentration of a substance in the tissues of organisms at every higher trophic levels within a food chain.

Bioaccumulation: Increase in concentration of a pollutant within an organism



Cap and Trade: An approach that is used in order to control pollution by providing various economic incentives in hopes of achieving reductions in the emissions of pollutants

TREATMENT, DISPOSAL, AND CLEANUP OF CONTAMINATED SITES

- **Brownfields:** An area of land that was previously used for industrial purposes and is now typically abandoned due to suspected contamination
- Incineration: Burning hazardous wastes
- **Capping:** Forms a barrier between the contaminated media and the surface, which protects humans to a certain extent from the contents
- **Landfills:** A private or municipal site where nonhazardous solid or municipal waste is disposed of in a series of compacted layers

Global Change

- Ozone depletion
- Global climate change
- Ocean warming and acidification
- Invasive species
- Human impacts on diversity

Stratospheric ozone:

Natural Ozone Cycle:

Destruction: O3+UVC/UVB → **O**+O2 *and* O2+UV Radiation → **O**+**O**

Production: O2+**O** → O3

Chlorofluorocarbons (CFCs):

CFC catalyzed depletion of O3:

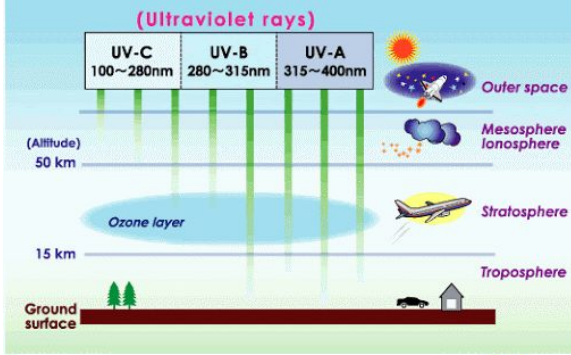
CFCl3+UV Radiation→ **Cl**+CFCl2

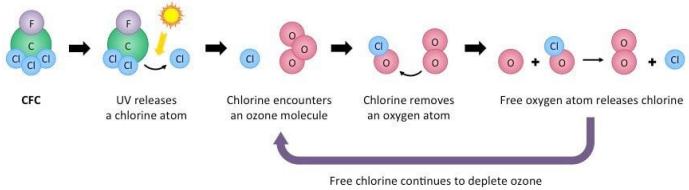
O3+**Cl**→ **ClO**+O2

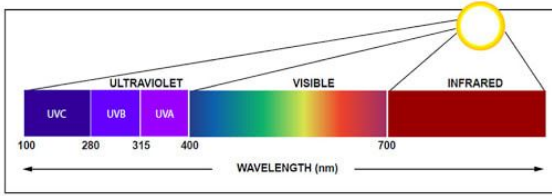
ClO+O2→O3+**Cl**

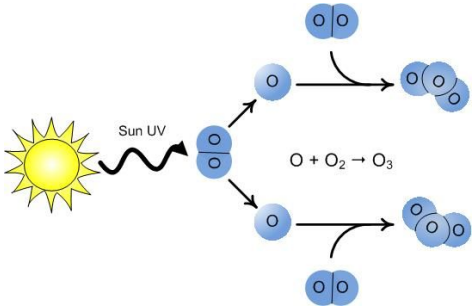
HFCs vs CFCs

> Montreal Protocol









/Note to self: put Ozone depletion Global climate change together

Global climate change:

- Changes in precipitation and temperature patterns
- Changes in ocean circulation patterns
- Increased storm intensity
- **Global warming:** the warming of the Earth's land, air, and water
  - Increased heat waves
  - Reduced cold spells

Greenhouse effect: a natural process that contributes to the warming of the Earth

Greenhouse gases: Certain gasses have a higher thermal retention property

Global warming potential: how much a molecule of any compound could contribute to global warming within 100 years, in comparison to carbon dioxide

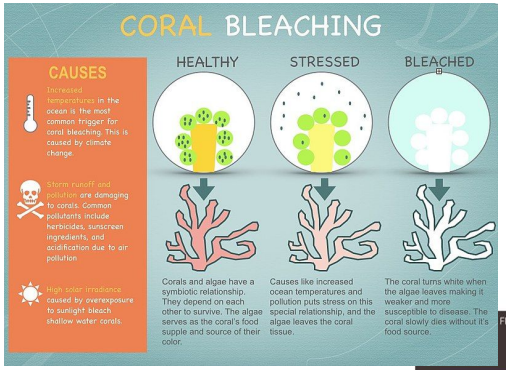
- **Carbon dioxide (CO_2):**
  - **Sources:** volcanic eruptions (historically largest contributor), metabolic reactions, combustion of fossil fuels
  - **Significance:** GWP = 1
- **Methane (CH_4):**
  - **Significance:** GWP = 27-30
  - **Sources:** anaerobic decomposition
    - ex. Wetlands
    - Ex. the guts of animals; cattle farming increased global CH_4 production
- **Water vapor (H_2O):**
  - **Significance:** absorbs the most infrared radiation from Earth, but does not persist as long as other GHGs (no GWP)
- **Nitrous oxide (N_2O):**
  - **Sources:**
    - anaerobic processes like denitrification
    - Combustion of fossil fuels. Ex. coal for electric power generation. The use of excess nitrates as fertilizers
  - **Significance:** GWP = 273
- **Hydrofluorocarbons (HFCs):**
  - **Significance:** used to phase out CFCs, but still contribute to greenhouse effect

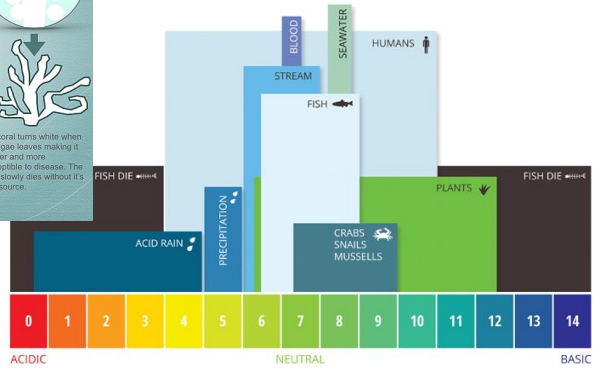
Ocean warming: caused by the increase in greenhouse gasses in the atmosphere

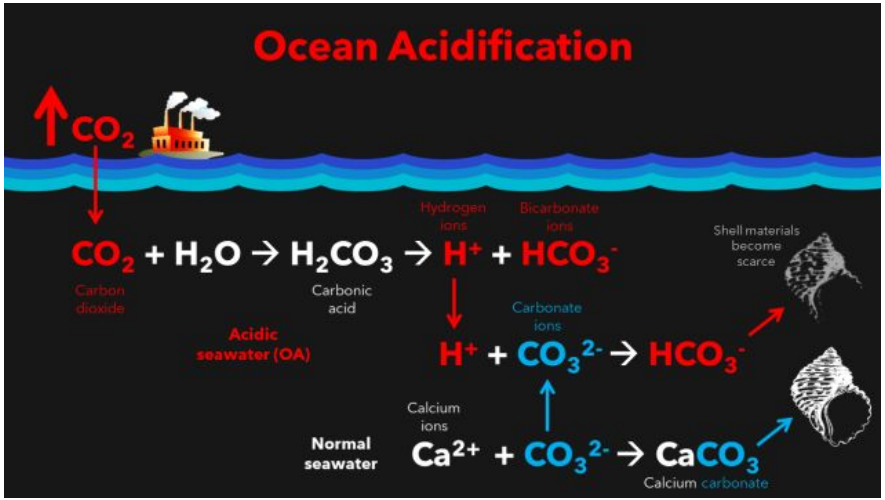
- **Effects on marine life:** loss of habitat, metabolic and reproductive changes

Ocean acidification: the decrease in pH of the oceans (typically 8.2, can range between 7.5-8.5), primarily due to increased CO2 concentrations in the atmosphere

- CO2 reacts with water to form carbonic acid, which lowers pH (increases H+ in water)
- Anthropogenic causes: burning of fossil fuels, vehicle emissions, and deforestation.
- Effects: depletes the calcium carbonate sources needed to build corals, shells and exoskeletons







Non-native species: species that are not naturally found in an area
Invasive species: species that enter new ecosystems and threaten the native species and habitat

-

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