APES First Semester Study Guide

**Quick Notes**

**Earth Science**

* Earth made of core (solid inner, molten outer, iron), mantle (mostly solid rock, asthenosphere flowing), lithosphere (contains crust)
* Lithosphere broken into tectonic plates, largest is Pacific Plate

**Plate Boundaries**- where 2 plates touch

* Convergent boundary- pushed toward each other
* Divergent boundary- moving away from each other
* Transform fault boundary- slide from side to side

##### Volcanoes

* Volcano- mountains formed by magma from Earth's interior
* Active volcanoes- currently erupting or have erupted in recorded history
* Dormant volcanoes- never known to erupt
* Extinct volcanoes- never erupt again
* Rift volcanoes- plates move away from each other
* Subduction volcanoes- plates collide and slide over each other
* Hot spot volcanoes- found at areas where magma rises to surface, Hawaiian islands

##### Earthquakes

From vibrations of plate movements deep in Earth

* Focus- location where earthquake begins inside Earth
* Epicenter- spot on surface of earth directly above focus
* Seismograph- measures size or magnitude

##### Rock Cycle

* Sedimentary- sediments build up and compress, limestone
* Metamorphic- pressure and heat applied to rock inside Earth's mantle, slate
* Igneous- rock melts and resolidifies, magma comes to surface, emerges as lava, cools to make rock, basalt

**Soil**

##### Horizons

* O horizon- surface and plant litter, lots organic matter, fungi, freshly fallen
* A horizon- topsoil, lots of organic matter, mineral material, humus, partially decomposed
* E horizon- zone of leaching, contains less organic material and little inorganic coloring material
* B horizon- subsoil, iron, aluminum, clay , humus, zone of accumulation
* (K horizon- calcium carbonate fills pore spaces)
* C horizon- regolith, partially broken down inorganic materials, parent material - R horizon- bedrock, unaltered parent material

##### Vocabulary

* Humus- sticky, brown, insoluble residue from partially decomposed organisms
* Topsoil- A horizon, mineral particles mixed with organic material, under surface litter
* Subsoil- B horizon, accumulated clays and nutrients, sometimes develops hardpan layer
* Sheet erosion- thin layer taken off land surface
* Rill erosion- little rivulets of running water cut small channels in soil
* Gully erosion- bigger channels of water that erode
* Waterlogging- soil saturated with water, kills plants from lack of oxygen
* Salinization- mineral salts accumulate in soil, saline irrigation
* Soil Fertility- capacity to supply nutrients (nitrogen, phosphorus, potassium) for plant growth
* Soil Porosity/Infiltration- pore spaces filled with water= saturated, otherwise it is unsaturated
* Infiltration- water through soil
* Soil porosity- space between pores

##### Soil Properties

* Plasticity- high > soil likely to have excessively expand and contract on wetting and drying - Strength- ability of a soil to resist deformation
* Cohesion- measure of the ability of soil particles to stick together
* Friction- high in sand, strength of forcing particles together
* Sensitivity- changes in soil strength resulting form disturbances such as vibrations or excavations
* Compressibility- tendency to consolidate, decrease in volume, coarse > low comp.
* Erodibility- ease with which soil materials are removed by wind or water
* Permeability- ease with which water moves through a material
* Corrosion- slow weathering or chemical decomposition that proceeds from surface into ground
* Ease of excavation- procedures required to remove soil during construction - Shrink-swell potential- tendency of soil to gain or lose water

##### Soil Conservation Techniques

contour and strip plowing, terracing, planting perennial species, plant ground cover and use mulch, reduced tillage systems, vegetarian or locavore, join community-supported agriculture program, add legumes (nitrogen) to the soil

**Energy flow**

**Producers**

Convert sun energy or chemical energy into carbohydrates, photosynthesis or chemosynthesis

##### Consumers

* Primary consumer- herbivores, only eat producers
* Secondary consumer- eat primary consumer
* Tertiary consumer- eat secondary consumer
* Detritivore- eat dead animals or fallen leaves
* Decomposer- bacteria and fungi, break plant material, waste, and dead bodies into inorganic forms

**Food chain**- contains trophic levels of producers and consumers and decomposers, 10% energy passes on

**Food web**- multiple food chains in one, more realistic depiction

**Ecosystem diversity**

**Biodiversity**- number and variety of organisms in ecosystem, also variability between species

* Gives species greater chance of survival
* Aesthetic appeal
* Human health and pharmaceuticals
* More types of agriculture

##### Succession

* Primary succession- lichens grow in lifeless area
* Secondary succession- grasses, existing community has been cleared with soil leftover
* Pioneer species- species in first stages of primary or secondary succession - Climax community- final stage of succession

**Energy Concepts**

##### Units

Energy units: Joule, Calorie, British thermal unit, kilowatt hour

Power units: Watt and Horsepower

##### Laws of Thermodynamics

1. Energy cannot be created or destroyed, only transformed
2. Entropy increases because energy lost as heat in energy transformations

* Energy- capacity to do work
* Potential energy- energy at rest
* Kinetic energy- energy in motion
* Radiant energy- sunlight
* Convection- transfer of heat by movement of heated matter - Conduction- transfer of energy through matter

##### Energy consumption

Fossil fuels provide 64% world's electricity

Nuclear energy provides 17% of world's electricity

Renewable energy sources provide 19%

##### Fossil Fuels Coal

Purest- anthracite, then bituminous, then subbituminous, worst is lignite

Scrubbers remove sulfur dioxide

Fly ash and boiler residue are waste products

##### Oil

Crude oil is what is pumped out

Most environmental damage is from transporting thousands of miles

##### Natural Gas

Mostly methane, but also pentane, butane, etc

Comes from wetlands and livestock

Transported in gas tanks as Liquefied Natural Gas, compressed

##### Nuclear energy

Nonrenewable, non-fossil fuel

Use uranium-238 with a 3% uranium-235

Isotopes are split with fission

Two types of reactors- Boiling Water and Pressurized Water **Hydroelectric power**

Moving water turns a turbine which generates elect.

Production releases no pollutants %uF04A

Does produce thermal pollution and dams rivers, which destroys habitats and changes river flow speed

Bad: huge buildup of sediment behind dam

Fish can't spawn unless they have fish ladders to go upriver

##### Energy conservation

Biofuel- fuel made of something other than fossil fuels, such as cooking oil

Important to find alternative fuel sources

CAFE, Corporate Average Fuel Economy, set standards for mile per gallon for cars Hybrid vehicles run on electricity and gasoline only for starting and stopping car

**Renewable energy**

Hydroelectric, solar, wind, geothermal, ocean tides, hydrogen cells

##### Solar

* Passive solar energy collection- collect sunlight with windows and building placement - Active collection- solar panels
* Photovoltaic cells- collect solar energy, produce electricity to store in batteries

##### Wind

* Turbine- wind turns blades, main part of wind turbine
* Nacelle- gearbox and generator to control turbine
* Wind farms- wind turbines put in groups

**Geothermal**

Energy from within Earth, take Earth's internal heat from heated water and steam

Longer APES Notes

##### SOIL: A RENEWABLE RESOURCE

~mixture of weathered minerals from rocks, decaying organic material, and living organisms

~with good husbandry, soil can be replenished and renewed

~1/2 of cropland is being destroyed quicker than replaced

##### Soil Composition

~1/2 mineral (from bedrock/sediments), plant & animal residue, air, water, organisms

~sandy soil: light soil, good drainage, dries quickly vs. clay (tiny particles), heavy, impermeable, holds water longer

~Humus: a sticky, brown residue from decaying plants & animals, gives structure to soil and helps drainage **Soil Organisms**

~Topsoil contains millions of organisms, most microscopic (bacteria, algae), worms insects, animals, plant roots draw up minerals and release acids that decompose particles

~leaf litter creates new organic material

##### Soil Profiles

~soil horizons: layers of soil, reveal the history, classified by color, texture, composition, ~Horizons make up soil profiles

~Topsoil: A horizon, covered by O horizon (newly deposited material), minerals mixed w/ organic matter, where most plants spread their roots to absorb nutrients

~subsoil: B horizon, dense with clay and nutrients (soluble)

~C horizon: parent material, weathered rock, weathering allows soil to extend downward

**Soil Types**

~classified into soil orders by their structure and composition

##### WAYS WE USE AND ABUSE SOIL Land Resources

~11% of Earth is used for agriculture

~the average land area available to each individual is decreasing

~ways to improve usage of land: variety, better fertilizers, irrigation, pesticides, labor, water- 95% of agricultural growth

~forests, plains being converted to farmland, will eventually have to increase output/acre ~some land shouldn't be farmed (more valuable in natural state)- nutrients in the plants, not soil, would result in loss of biodiversity

##### Land Degradation

~land destroyed by: 1) humans (buildings, etc) 2) desertification 3) erosion

~in some places, the degradation is so bad that no crops can be supported

~effects: less species, crops, biomass, diversity, vegetation, soil eroded, water runs off

~Causes: 1) water (55%) 2) wind (29%) 3) chemical (12%) 4) physical (4%)

##### Erosion: The Nature of the Problem

~Importance: redistributed sediments, part of soil formation and loss, sculpts landscapes, creates silt for farming

~However, erosion can destroy topsoil, (exposing the subsoil) reduce land fertility, load rivers with sediments, smother wetlands, clog water intakes, coat reservoirs with silt ~Erosion equals a 1% loss in cropland/year

**Other Agricultural Resources:**

water- 73% of all freshwater used for irrigation (15% crops are irrigated world wide) -80% water irrigated never reach destination (because of evaporation and seepage) water logging- water-saturated soil causing plants roots to die from lack of oxygen salinization- when mineral salts accumulate in the soil (particularly occurs when soil in dry climates are irrigated with saline water)

-when water evaporates, leaves behind lethal salt accumulation for plants

-irrigation problems: 150 million acres worldwide crop land damaged by water logging and salinization.

Water Conservation: greatly reduced problems from excess water use

-makes water available for other uses

Fertilizer- inorganic nutrients

-plants need: nitrogen, potassium, phosphorus, calcium, magnesium and sulfur

-calcium and magnesium limited in areas w/ high rainfall: must be supplied in form of lime

(fertilizer)

-lack of nitrogen, potassium and phosphorus also limits plants growth and these elements are added in fertilizers to enable plant growth

-crop production up since 1950: Nitrate levels in ground water have increased from fertilizers and young children are sensitive to this and it can be fatal **Alternatives for fertilizer:**

-manure and green manure

-nitrogen-fixing bacteria in root nodules of legumes

-interplanting or rotating beans (or other leguminous crop) with other crops (corn, wheat) **Energy:**

Direct- Fossil fuels supply almost all energy for farming

Indirect-energy synthetic fertilizers, pesticides (agricultural chemicals)- increase in this energy

-food system in U.S.: 16% of total energy use

-more energy put to produce, process and transport than actual farming

-present energy usages unsustainable (need alternatives for future because going to run out)!

**BIODIVERSITY**

Biodiversity preserves three ecological systems -Genetic Diversity: the measure of the variety of different versions of the same genes with individual species -Species diversity: the number of different kinds of organisms (richness) -Ecological diversity: the richness and complexity of a biological community

Only 1.4 million species are known- a fraction of the total. 70% known species are invertebrates, only 10-15% species live in North America and Europe Hot Spots of the World: The centers of greatest biodiversity tend to be in the tropics, especially tropical rain forests and coral reefs.

**How do we benefit from Biodiversity?**

 -Food- 80,000 plants are edible to humans

 -Drugs and Medicines- more than half of prescription drugs come from natural products. ex.

Madagascar periwinkle inhibits cancer growth!

-Ecological Benefits-soil formation, waste disposal, air and water purification, nutrient cycling, etc. 95% of pests are controlled by other species that prey on them- better than chemicals! -Aesthetic and Cultural Benefits- nature as "church". Provides psychological and emotional rejuvenation. Ecotourism is big.

##### Loss of Biodiversity: HIPPCO

-**Extinction**: the elimination of a species 99% of all species that have ever existed are now extinct!

 -Natural Causes of Extinction: in an undisturbed ecosystem. Mass extinctions (that wiped out dinosaurs at the end of the Cretaceous period and two thirds of all marine life at the end of the Permian period) were caused by climate changes, perhaps triggered when large asteroids struck the earth. Now we are losing species at thousands of times the natural background rate of extinction. 1/3 to 2/3 of all current species could go extinct by the MIDDLE of this century. :( -**Habitat Destruction:** The biggest reason for the current increase in extinction is habitat loss. Habitat Fragmentation: Habitat fragmentation divides populations into isolated groups that are vulnerable to catastrophic events.

 -**Over harvesting** (hunting and fishing) is responsible for depletion or extinction of many species. Ex. Passenger pigeon: 3 to 5 BILLION birds lived 200 years ago. In addition to over harvesting wild species for food, we also obtain a variety of valuable commercial products from nature. ex. Rhino horns.

-Predator and Pest Control- some animals are killed off because they are deemed as dangerous.

ex. coyotes

##### Exotic Species Introduction

-Exotic organisms are aliens introduced into habitats where they are not native and they are one of the greatest threats to native biodiversity. Exotics can be thought of as biological pollution. There are now more than 4,500 alien species in the United States. ex. Kudzu vine, purple loosestrife, asian longhorn beetles. They have no natural predators in their new home and can often out compete native plants for food and space. -Diseases- pathogens (disease organisms) can become predators when natural checks and balances are lost.

##### Endangered Species Management

-Hunting and Fishing Laws- 1890's most states authorized laws. ex. white tailed deer

 -The Endangered Species Act- ESA of 1973 prohibits the killing of a endangered species. The act has now expired. Endangered: considered in imminent danger of extinction Threatened: those that are likely to become endangered **Vulnerable** **species**:

-naturally rare or have become so because of human activities. Problems arose with lawsuits.

What about saving Mrs. Furbisher's lousewort??? Area in US with most endangered species is Southwest. Characteristics of endangered species: large body size, large or very small territory requirement, long-lived, specialist species, low reproduction rate.

**Successful Comebacks**: American alligator, Bald Eagle and California condor Some people want the economic cost of recovery to be included in the decision making process. ex. Snail darter and Northern Spotted Owl. 80% of the habitat for more than half of endangered species live on nonpublic property. Land owners are resistant. Over the past decade, growing numbers of scientists, land managers, policy makers, and developers have been making that case that it is time to focus on a rational, continent

-**wide preservation** of ecosystems that support maximum biological diversity rather than a species-by-species battle for the rarest or most popular organisms.

-**Minimum Viable Populations**: small numbers of surviving species are more vulnerable to extinction.

**Island Biogeography**. The smaller and farther away an "island" is from a continent, the faster the extinction rate. -International Wildlife Treaties Convention on International Trade in Endangered Species (CITES). Prohibits the trade of endangered species internationally. ex. Elephants -Captive Breeding and Species Survival Plans: zoo breeding can reintroduce endangered species back into the wild **Land Use: Forests and Range lands** Land Use Distribution of World:

-32% Forest and wetlands,

-31% Tundra, desert, wetlands, and urban areas,

-26% Range and pasture,

-11% Cropland Forests regulate climate, control water runoff, provide shelter and food and purify the air. Plus they are pretty to look at! 50 to 60% of the world depends upon wood or charcoal for heating and/or cooking. Forests in NE USA (Temperate) are rejuvenating! Tropical Forests are critically threatened. Jungles contain 2/3 of all plants and 1/2 of all animal life. There needs to be laws preventing deforestation in developing countries.

**BIOLOGICAL COMMUNITIES**

**CONVENTIONAL ENERGY**

**History of Energy Use in United States- in order of supremacy.**

Wood, slaves, coal, steam engine, and oil. Undeveloped countries still use biomass as 90% of their energy source. Amercians and Canadians (at 5% of the world population) use over one quarter of the WORLD's available energy. Hummer=Dummer. If we stopped driving gas hogs and living in sieves we could drastically reduce the amount of oil we use. Each person in the US uses an average of 60 barrels of oil/year- most of which is imported.

The 20 richest countries (1/5 the world's population) use 80% of the world's gas, 65% of the world's oil and 50% of the coal produced each year.

**Calorically:**

Hunter-gatherers required 2500 cal/day

World consumption is 31,000 cal/day

US consumption is 108,000 ca/day (including oil)

Fossil Fuels- provide 64% of the worlds electricity. Made from fossilized remains of once living organisms buried for years under intense heat and pressure.

**Oil** (liquid form of petroleum)- our primary source of energy.

Oil is formed when microorganisms accumulate at the bottom of the sea where oxygen is limited.

There it is chemically transformed anaerobically into oil and gas by a process called maturation. The longer the hydrocarbon molecule, the more solid it is. Less than 5 carbon atoms is gas. Huge numbers of carbon atoms turn into crude oil. Geologists drill exploratory wells to find a "proven" reserve, a known large quantity of oil. Measured in barrels which are equal to 42 gallons of oil. We have a very vague idea of how much oil is left, but most estimates place our world reserves at 50 more years and US reserves at 25 years. The Hubbert peak theory predicts that the oil production will soon reach a peak and then decline rapidly. We reached peak world oil production in the mid-90's most likely. Iran and Saudi Arabia are a little touchy about informing us of EXACTLY how much oil they have. The US peaked in the 70's.

Petrochemicals are chemicals refined from oil. They include plastic, synthetic fibers, medicine, wax, synthetic rubber, insecticides, fertilizers, detergents, shampoos!!!

Extraction from a reserve is done by pumping (first 25%), then another 50-60% is done by pressure extraction- whereby steam, salt water is pumped into the oil field and pushes out the oil.

As oil prices rise it will be more cost effective to remove more of the oil from the field. Right now removing oil from tar sands and oil shale is cost prohibitive.

Oil prices in the US are heavily subsidized by the government. Europeans pay at least twice as much for oil. The US imports more than half of its oil.

##### Coal

Most coal originally formed from a dense swampy mat of decaying plants during the

Carboniferous period- 300 million years ago. As plant material becomes buried it turns to peat (5% carbon). Further compaction and burial create lignite coal which is 60% carbon. Coal has various grades depending on purity and degree of metamorphism. The least favorable is lignite, then bituminous (sedimentary, 75% carbon) then anthracite (metamorphic, over 90% carbon).

We have roughly 200 years left of coal supplies. It is the most abundant fossil fuel and creates over one half of our electricity in US. Most of the coal supplies are in US, Russia and China.

Coal mining occurs through strip mining and underground mining. Underground mining requires shafts to be sunk to reach deposits. Networks of tunnels are created to reach the deposits and can be very unstable and dangerous. strip mining is horrible for the environment. The earth is removed all the way to the coal seam. Hazardous slag heaps are created containing sulfur which can leach out and damage the water table.

Coal fired electric plants are only 30% efficient AND they emit tons of sulfur and mercury into the air.. floating on the wind currents.... straight to NPZ! Scrubbers should be mandatory to remove S from coal's combustion gases.

##### Natural Gas

It’s convenient, cheap and cleaner burning the previous two fossil fuels. It emits considerably less CO2 when combusted. Only 10% of energy lost during conversion. (As opposed to 95% energy lost in a light bulb!) Difficult to transport as it has a tendency to blow up if hit. If transporting must keep under pressure to keep in liquid form or put into pipelines.

2/3 of natural gas is burned off when activating a oil well. Maybe they should rethink that.

Nuclear Fusion

2 isotopes of light elements are forced together at high temperatures till they fuse to form a heavier nucleus. 15 million degrees C to fuse H into He. Forgetaboutit. Too unstable. Cars running on nuclear fusion keep on blowing up. Very annoying trait. Takes

##### Nuclear Power

India and China create the most nuclear power

-Designs and Disasters

Nuclear reactors have fuel rods of uranium and some kind of control rod (cadmium, boron, graphite) to absorb neutrons and slow the chain reaction in the core inside a containment building, a heat exchanging material, steam generator, cooling system and a turbine. The greatest danger is a cooling system failure.

Types of reactors include- Boiling reactors, pressurized water reactors, heavy water reactors and graphite reactors.

After the Three Mile Island partial meltdown in Penn in 1979 and Chernobyl disaster in Russia in 1986 all new nuclear power plant construction projects in the US have been on hold.

-Radioactive Waste Management

-"Too cheap to meter?"

"Technology and engineering would tame the evil genie of atomic energy and use its enormous power to do useful work."

-nuclear power was supposed to be a cheap and safe solution for the projected natural oil and gas deposits being depleted.

-a lot of the future projections for the use of nuclear power were made under the assumption that future advancements in technology would figure out a way to get rid of the waste.

-1970-1974, 140 new reactors for power plants were ordered. Only forty of which were actually built.

-Nuclear energy supplies 20% of power in the US, 8% world wide.

-Nuclear power first developed in the 1950's after WWII, and the invention of the atomic bomb. -Scientists thought this would be a safe and renewable energy source, but it was proven dangerous to work around, and even minor accidents could have long lasting, and long ranging affects.

-Technology did not catch up with the expectations of the scientists for disposing of the hazardous wastes.

-Another major problem is that because the reactor can not be allowed to melt down, all the systems had to be redundant, making an extremely complex and delicate system that causes more accidents than it prevents.

-Nuclear power plants need to be located next to an abundant source of water to provide the power plant with water. This harms the natural environment of the waterway, and poses great risk if the power plant were to leak nuclear waste. The Hudson river has thermal pollution from Indian Point.

"How does our misunderstood friend work"

-the thing that makes something radioactive is the fact that it is an unstable isotope. All isotopes long to be stable. That is their goal in life. Most plants use 97% U-238 and 3% U-235.

The way they attain this goal is by releasing charged particles. These particles can alter animal

DNA

by mutating it in undesirable ways. Exposure to high levels of radiation creates bizarre types of cancer.

This very same process is what gives us power.

-when radioactive isotopes like U238 come in contact with neutrons, they break up into more stable

isotopes releasing massive amounts of energy such as heat and light. This is called nuclear fission. It also releases other neutrons, 2 or 3,making a chain reaction. The way this reaction is controlled is by the use of neutron absorbing materials like graphite. When the operators want to slow down the reaction, they put neutron absorbing material between the fuel rods. This material is removed if the reaction is to speed up. The way the energy is harnessed is

through the use of steam. The nuclear rods sit in a pool of water causing the water to become super heated. This heat is then transferred to another water pool that boils which then spins a turbine that spins a generator that creates electricity.

... And there is no harmful air pollution- no NOx or SOx. Environmentalists are pessimists. Air pollution will kill us slowly, nuclear power will kill us within a few short days! The half-life of uranium (the amount of time it takes for one half of uranium to decay is 4.5 billion years! It would take 10 half lives for uranium to decay to a safe level.

Waste disposal aka just put it where no one will find it.

- There are many ways to dispose of the waste that is generated by nuclear power.

-Waste is generated when the isotopes are first mined, and again when the isotopes are refined, and later when the isotopes are used. All the equipment that comes in contact with the isotopes also becomes waste.

-Countries that use nuclear power have devised many interesting ways to get rid of the waste. Some countries, ahh, like America, have chosen to store the waste on the nuclear reactor site for many years,

and then beginning in 2010 move it to Yucca Mountain, Nevada. This long term storage facility is between two active fault lines, above a major aquifer! Other countries, like Russia took the NIMBY approach, and decided to transport the waste to unprotected cites that are easily accessible by hostile peoples. They even dumped a bunch of nuclear waste on the bottom of the Arctic Ocean!

**ECONOMICS**

##### Ecological Economics

Natural Resource

-anything with potential use in creating wealth or giving satisfaction.

Renewable vs. Nonrenewable Resources

Nonrenewable resource

-resources that cannot be replaced (in a human time scale) because they take long periods of time to generate by earth's geological development or they are finite: the minerals, fossil fuels and metals.

-present supplies are becoming exhausted by human standards and will be gone.. soon. Yikes!

Renewable Resources

-things that can be replenished or replaced (usually refers to energy resources) such as sunlight, biological organisms, fresh water, fresh air, wind, and used cooking oil!!!

-but if we rip apart habitats we disrupt self renewing biological cycles. Yikes!

##### \*Tragedy of the Commons\*

-Article written in 1968 by biologist Garret Hardin.

-resources are being destroyed or degraded because people care more about the interest of themselves than they do about public interests. People who use or destroy more than their fair share of common property.

-Hardin described an open access system- no rules to manage resource use. (ex. Native American management of rice beds and hunting grounds, Maine lobster fisheries)

-communal resource management systems- resources managed by a community for long-term sustainability- can work IF collectively enforced and community anticipates continually living on the land which will be then be passed onto their children. **Classical Economics**

The theory is built on the idea that a free capitalistic market is the best method to govern our financial well-being... maybe.

Law of Supply and Demand. As supply (how much product is available) increases its demand

(the amount of product the consumers will buy) decreases and the price of the good also decreases. As supply decreases, the demand increases and its price increases. Kind of like a school dance when too many students of the same sex show up.

Market equilibrium is when the demand for a good equals its supply. Supply and demand are inversely proportionate.

**ENVIRONMENTAL GEOLOGY**

- Forces inside the earth cause continents to drift, split and crash into each other (very slowly).

##### A Layered Sphere

-**core**: interior of the earth, composed of hot metal (mostly iron), solid center, semi fluid outer, 2,900-5,000 km in diameter.

-Mantel: surrounds core, much less dense, high concentration of light elements (O2, Si, and Mg), 2,900 km in depth.

-**Crust**: cool, lightweight brittle rock that floats on the mantle (oceanic crust is like the mantle but has more Si while the continents are thicker, lighter regions of crust rich in Ca, Na, K, and Al).

Tectonic Processes and Shifting Continents

-**Tectonic Plates**: large pieces of land broken and moved by huge convection currents on the upper layer of the mantle.

-**Magma**: molten rock that gets pushed up from the mantle through cracks in the oceanic crust and piles underwater to create ocean ridges. Huge mountains and trenches are formed, greater than anything on the continents.

-Earthquakes are caused by grinding and jerking as plates slide past each other.

-When plates collide mountain ranges are pushed up.

-When an oceanic plate collides with a continental landmass, the ocean plate will be subducted and move into the magma where it is melted and the continent will be pushed up (deep ocean trenches form where the ocean plates submerge and volcanoes form where magma erupts though vents and fissures in the crust usually due to this process).

-"**Ring of Fire**" is the place where oceanic plates are subducted under the continental plates.

More earthquakes and volcanoes occur here than any other place on the planet.

-The continents are known to have been connected at least once (**Pangaea**). The moving plates and changing climates may have something to do with the mass extinctions that have occurred.

**ROCKS AND MINERALS:**

-**Mineral**: a naturally occurring, inorganic solid element or compound with a defiant chemical composition and a regular internal crystal structure (must be solid therefore ice is a mineral but liquid water is not) (when an element is purified and in a solid noncrystaline structure, it is no longer a mineral but the ore it was extracted from is). -**Rock**: a solid, cohesive, aggregate of one or more minerals.

-Each rock is made of grains of different minerals and the size of the grains will depend on how the rock was formed.

##### Rock Types and How They Were Formed

-**Rock Cycle**: creation, distraction and metamorphosis of rocks. Knowing this cycle can explain the origin and characteristics of rocks and how they are shaped, worn away, transported, deposited, and altered by geologic forces.

-**Igneous Rocks**: solidified from magma from the earth's interior. Magma that reaches the earth's surface cools quickly into basalt, rhyolite, andesite. These rocks have fine grains. Magma that is cooled in subsurface chambers has coarser grains and forms granite, gabbro etc.

-**Weathering**: exposure to air, changing temps and chemical reactions cause the breakdown of even durable rocks. (Mechanical weathering -physical breakup of rocks into smaller particles w/o a change in chemical composition. Chemical weathering- selective removal or alteration of specific components that leads to the weakening and disintegration of rocks ex. oxidation and hydrolysis. The products of chemical weathering are very susceptible to mechanical weathering and dissolving in water).

-**Sedimentation**: deposition of particles of weathered rock

-**Sedimentary Rock**: when deposited material remains in one place long enough or covered with enough material to compact it will become this type of rock. These rocks usually have layers.

-Relatively soft sedimentary rocks can be formed into unique shapes by the wind.

-**Geomorphology**- study of the processes that shape the earth's surface and the structures they create.

-**Metamorphic rocks**: preexisting rocks that have been modified by heat, pressure (sediments pile on top and tectonic buckling) and chemical agents. These rocks often hold the most economically important minerals such as talc, graphite and gemstones.

**MATTER**

##### Energy Flow

-**First Law of Thermodynamics-** Energy is conserved, not created or destroyed. It can only change in form.

-**Second Law of Thermodynamics**- Energy transfers lead to the energy being in a less "useful", lower form.

Matter recycles itself, unlike energy. Energy always degrades to a less concentrated level.

**High Quality Energy**: Very concentrated, rich, intense, has high temperatures.

**Low Quality Energy**: dispersed, diffused, sporadic, low temperature

-**Photosynthesis**: Plants convert energy from sun along with carbon dioxide and water into sugars (C6H12O6) and oxygen within the chlorophyll. Only 1-2% of the sunlight ever makes it into the plant's tissue!

-**Aerobic Respiration**: Oxygen consuming producers, consumers and decomposers break down complex organic compounds (glucose, etc) and convert carbon back into carbon dioxide. The energy stored in the glucose bonds is transformed into chemical and heat energy- it is not lost! The formulas for photosynthesis and respiration are the same but reversed!

**Biotic**- living components of the ecosystem **Abiotic**-nonliving components of the ecosystem

**Trophic Levels**:

1. Tertiary Consumers- eats secondary consumers
2. Secondary Consumers- eats primary consumers
3. Primary Consumers/Herbivores -eats plants
4. Producers/Autotroph- Photosynthesize energy

The biomass of each level is 90% greater than the one below it! Only 10% of useable energy is transferred up to the next trophic level because so much is lost.

-Some of the food source many be inedible or indigestible.

-Energy may be expended catching the prey

-Energy is degraded through normal metabolic processes (Second law of thermodynamics).

-**Food Chain**- A linear list of who eats who. The arrow points to who is doing the consuming.

-**Food Web**- A more complex interwoven diagram of which organisms prefers to eat each other.

Scavenger- Feeds on dead animals. ex. coyote

Detritivore- Eats leaf litter, dung. ex. ants

Decomposers- organsims that break down or feeds on dead organic matter. ex. Fungus or bacteria

**SUSTAINABLE ENERGY**

***Solar*:**

.1% of the electricity in US produced through solar panels.

Constant, free energy supply

-Amount of solar energy reaching the earth's surface is 10,000 times all the commercial energy used each year.

-Until this century it was too diffuse and low in intensity to use except for environmental heating and photosynthesis.

**-*Passive Solar Heat***

Much of passive solar heat is simply orientating your home toward the sun and absorbing the heat- naturally.

- Indirect gain: Absorption-using natural materials or absorptive structures with no moving parts to simply gather and hold heat.

-Old Method: Thick-walled stone and adobe dwellings that slowly collect heat during the day and gradually release heat during the night. After cooling at night, they maintain a comfortable daytime temperatures while still absorbing external warmth.

-New Method: glass-walled "sunspace" or greenhouse on the south side of a building. Uses massive energy-storing materials such as brick walls, stone floors, or barrels of heat-absorbing water to collect heat to be released at night.

-Direct gain: Use a roof overhang that blocks the direct sunlight in the summer, but lets the sun in when its at a lower angle in the winter.

**-*Active Solar Heat***

-Solar panels-Photovoltaic Cells-capture solar energy and convert it directly to electrical current by separating electrons from their parent atoms and accelerating them across a one-way electrostatic barrier formed by the junction between two different types of semiconductor material. This is known as the photovoltaic effect.

-They used to be too expensive for practical use but prices are falling.

-In 2001 prices were approaching $5 per watt.

-By 2020 it will be down to about $1 per watt and nuclear energy will cost twice as much. -World market for solar energy is expected to grow rapidly in the near future, especially in remote places where conventional power isn't available. -Already used in watches, solar-powered calculators and toys

-Solar energy could mean being able to build a house anywhere and have a cheap, reliable, clean, quiet source of energy with no moving parts to wear out, no fuel to purchase, and little equipment to maintain.

Pro:

No pollution, unlimited resource, can store energy during the day and release it at night, cost going down- decreased by a factor of ten in 2 years!

Con:

Needs a storage system like deep cell batteries, not efficient if climate too cloudy, high costs for purchasing solar panels and have limited life span, Visual pollution, efficiency between 10 and 25%.

-Solar water heaters- generally pump a heat-absorbing, fluid medium through a relatively small collector instead of passively collecting heat.

-Can be located next to or on top of buildings.

-Flat, black surface sealed with a double layer of glass makes a good solar collector. -A fan circulates air over the hot surface and into the house through ductwork, like standard forced-air heating.

-A simple flat panel of 5 square meters can provide enough hot water for an average family of four.

-What about when it's not sunny?

1. For climates where sunless days are rare- small, insulated water tank makes a good solar energy storage system.
2. For winter months-A large, insulated bin containing a heat-storing mass, such as stone, water, clay provides solar energy storage.

***Fuel Cells:***

* Devices that use an ongoing electrochemical reaction to produce an electric current.
* Discovered by William Grove in 1839 during his study of electrolysis.
* Fuel cells consist of a cathode (positive electrode) and an anode (negative electrode) and are separated by an electrolyte.
* an electrolyte is a material that allows ions (positively charged atoms) to pass through but not electrons.

How a fuel cell works: hydrogen passes over the anode and a catalyst on the anode takes an electron from each hydrogen atom, creating a positive hydrogen ion. The ion can pass through the electrolyte to the cathode, but not the electron. The electron then passes through an external circuit going into the cathode creating an electrical current. Then, at the cathode the electrons and positive ions rejoin and combine with oxygen creating water.

Pro:

-Emits water as waste! no pollution, minimal environmental impact, easily transported, not explosive when stored in compounds

Con:

* takes energy to produce hydrogen, changing from fossil fuels to hydrogen would take a lot of money to build the infrastructure, hydrogen gas is explosive which is inconvenient- how could we store it in a car?

***Biofuels:***

-Biofuels produce 15% of the world's energy, 4% of that energy is used by the U.S (.1% electricity).

-Types of biofuels include switchgrass, woodchips, sawdust, wood residue, any kind of wood or plant material. Maybe we should use all the paper we throw into the dumps... if I were queen...- Biomass (plants, wood, etc.) converted into a liquid form making storage and transportation easier.

Pro:

-It is a renewable resource if used in moderation; biofuel could produce 1/2 of the world's electrical needs if managed properly; many marginal areas of the world could support biomass plantations with plants like cottonwoods, poplars, sycamores and shrubs; its inexpensive, and the burning of biofuels produce less SOx and NOx then coal.

Con:

-Deforestation and soil erosion occur, requires fertilization and water. It is expensive to transport and can cause the loss of wildlife and habitats. Some methods of burning biomass causes air pollution such as CO2 emission. Also the use of corn to produce ethanol takes more energy than it creates and is driving the price of corn up for the poor who depend on it for food (ex.

Mexicans).

-When biofuels are converted to electricity, 70% of the energy is lost!

***Hydroelectric Power:***

-Dams trap water which is then released and channeled through turbines which generate electricity.

* 9% of USA's electricity, 3% worldwide. There are 2000 dams in the US.

Pro:

* Good because there's no pollution, low operation costs and they control flooding. They also have a high to moderate energy yield and a long life span.

Con:

Dams create large floods, which uproot people, destroy habitats, and disrupt natural soil fertilization of agricultural land downstream. Sediments eventually need to be dredged from the reservoir. Also dams upset fish migration patterns (salmon!) and the natural beauty of rivers.

Also dams are extremely expensive to build.

***Tidal and Wave energy:***

The natural movement of tides spin turbines which generate electricity. Very few plants exist- only in US, France and Scotland.

Pro:

No pollution, moderate energy yield, minimal environmental impact, cheap to maintain.

Con:

 Costs a lot to construct, few suitable sites. Plants get hurt by corrosion from salt and storms.

***Wind Power:***

Large blades of wind mills spin create electricity. Now make less than .1% of electricity in US but growing!

Pro:

 -Fastest growing renewable energy resource today- no pollution -Very promising

 -Unlimited source (quick fact: all electrical needs of the US could be met by wind in North

Dakota, South Dakota and Texas!)

 -Wind farms can be built quickly

 -Maintenance is low and automated

 -Moderate to high net-energy yield

 -Production of wind turbines would be a boost to economy -Land underneath turbines can be used for agriculture

 Con:

 -Steady wind is required to make it economical. Back up systems needed when wind is not blowing

 -Visual Pollution- ugly

 -Noise pollution

 -May interfere with communications (radio, TV, Microwave)

- may kill some birds if on migrational pattern

***Geothermal Power:***

 -Two kinds: Heat contained in underground rocks and fluids from magma are used or just the stable subsurface ground temperature is used to heat air in winter and cool it in summer.

 -Geothermal energy supplies less than 1% of energy needs in the U.S.

 -It is being utilized in Hawaii, Iceland, Japan, Mexico, New Zealand, Russia and California

Pro:

 -Moderate net-energy yield

 -Limitless and reliable source if managed

 -Little air pollution -Competitive cost

 Con:

 -Reservoir sites for hot geothermal power are scarce

 -Source can be depleted if not managed

 -Non-renewable

 -Noisy

 -Odor

 -Local climate changes

 -Land damage involved for pipes and roads- can cause land sinks.

 -Can degrade ecosystems due to hot water wastes and corrosive or saline water