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| **First Law of Thermodynamics** | energy is neither created nor destroyed, but may be converted from one form to another |
| **Second Law of Thermodynamics** | when energy is changed from one form to another, some useful energy is always degraded into lower quality energy (usually heat) |
| **Ionizing radiation** | Radiation w/enough energy to free electrons from atoms forming ions, may cause cancer (ex. gamma, X-rays, UV). |
| **High Quality Energy** | Organized & concentrated, can perform useful work (ex. fossil fuels & nuclear). |
| **Low Quality Energy** | Disorganized, dispersed (ex. heat in ocean or air/wind, solar). |

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| **Natural radioactive decay** | Unstable radioisotopes decay releasing gamma rays, alpha & beta particles (ex. Radon). |
| ***Half-life*** | The time it takes for 1⁄2 of the mass of a radioisotope to decay. A radioactive isotope must be stored for approximately 10 half-lives until it decays to a safe level |
| ***Nuclear Fission*:** | nuclei of isotopes split apart when struck by neutrons |
| ***Nuclear Fusion*** | 2 isotopes of light elements (H) forced together at high temperatures till they fuse to form a heavier nucleus. Happens in the Sun, very difficult to accomplish on Earth, prohibitively expensive. |
| ***Ore*** | Rock that contains a large enough concentration of a mineral making it profitable to mine. |

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|  ***Mineral Reserve*** |  Identified deposits currently profitable to extract. |
|  ***Surface mining*** |  cheaper, can remove more minerals, less hazardous to workers |
|  ***Humus*** |  Organic, dark material remaining after decomposition by microorganisms. |
|  ***Leaching*** |  removal of dissolved materials from soil by water moving downwards through soil |
|  ***Loam*** |  perfect agricultural soil with equal portions of sand, silt, and clay |

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| ***Soil Conservation Methods*** | Conservation tillage, crop rotation, contours plowing, organic fertilizers. |
| ***Soil Salinization*** | In arid regions, water evaporates leaving salts behind. (ex. Fertile crescent, southwestern US) |
| ***Water Logging*:** | water completely saturates soil starves plant roots of oxygen, rots roots |
| ***Hydrologic Cycle Components*:** | Evaporation, transpiration, runoff, condensation, precipitation, and infiltration. |
| ***Watershed*:** | All of the land that drains into a body of water. |
| ***Aquifer*** | underground layers of porous rock allow water to move slowly |

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|  ***Salt Water Intrusion*:** |  Near the coast, over pumping of groundwater causes saltwater to move into the aquifer. |
|  ***ENSO*:** |  El Nino Southern Oscillation, trade winds weaken & warm surface water moves toward South America. Diminished fisheries off South America, drought in western Pacific, increased precipitation in southwestern North America, fewer Atlantic hurricanes. |
|  ***La Nina*** |  “Normal” year, easterly trade winds and ocean currents pool warm water in the western Pacific, allowing upwelling of nutrient rich water off the West coast of South America. |
|  ***Nitrogen Fixation*:** |  Because atmospheric N cannot be used directly by plants, it must first be converted into ammonia by bacteria. |
|  ***Ammonification*:**  |  Decomposers covert organic waste into ammonia.  |
|  ***Nitrification*:**  |  Ammonia is converted to nitrate ions (NO3-).  |

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|  ***Assimilation*** |   Inorganic N is converted into organic molecules such as DNA/amino acids & proteins. |
|  ***Denitrification*:** |  Bacteria convert ammonia back into N. |
|  ***Phosphorus*:** |  Does not exist as a gas; released by weathering of phosphate rocks, it is a major limiting factor for plant growth. Phosphorus cycle is slow, and not atmospheric |
|  ***Photosynthesis*** |  Plants convert CO2 (atmospheric carbon) into complex carbohydrates (glucose C6H12O6). |
|  ***Aerobic Respiration***  |  Oxygen consuming producers, consumers & decomposers break down complex organic compounds & convert C back into CO2. |
| ***Trophic Levels*:**  | Producer’s → primary consumer → secondary consumer → tertiary consumer. |

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| ***Energy Flow through Food Webs*** |  10% of the usable energy is transferred to the next trophic level. Reason: usable energy lost as heat (2nd law of Thermodynamics), not all biomass is digested & absorbed, and predators expend energy to catch prey. |
| ***Primary succession*** | Development of communities in a lifeless area not recently inhabited by life (ex. lava flow, retreating glacier). |
| ***Secondary succession*** | Life progresses where soil remains (ex. clear-cut/burned forest, old farm, vacant lot). |
| ***Mutualism*** |  symbiotic relationship where both organisms benefit |
| ***Commensalism*** | Symbiotic relationship where one organism benefits & the other is unaffected. |
| ***Parasitism*:**  | Relationship in which one organism (the parasite) obtains nutrients at the expense of the host.  |

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| **Carrying Capacity** |  Number of individuals that can be sustained in an area. |
| **r-strategist** | Reproductive strategy in which organisms reproduce early, bear many small, unprotected offspring (ex. insects, mice). |
| **K-strategist:** | Reproductive strategy, in which organisms reproduce late, bear few, cared for offspring (ex. humans, elephants). |
| **Natural Selection** | Organisms that possess favorable adaptations pass them onto the next generation. |
| **Thomas Malthus** | “Human population cannot continue to increase. Consequences will be war, famine & pestilence (disease).” |
| **Doubling Time:**  | (Rule of 70) doubling time equals 70 divided by percent growth rate. (ex. a population growing at 5% annually doubles in 70 ÷ 5 = 14 years) |

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| ***Replacement Level Fertility*** | The number of children a couple must have to replace those (averages 2.1 in more developed nations, 2.7 in less developed nations). In an area. |
| ***Methods to Decrease Birth Rates*** | Family planning, contraception, economic rewards & penalties. |
| ***Point Source*** | source from specific location such as pipe or smokestack |
| ***Non-Point Source (Area/Dispersed Source)*:** | Source spread over an area such as agricultural/feedlot runoff, urban runoff, traffic. |
| ***Primary Sewage Treatment*** | first step of sewage treatment; eliminates most particulate material from raw sewage using grates, screens, and gravity (settling) |
| ***Secondary Sewage Treatment*** | Second step of sewage treatment; bacteria breakdown organic waste, aeration accelerates the process. |

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| ***BOD*:** | Biological Oxygen Demand, amount of dissolved oxygen needed by aerobic decomposers to break down organic materials. |
| ***Eutrophication*** | rapid algal growth (algal bloom) caused by an excess of nitrogen & phosphorus, blocks sunlight, causing the death/decomposition of aquatic plants, decreasing dissolved oxygen (DO), suffocating fish. |
| ***CAFE standards*** | Corporate Average Fuel Economy standards enacted into law in 1975, established fuel efficiency standards for passenger cars and light trucks. |
| ***Primary Air Pollutants)*:** | Produced by humans & nature (CO, CO2, SO2, NO, hydrocarbons, particulates). |
| ***Secondary Air Pollutants*** | Formed by reaction of primary pollutants. |
| ***Particulate Matter*** | Sources include burning fossil fuels and car exhaust. Effects include reduced visibility, respiratory irritation. Methods of reduction include filtering, electrostatic precipitators, alternative energy). |

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| ***Nitrogen Oxides*: (NOx)** | Major source is auto exhaust. Primary and secondary effects include acidification of lakes, respiratory irritation, leads to smog and ozone. Reduced using catalytic converters. |
| ***Ozone*:** | Secondary pollutant, NO2 + UV → NO + O; O + O2 → O3, with VOCs. Causes respiratory irritation and plant damage. Reduced by reducing NO emissions and VOCs. |
| ***Sulfur Oxides*: (SOx)** | Primary source is coal burning. Primary and secondary effects include acid deposition, respiratory irritation, and plant damage. Reduction methods include: scrubbers, burn low sulfur fuel. |
| ***Carbon Dioxide*: (CO2)** | Sources include the combustion of fossil fuels. Effects: greenhouse gas–contributes to global warming. Reduction accomplished by increased fuel efficiency (gas mileage), mass transit (reduction). |
| ***Carbon Monoxide*: (CO)** | Sources include incomplete combustion of fossil fuels. Effects: binds to hemoglobin reducing bloods ability to carry O2. Reduction accomplished by catalytic converters, oxygenated fuel, mass transit (reduction). |
| ***Photochemical Smog*:** | formed by chemical reactions involving sunlight (NO, VOC, O2) |

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| ***Acid Deposition*** | caused by sulfuric and nitric acids resulting in lowered pH of surface waters |
| ***Effects of Global Warming*** | Rising sea level (due to thermal expansion not melting ice), extreme weather, droughts (famine), and extinctions. |
| ***Ozone Depletion*:** | Caused by CFCs, methyl chloroform, carbon tetrachloride, halon, methyl bromide all of which attack stratospheric ozone. Negative effects of ozone depletion include increased UV, skin cancer, cataracts, and decreased plant growth. |
| ***Brownfield*** | Abandoned industrial sites. |
| ***Keystone Species*** | Species whose role in an ecosystem is more important than others. |
| ***Indicator Species*** | species that serve as early warnings that an ecosystem is being damaged |

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| ***Pesticide*** | Pros: saves lives from insect transmitted disease, increases food supply, and increases profits for farmers. Cons: genetic resistance, ecosystem imbalance, pesticide treadmill, persistence, bioaccumulation, and biological magnification. |
| ***Natural Pest Control*** | Better agricultural practices, genetically resistant plants, natural enemies, and biopesticides, sex attractants. |
| ***Genetically Modified Organisms*** | New organisms created by altering the genetic material (DNA) of existing organisms; usually in an attempt to remove undesirable or create desirable characteristics in the new organism. |
| ***Petroleum (Crude Oil) Formation*** | Microscopic aquatic organisms in sediments converted by heat & pressure into a mixture of hydrocarbons. Pros: cheap, easily transported, high-quality energy. Cons: reserves depleted soon, pollution during drilling, transport and refining, land subsidence, burning oil produces CO2. |
| ***Coal Formation*** | Prehistoric plants buried un-decomposed in oxygen-depleted water of swamps/bogs converted by heat and pressure. *Ranks of Coal*: peat, lignite, bituminous coal, anthracite coal |
| ***Nuclear Reactor*** | consists of a core, control rods, moderator, steam generator, turbine, containment building |

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| ***Remediation*** | return a contaminated area to its original state |
| ***LD-50*:** | the amount of a chemical that kills 50% of the animals in a test population |
|  ***Inversion Layer (Temperature Inversion)*:** | warm layer of air above a cooler layer traps pollutants close to the Earth’s surface |
| ***Mutagen*** | substances that cause changes in DNA; may result in hereditary changes |
| ***Teratogen*:** | Substances that cause fetus deformities (birth defects). |
| ***PCBs (Polychlorinated Biphenyls)*:** | Stable, long-lived, carcinogenic chlorinated hydrocarbons. Produced by the electronics industry. |

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| ***Divergent Plate Boundaries*** | Tectonic plates spreading apart, new crust being formed (ex. mid-ocean ridges, rift valleys). |
| ***Convergent Plate Boundaries*** | Tectonic plates with the oldest crustal material on Earth moving together, one moving under another (ex. mid-ocean trenches). Mineral deposits and volcanoes are most abundant at convergent plate boundaries |
| ***Transform Fault*** | Plates sliding past one another (ex. San Andreas fault). |
| ***Biome*** | large distinct terrestrial region having similar climate, soil, plants & animals |
| ***Tropical Rain Forests*:** | Characterized by the greatest diversity of species, believed to include many undiscovered species. Occur near the equator. Soils tend to be low in nutrients. Distinct seasonality: winter is absent, and only two seasons are present (rainy and dry). |
| ***Temperate Forest*:** | Occur in eastern North America, Japan, northeastern Asia, and western and central Europe. Dominated by tall deciduous trees. Well-defined seasons include a distinct winter. Logged extensively, only scattered remnants of original temperate forests remain. |

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| ***Boreal Forests or Taiga*** | Represent the largest terrestrial biome. Dominated by needleleaf, coniferous trees. Found in the cold climates of Eurasia and North America: two-thirds in Siberia with the rest in Scandinavia, Alaska, and Canada. Seasons are divided into short, moist, and moderately warm summers and long, cold, and dry winters. Extensive logging may soon cause their disappearance |
| ***Temperate Shrub Land/ Chaparral*** | Occurs along the coast of Southern California and the Mediterranean region. Characterized by areas of Chaparral–miniature woodlands dominated by dense stands of shrubs |
| ***Savannas*:** | Grassland with scattered individual trees. Cover almost half the surface of Africa and large areas of Australia, South America, and India. Warm or hot climates where the annual rainfall is 20-50 inches per year. The rainfall is concentrated in six or eight months of the year, followed by a long period of drought when fires can occur. |
| ***Temperate Grasslands*** | Dominated by grasses, trees and large shrubs are absent. Temperatures vary more from summer to winter, and the amount of rainfall is less than in savannas. Temperate grasslands have hot summers and cold winters. Occur in South Africa, Hungary, and Argentina, the steppes of the former Soviet Union, and the plains and prairies of central North America. |
| ***Deserts*** | About one fifth of the Earth’s surface and occur where rainfall is less than 50 cm/year. Most deserts occur at low latitudes, have a considerable amount of specialized vegetation, as well as specialized animals. Soils have abundant nutrients, need only water to become productive, and have little or no organic matter. Common disturbances include occasional fires or cold weather, and sudden, infrequent, but intense rains that cause flooding. |
| ***Tundra*** | Treeless plains that are the coldest of all the biomes. Occur in the arctic and Antarctica. Dominated by lichens, mosses, sedges, and dwarfed shrubs Characterized by extremely cold climate, permanently frozen ground (permafrost) low biotic diversity, simple vegetation structure, limitation of drainage, short season of growth and reproduction. |

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| ***Wetlands*** | Areas of standing water wet all or most of the year that support aquatic plants including marshes, swamps, and bogs. Species diversity is very high. Includes bogs, swamps, sloughs, marshes |
| ***Fresh Water*:** | Defined as having a low salt concentration (less than 1%). Plants and animals are adjusted to the low salt content and would not be able to survive in areas of high salt concentration (i.e., ocean). There are different types of freshwater regions: ponds and lakes, streams and rivers, and estuaries. |
| ***Oceans*** | The largest of all the ecosystems. The ocean regions are separated into separate zones: intertidal, pelagic, abyssal, and benthic. All four zones have a great diversity of species |
| ***Chernobyl, Ukraine*** | April 26, 1986, unauthorized safety test (irony), leads to fire and explosion at nuclear power plant—millions exposed to unsafe levels of radiation. |
| ***Three-Mile Island, Pennsylvania*:** | March 29, 1979, nuclear power plant loses cooling water 50% of core melts, radioactive materials escape into atmosphere, near meltdown (disaster). |
| ***Yucca Mountain, Nevada*** | Controversial as proposed site for permanent storage of high-level nuclear waste, 70-miles northwest of Las Vegas, near volcano and earthquake faults. |

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| ***Love Canal, NY*** | Chemicals buried in old canal, school and homes built over it led to birth defects and cancers. |
| ***Three Gorges Dam, China*** | World’s largest dam on Yangtze River will drown ecosystems, cities, archeological sites, fragment habitats, and displace 2 million people. |
| ***Ogallala Aquifer*** | world’s largest aquifer; under parts of Wyoming, South Dakota, Nebraska, Kansas, Colorado, Oklahoma, New Mexico, and Texas (the Midwest). Holds enough water to cover the U.S. with 1.5 feet of water. Being depleted for agricultural and urban use |
| ***Safe Drinking Water Act*** | set maximum contaminant levels for pollutants that may have adverse effects on human health |
| ***Ocean Dumping Ban Act*** | Bans ocean dumping of sewage sludge & industrial waste. |
| ***Clean Water Act*** | Set maximum permissible amounts of water pollutants that can be discharged into waterways. Aim: to make surface waters swimmable and fishable |

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| ***Surface Mining Control & Reclamation Act*** | Requires coal strip mines to reclaim the land. |
| ***National Environmental Policy Act (NEPA)*:** | Environmental Impact Statements must be done before any project affecting federal lands can be started. |
| ***Clean Air Act*:** | Set emission standards for cars, and limits for release of air pollutants |
| ***Kyoto Protocol*** | Controlling global warming by setting greenhouse gas emissions targets for developed countries. |
| ***Montreal Protocol*** | Phase out of ozone depleting substances. |
| ***Resource Conservation & Recovery Act (RCRA)*:** | controls hazardous waste with a cradle to grave system |

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| ***Comprehensive Environmental Response, Compensation & Liability Act (CERCLA)*:** | The “Superfund” act, designed to identify and clean up abandoned hazardous waste dumpsites. |
| ***Endangered Species Act*** | Identifies threatened and endangered species in the US, and puts their protection ahead of economic considerations. |
| ***Convention on International Trade in Endangered Species*: (CITES)** | lists species that cannot be commercially traded as live specimens or wildlife products |
| ***U.S. Marine Mammal Protection Act*** | prohibits taking marine mammals in U.S. waters and by U.S. citizens, and the importing marine mammals and marine mammal products into the U.S. |
| ***Rachel Carson*** | Published *Silent Spring* in 1962; documented the environmental damage done by DDT and other pesticides. Which heightened public awareness at the start of the modern environmental movement. |
| ***Garrett Hardin*:** | published “The Tragedy of the Commons” in the journal *Science* in 1968; argued that rational people will exploit shared resources (commons) |

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| **Largest reservoirs of C** | carbonate (CO3)2- rocks first, oceans second |
| **The Tragedy of the Commons** | (1968 paper by ecologist Garret Hardin) “Freedom to breed” is bringing ruin to all.Global commons such as atmosphere & oceans are used by all and owned by none. When no individual hasOwnership, no one takes responsibility. Examples: overfishing in the oceans, over pumping of the Ogallala Aquifer |
| **Positive feedback** | when a change in some condition triggers a response that intensifies the changing condition (warmerEarth - snow melts - less sunlight is reflected & more is absorbed, therefore warmer Earth) |
| **Negative feedback** | when a changing in some condition triggers a response that counteracts the changed condition(warmer Earth - more ocean evaporation - more stratus clouds - less sunlight reaches the ground - therefore cooler Earth) |
| **Electricity generated by fossil fuels, biomass or nuclear power:** | heat is produced which creates steam \_ steam turns a turbine \_ the mechanical energy from the turbine is converted to electrical energy in a generator and that energy is transmitted to homes through power lines. |
| **Best solutions to energy shortage** | conservation, increase efficiency, explore alternative energy options |

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| **Fecal coliform/*Enterococcus* bacteria** | indicator of sewage contamination ; found in the intestines of all warm bloodedmammals (coliform bacteria) |
| **Soil Profile, horizons in order** | O – A – E – B – C –R |
| **Threshold dose** | the maximum dose that has no measurable effect on a given population |
| **Stockholm Convention on Persistent Organic Pollutants:** | (2004) Seeks to protect human health from the 12 most toxic chemicals (includes 8 chlorinated hydrocarbon pesticides / DDT can be used for malaria control) |