APES REVIEW
118 WAYS TO GO APE

PUT THESE FACTS ON INDEX CARDS. Main term on one side – definition or concept on the other

1. Ionizing radiation: enough energy to knock electrons from atoms forming ions, capable of causing cancer (gamma-Xrays-UV)
2. High Quality Energy: organized & concentrated, can perform useful work (fossil fuel & nuclear)
3. Low Quality Energy: disorganized, dispersed (heat in ocean or air wind, solar)
4. First Law of Thermodynamics: energy is neither created nor destroyed, but may be converted from one form to another
5. 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) - entropy
6. Thermal gradient – spontaneous flow of heat from warmer to cooler bodies
7. Natural radioactive decay: unstable radioisotopes decay releasing gamma rays, alpha & beta particles
8. Half life: the time it takes for ½ the mass of a radioisotope to decay
9. Estimate of how long a radioactive isotope must be stored until it decays to a safe level: approximately 10 half-lives
10. Nuclear Fission: nuclei of isotopes split apart when struck by neutrons
11. Nuclear Fusion: 2 isotopes of light elements (H) forced together at high temperatures till they fuse to form a heavier nucleus. Expensive, break even point not reached yet
12. Mass deficit – not all matter is converted into matter in a fusion reaction – some (the mass deficit) is converted into energy. $E = mc^2$
13. Ore: a rock that contains a large enough concentration of a mineral making it profitable to mine
14. Organic fertilizer: slow acting & long lasting because the organic remains need time to be decomposed
15. Best solution to Energy crisis: conservation and increase efficiency
16. Surface mining: cheaper & can remove more mineral, less hazardous to workers
17. Humus: organic, dark material remaining after decomposition by microorganisms
18. **Soil Profile** → O- A- E- B- C
19. Leaching: removal of dissolved materials from soil by water moving downwards
20. Illuviation: deposit of leached material in lower soil layers (B)
21. Loam: perfect agricultural soil with portions of sand, silt, clay
22. Conservation: allows the use of resources in a responsible manner (see file# 10)
    Preservation: setting aside areas & protecting them from human activities
23. Parts of the hydrologic cycle: evaporation, transpiration, runoff, condensation, precipitation, infiltration
24. Aquifer: any water bearing layer in the ground (confined or artesian and unconfined or water table)
25. Cone of depression: lowering of the water table around a pumping well
26. Salt water intrusion: near the coast, overpumping of groundwater causes saltwater to move into the aquifer
27. Subsidence – land sinks as result of over pumping the aquifer
28. ENSO: El Nino Southern Oscillation, see-sawing of air pressure over the S. Pacific
29. During an El Nino year: trade winds weaken & warm water sloshed back to SA
    During a Non El Nino 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
30. Effects of El Nino: upwelling decreases disrupting food chains, N US has mild winters, SW US has increased rainfall, less Atlantic Hurricanes
31. Nitrogen fixing: because atmospheric N cannot be used directly by plants it must first be converted into ammonia by bacteria (rhizobium or cyanobacteria)
32. Ammonification: nitrogen is converted into ammonia by ammonifying bacteria; may occur when nitrogen in organic wastes in the soil are converted to ammonia
33. Nitrification: ammonia is converted to nitrate ions (NO-3)
34. Assimilation: inorganic N is converted into organic molecules such as DNA/amino acids & proteins - plants assimilate nitrogen as NH_4^+ or NO_3^- through their roots; animals (herbivores) assimilate organic nitrogen compounds by eating plants
35. Denitrification: bacteria convert ammonia back into N_2 or N_2O – typically accomplished by anaerobic bacteria
36. Phosphorus does not circulate as easily as N because: it does not exist as a gas, but is released by weathering of phosphate rocks - this is a SEDIMENTARY cycle – it is never found as a gas
37. Sustainability: the ability to meet humanities current needs without compromising the ability of future generations to meet their needs
38. Excess phosphorus is added to aquatic ecosystems by: runoff of animal wastes, fertilizer, discharge of sewage ; limiting factor in freshwater ecosystems; excess P leads to eutrophication
39. Photosynthesis: plants convert atmospheric C (CO_2) into complex carbohydrates (glucose $C_6H_{12}O_6$) ; energy is consumed and oxygen is released as a waste product
40. Aerobic respiration: oxygen consuming producers, consumers & decomposers break down complex organic compounds & convert C-containing carbohydrates back into CO_2 ; energy is released and oxygen is consumed in the process
41. Anaerobic Respiration – break down of carbohydrates without oxygen – products into methane (CH_4), alcohols and other organics
42. Largest reservoirs of C: carbonate rocks first, oceans second
43. Biotic/abiotic: living & nonliving components of an ecosystem
44. Producer/Autotroph: photosynthetic organisms; base for any food chain or web. Chemautroph – chemosynthesis – usually carried

out by sulfur bacteria in aphotic zones in the ocean (deep ocean vents for ex.)
45. **Fecal coliform/Enterococcus**: : indicator of sewage contamination; found in the intestines of all warm blooded mammals
46. Energy flow in food webs (or chains ; through trophic systems): only 10% of the usable energy is transferred because usable energy lost as heat (2nd law) and through respiration, not all biomass is digested & absorbed, predators expend energy to catch prey; the 10% value is an average value
47. Chlorine: (good→disinfection of water)(bad→forms trihalomethanes when organics ar present in the water) Many systems now use chloramines to treat waste water before it is discharged. Alternatives to chlorine disinfection – ozone or UV light.
48. Primary succession: development of communities in a lifeless area not previously inhabited by life (lava); no soil substrate.
49. Secondary succession: life progresses where soil remains (clear cut forest, fire) ; disturbed areas
50. Cogeneration: using waste heat to make electricity; two outcomes with one energy resource
51. Mutualism: symbiotic relationship where both partners benefit and both participate
52. Commensalism: symbiotic relationship where one partner benefits & the other is unaffected or may benefit
53. Parasitism: relationship in which one partner obtains nutrients at the expense of the host
54. Competition – a type of population interaction, usually over a limited resource – may be intraspecific or interspecific
55. Biome: large distinct terrestrial region having similar climate, soil, plants & animals ; Terrestrial biomes determining factors → temperature and precipitation
56. Carrying capacity: the number of individuals (size of the population) that can be sustained in an area (supported by available resources in the environment)
57. R strategist: reproduce early, many small unprotected offspring, tend to be generalists, short lifespan
K strategist: reproduce late, few offspring, care for offspring, tend to be specialists (also see file #10)
58. Positive feedback: when a change in some condition triggers a response that intensifies the changing condition (EX: warmer Earth - snow melts - less sunlight is reflected & more is absorbed, therefore warmer earth)
59. Natural selection: organisms that possess favorable adaptations survive and pass those traits onto the next generation
60. **Malthus**: said human population increases exponentially, while food supplies increase arithmetically. Factors that keep the population in check include war, famine & disease
61. **Doubling time**: rule of 70 70 divided by the percent growth rate = the doubling time
62. Replacement level fertility: the number of children a couple must have to replace themselves (2.1 developed, 2.7 developing) ; biotic potential; total fertility rate
63. World Population (2009) is about 6.7 billion people
US Population (2009): ~300 million
64. Preindustrial stage: birth & death rates high, population grows slowly, infant mortality high
65. Transitional stage: death rate lower, better health care, population grows fast
66. Industrial stage: decline in birth rate, population growth slows
67. Postindustrial stage: low birth & death rates
68. Age structure diagrams: (broad base, rapid growth)(narrow base, negative growth)(uniform shape, zero growth) ; Major Age Cohorts → Pre-reproductives, reproductives, post-reproductives
69. 1st & 2nd most populated countries: China & India
70. Most important thing affecting population growth: low status of women
71. Ways to decrease birth rate: family planning, contraception, economic rewards & penalties
72. Percent water on earth by type: 97.5% seawater, 2.5% freshwater
73. Salinazation of soil: in arid regions, water evaporates leaving salts behind
74. Ways to conserve water: (agriculture, drip/trickle irrigation)(industry ,recycling)(home, use gray water, repair leaks, low flow fixtures), reclaimed water for agriculture, golf courses
75. Point vs non point sources: (Point, from specific location such as pipe)(Non-point, from over an area such as runoff)
76. BOD: biological oxygen demand, amount of dissolved oxygen needed by aerobic decomposers to break down organic materials
77. Eutrophication: may result in rapid algal growth or plant growth → caused by an excess of N & P
78. Hypoxia: May occur when aquatic plants die, the BOD rises as aerobic decomposers break down the plants, the DO drops & the water cannot support life; very low DO levels; Dead zone in the Gulf of Mexico
79. Anoxic – no DO
80. Minamata Bay Disease: physical and mental impairments, death, caused by mercury (caused by methyl mercury)
81. Primary air pollutants: produced by humans & nature (CO, CO_2, SO_2, NO, hydrocarbons, particulates); 82 Secondary Air Pollutants → produced as a result of reactions that primary air pollutants undergo (Include photochemical pollutants O_3, PAN and NO_2 and acids such as H_2SO_4 and HNO_3.)
83. Negative feedback: when a changing in some condition triggers a response that counteracts the changed condition (EX: warmer earth - more ocean evaporation - more stratus clouds - less sunlight reaches the ground - therefore cooler Earth)
84. Particulate matter (source, effect, reduction): (burning fossil fuels & diesel exhaust) (reduces visibility & respiratory irritation) (filtering, electrostatic precipitators, alternative energy)
85. Nitrogen Oxides (NO_x): Sources: transportation (exhaust) ~50%, industry - ~50% . Effects: acidification of lakes, respiratory irritation, leads to photochemical SMOG. Equation for acid formation: $NO + O_2 = NO_2 + H_2O = HNO_3$. Reduction: selective catalytic reduction unit, more efficient combustion processes like FBC, lower combustion temperatures, find alternatives to fossil fuels.
86. Sulfur oxides (SO_x): (Source: coal burning) (Effects: acid deposition, respiratory irritation, damages plants) (Equation for acid formation: SO2 + O2 = SO3 + H2O = H2SO4) (Reduction: scrubbers, burn low sulfur fuel)

87. Carbon oxides: (Source: auto exhaust, incomplete combustion) (Effects: CO binds to hemoglobin reducing bloods ability to carry O, CO_2 contributes to global warming) (Reduction: catalytic converter, emission testing, oxygenated fuel, mass transit, increase efficiencies, find alternatives to fossil fuels)
88. Ozone: (Formation: secondary pollutant, NO_2+UV=NO+O O+O_2=O3, with VOC's) (Effects: respiratory irritant, plant damage,) (Reduction: reduce NO_x emissions & VOCs) Tropospheric ozone is BAD
89. Radon: radioactive gas, formed from the decay of Uranium, causes lung cancer and is a problem in the Reading Prong. Radon decays to Polonium, which is a solid. Po particles sit in lung tissue and are alpha emitters. This leads to lung cancer.
90. Photochemical smog: formed by chemical reactions involving sunlight (NO, VOC,O) ; associated with automobile traffic
91. Acid deposition: caused by sulfuric and nitric acids resulting in lowered pH of surface waters, soil acidification and destruction of building materials
92. Greenhouse gases: (Examples: H_2O, CO_2, O_3, methane (CH_4), CFC's) (EFFECT: they trap outgoing infrared (heat) energy causing earth to warm. Greenhouse Effect has allowed the Earth to remain at ~ 15.5°C. **INCREASED** concentrations of greenhouse gases have resulted in warmer temperatures -- climate change
93. Effects of global warming: rising sea level (thermal expansion), extreme weather, droughts (famine), extinctions, environmental refuges, etc
94. Stratospheric Ozone depletion: caused by Ozone Depleting Chemicals (ODCs) - CFC's, methyl chloroform, carbon tetrachloride, halon, methyl bromide all of which attack stratospheric ozone ; the Cl or Br atoms "attack" the ozone molecules and cause the thinning of this layer (see class notes for reaction mechanism). Global Agreement to decrease ODC -- Montreal Protocol (1987)
95. Effects of ozone depletion: increased UV light that results in skin cancer, cataracts, decreased plant growth (inhibits photosynthesis, decline in Antarctic and Arctic phytoplankton population, impaired immune systems
96. Love Canal, NY: chemicals buried in old canal and school & homes built over it causing birth defects & cancer
97. Municpal solid waste is mostly: paper and most is landfilled
98. True cost / External costs: harmful environmental side effects that are not reflected in a products price
99. Sanitary landfill problems and solutions: (leachate, liner-with collection system) (methane gas, collect gas and burn) (volume of garbage, compact & reduce)
100. Incineration advantages: volume of waste reduced by 90% & waste heat can be used
101. Incineration disadvantages: toxic emissions (polyvinyl chloride---dioxin), scrubbers & electrostatic precipitators needed, ash disposal (contains heavy metals)
102. Best way to solve waste problem: reduce the amounts of waste at the source, ie, source reduction
103. Keystone species: species whose role in an ecosystem are more important than others, ex sea otter
104. Indicator species: species that serve as early warnings that an ecosystem is being damaged ex trout
105. Most endangered species: have a small range, require large territory or live on an island
97. In natural ecosystems, 50-90% of pest species are kept under control by: predators, diseases, parasites
106. Major pesticide groups and examples: (chlorinated hydrocarbons, DDT) (organophosphates, malathion) (carbamates, aldicarb)
107. Pesticide pros: saves lives from insect transmitted disease, increases food supply, increases profits for farmers
108. Pesticide cons: genetic resistance, ecosystem imbalance, pesticide treadmill, persistence, bioaccumulation, biological magnification
109. Natural pest control: better agricultural practices, genetically resistant plants, natural enemies, biopesticides, sex attractants
110. 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.
111. Hydroelectric power – potential energy of stored water is used to turn 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.
112. Petroleum forms from: microscopic aquatic organisms in sediments converted by heat & pressure into a mixture of hydrocarbons (animal remains)
113. Pros of petroleum: cheap, easily transported, high quality energy
114. Cons of petroleum: reserves depleted soon, pollution during drilling, transport and refining, burning makes CO_2
115. Steps in coal formation: peat, lignite, bituminous, anthracite (from plants)
116. Major parts of a nuclear reactor: core, control rods, steam generator, turbine, containment building
117. Two most serious nuclear accidents: (Chernobyl,Ukraine 1986) (Three Mile Island, PA 1979)
118. Alternate energy sources: wind, solar, waves, biomass, geothermal, fuel cells
119. LD50: the amount of a chemical that kills 50% of the in a test population within 14 days of the dose
120. Hazardous Waste (as defined by RCRA) - Mutagen, Teratogen, Carcinogen: causes hereditary changes, Fetus deformities, cancer
121. Endangered species: North spotted Owl (loss of old growth forest), Bald Eagle (thinning of eggs caused by DDT), Piping Plover (nesting areas threatened by development)
122. Exotic species: gypsy moth, Asian Long Horned Beetle
123. Garret Hardin & The Tragedy of the Commons: 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 has ownership – no one takes responsibility. Ex. Overfishing in the oceans, over pumping of the Ogallala Aquifer

124. Volcanoes and Earthquakes occur: at plate boundaries (divergent, spreading, mid-ocean ridges) (convergent, trenches) (transform, sliding, San Andreas)

125. Sources of mercury: burning coal in power plants (25% of atmospheric deposition), Compact Fluorescent bulbs
126. Major source of sulfur: coal burning power plants
127. Threshold dose: the maximum dose that has no measurable effect

LAWS, LAWS & MORE LAWS

MINING

1. Surface Mining Control & Reclamation Act: requires coal strip mines to reclaim the land
2. Madrid Protocol: Moratorium on mineral exploration for 50 years in Antarctica

WATER

3. Safe Drinking Water Act: set maximum contaminant levels for pollutants in drinking water that may have adverse effects on human health
4. Clean Water Act: set maximum permissible amounts of water pollutants that can be discharged into waterways..aim to make surface waters swimmable and fishable
5. Ocean Dumping Ban Act: bans ocean dumping of sewage sludge & industrial waste in the ocean

AIR

6. Clean Air Act: Set emission standards for cars, and limits for release of air pollutants
7. Kyoto Protocol: controlling global warming by setting greenhouse gas emissions targets for developed countries
8. Montreal Protocol: phase out of ozone depleting substances

WASTE – Solid and Hazardous

9. Resource Conservation & Recovery Act: controls hazardous waste with a cradle to grave system
10. Comprehensive Environmental Response, Compensation & Liability Act: Superfund, designed to identify and clean up abandoned hazardous waste dump sites
11. Nuclear Waste Policy Act: US government must develop a high level nuclear waste site (Yucca Mtn)
12. Food Quality Protection Act: set pesticide limits in food, & all active and inactive ingredients must be screened for estrogenic/endocrine effects

SPECIES

13. Endangered Species Act: identifies threatened and endangered species in the US, and puts their protection ahead of economic considerations
14. Convention on International Trade in Endangered Species: lists species that cannot be commercially traded as live specimens or wildlife products
15. Magnuson- Stevens Act: Management of marine fisheries
16. Healthy Forest Initiative

GENERAL

17. National Environmental Policy Act: Environmental Impact Statements must be done before any project affecting federal lands can be started
18. Stockholm Convention on Persistent Organic Pollutants: Seeks to protect human health from the 12 most toxic chemicals (includes 8 chlorinated hydrocarbon pesticides / DDT can be used for malaria control) (Dirty Dozen)

Preparing for FRQ's

Assembled by J. Rodewald, Shaker High School, Latham NY.

General rules

- What are the requirements for the question – list, describe, cause and effect...
- If it asks anything besides identify, you should write at least two sentences. One stating your clear, specific answer and the second providing supporting evidence, examples or a detailed description.
- Know the difference between environmental, social, political and economic effects.
- How many examples are requested? If the question asks for two, only the first two will be graded
- If you are not sure about the meaning of a word in the question, figure out what it means by pulling apart the syllables (anthropogenic – anthro (man) genic (origin or made) is man-made)
- Start each question with whether it is A, B, C,... and leave a two to three line break between each section so you can come back later to add additional information
- Do not rewrite the question; it is a waste of time for you and the reader
- If you find yourself writing something vague, follow it up with a specific example. (Name a specific chemical that will cause the pollution and explain its impacts, name a specific specie or type of specie that would be impacted and explain how, name a specific law or specific possible law that will illustrate whatever you are talking about, etc.)
- If a fourth grader could say it, it is too vague.
- Be careful with absolutes, will it really kill all the animals? Will the entire ecosystem be harmed?
- Often wrong but never in doubt: even if you are making it up, make it sound good and confident. (Be specific. You might be right, but you will not get any credit if you are not specific enough. No "maybe" or "might" unless there is actual scientific uncertainty.)

Basic rules for a non-math question

- Make sure the answers are legible
- Always use complete sentences.
- Each answer should be organized, comprehensive, and in prose form; outline form is not acceptable.
- Drawings are acceptable only if there is a written explanation
- No eco-babble, flowery, or vague phrases

If the question is math-based

- Even if you can do the math in your head, show each step !
- Include units in each step to insure it is correct and in the answer
- Does the answer make sense? A monthly light bill for a family should not be in the trillions of dollars.

There are several strategies you can use to help boost your score on the Free Response section of the AP Environmental Science exam. One of those strategies is to avoid the use of vague and "flowery" terms and phrases. These terms and phrases may sound descriptive, but they frequently say little and provide none of the detail needed to earn credit. To avoid them you should try to explain yourself as best as possible using more detail.

The following is a listing of these terms and phrases to try to avoid:

1. "bad for the environment / planet"
2. "cause environmental degradation"
3. "cause global warming and pollution"
4. "change" (Instead of specifying increase or decrease.)
5. "destroy the environment"
6. "disrupt the environment"
7. "disturb the environment"
8. "ecofriendly"
9. "good for the environment"
10. "greener"
11. "global solution"
12. "global catastrophe"
13. "global cooperation"
19. "incentivize the system"
20. "kill all the plants/animals/wildlife"
21. "make it illegal" or "the water law" or "the air law" (Without identifying relevant laws.)
22. "make it more / less expensive" (When referring to incentives.)
23. "mother nature "
24. "overconsumption of natural resources"
25. "pollute the environment"
26. "pollute the water / air / soil" (Without specifying.)
27. "restore the environment"
28. "repair the damage"
29. "save the Earth"
30. "save the planet"
31. "stop global warming"

14. "harm the environment"
15. "harmful / dangerous chemicals" (Without specifying.)
16. "help keep the habitat cleaner"
17. "human footprint"
18. "human impact"
32. "sustainable" (Without elaboration.)
33. "toxins", "pollution", "chemicals" & "health effects" (Without specifying.)
34. "_____ the habitat" (impact, change, alter) (need to include specifics)
35. "_____ the ecology" (destroy, restore, maintain, support, harm, compromise, reinvent...)
36. Circle of life

Flowery & Vague Phrases to avoid on the AP Environmental Exam

Putting this list into action:
Weak: "Acid deposition hurts forests."
Strong: "Acid deposition can hurt forests in several ways. One way is by reducing the topsoil's ability to retain vital nutrients such as calcium, magnesium and potassium which are needed by trees."

Weak: "Runoff from farms can reduce water quality and harm the environment."
Strong: "Runoff from farms can reduce surface water quality by introducing nutrients such as nitrates and phosphates. These compounds promote algae growth which can reduce water clarity. Further, when the algae die their decomposition by aerobic bacteria can also reduce dissolved oxygen levels."

Weak: "The pollution from coal power plants causes a lot of environmental degradation."
Strong: "The air pollution from coal power plants includes nitrogen oxides, sulfur oxides and mercury which have been linked to several environmental problems including acid deposition and mercury contamination of surface water."

Weak: "Garbage incinerators cause a lot of air pollution."
Strong: "Garbage incinerators generate a variety of different air pollutants including carbon dioxide (CO2), dioxin, particulate matter (PM), heavy metals and sulfur oxides."

Now its your turn:
1. Take this weak statement: "High levels of poverty are bad for the planet."
And make it stronger:

2. Take this weak statement: "Mercury contamination in food can hurt children."
And make it stronger:

3. Take this weak statement: "Automobiles make a lot of air pollution which can disrupt the environment."
And make it stronger:

Scientific Method
1) Observation
2) Question
3) Hypothesis
4) Test Hypothesis
5) Experiment
6) Results
7) Conclusion
(Repeat steps 4-7 as need)

Critical Thinking
1) Gather information
2) Understand definitions/concepts
3) Question how data obtained
4) Question conclusions from data
5) Determine assumptions/biases
6) Frontier or Consensus science?
7) Reject or conditionally accept claims

Frontier vs. Consensus Science
Hypothesis: tentative explanation for observations
Theory: verified, reliable, accepted explanation of data & laws
Law: what's happening in nature
Inductive Reasoning: observations/measurements used for general hypothesis/conclusion (bottom-up)
Deductive Reasoning: logic used for specific conclusion based on premise (top-down)
Positive Feedback Loop: change in direction causes further change in same direction
Negative Feedback Loop: change leads to lessening of that change
Threshold Level: where fundamental shift in behavior occurs after time delays
Synergistic Interaction: combined effect greater than sum of individual parts
Convection: (gas/liquid) movement transfer
Conduction: (touch) collision transfer
Radiation: (light) wave transfer
Half-life: time needed for ½ of nuclei to decay
Fission: splitting atoms (nuclear power, bombs)
Fusion: combining atoms (bombs)

Ionizing Radiation Penetration
1) Alpha (6 in. air)
2) Beta (10 ft. air)
3) Gamma (miles air)

Ionizing Radiation Damage
1) Somatic (tissue damage)
2) Genetic (DNA changes)

Matter and Energy Quality
High (concentrated, near surface, great potential use—industrial processes)
Low (dilute, deep underground or dispersed, little potential use—space heater)
Material Efficiency/Resource Productivity (total material/energy needed to produce each good/service)

Pollutant Harmful Effects
1) Chemical nature
2) Concentration
3) Persistence (Degradable or biodegradable, slowly degradable, nondegradable)

Hydrocarbons (C, H)
Chlorinated hydrocarbons (C, H, O)
CFCs (Cl, F, C, H)
Simple carbohydrates (C, H, O)
Polymers (from monomers—complex carbohydrates, proteins, nucleic acids)

Easter Island
Isolated (resources)
Unsustainable Population Growth

Chemistry Review

Elements (pure) vs. compounds (2 or more elements with bond(s))
Mixtures (homogeneous—solutions, alloys—vs. heterogeneous—everything else not pure)
Atoms (building blocks) vs. molecules (bond atoms with bond) vs. ions (charge present)
Protons and Neutrons (in nucleus), Electrons (outside nucleus)
Atomic number = Protons = Electrons except ions (charge = protons – electrons)
Mass number = protons + neutrons Isotopes (same element, different # neutrons)
Ionic bonds (transfer or give/take electrons) Covalent bonds (share electrons)
Hydrogen bonds (N, O, or F with H)
Four phases (solid, liquid, gas, plasma) Temperature is molecular speed
Electromagnetic Spectrum (from shortest wavelength/high energy to longest wavelength/low energy)
Cosmic rays, Gamma rays, X rays, Far UV waves, Near UV waves, Visible waves,
Near IR waves, Far IR waves, Microwaves, TV waves, Radio waves

Wind: regulates global temperatures, transports nutrients; transports harmful pesticides, toxic metals, viruses, bacteria, fungi (coral reef killer),algae (red tides)
weather: short-term properties (temperature, pressure, humidity, precipitation, sunshine, cloud cover, wind direction/speed) troposphere at particular place/time
climate: general weather over long-term (average temperature/precipitation)
microclimate: local climatic conditions resulting from topographic features of Earth (sea/land breezes, cities)
rain shadow effect: moist ocean air hits mountains produces rain/snow on windward side, dry conditions on other

front: boundary between 2 air masses with different temperatures/densities.
warm front: advancing warm air (rising) replaces cool air (clouds, drizzle)
cold front: advancing cold air (ground) replaces warm air (thunderstorms, then cool clear skies)
high: cool dense air falls toward ground warming (fair) low: warm air spirals down as it cools, center rises (rain)
tornadoes: form over land tropical cyclones: form over ocean waters (Pacific—typhoon, Atlantic—hurricane)
storm benefits: flush excess nutrients/rotting vegetation, carve channels for fresh seawater (reduce brown tides, increase growth sea grasses, increase production seafood)
air circulation: uneven surface heating (equator hot, temperate warm, polar cold), seasonal variations (tilted axis), rotation on axis (6 air convection cells), long-term variations solar input (wobbles—axis, 22000 years; tilt, 44000 years), air/water properties (convection cells)
ocean currents: clockwise south, counterclockwise north air currents: E.0-30-0, W.60-30-60, E.60-90-60
upwellings: Ekman spiral—surface water pushed at right angles from wind flow away from land replaced by cold nutrient-rich bottom water (support phytoplankton, zooplankton, fish, seabirds)

El Nino-Southern Oscillation: 1) prevailing westerly winds weaken, 2) surface water along N. and S. American coasts becomes warmer, 3) upwellings suppressed causing sharp decline in some fish species; causes major weather changes that can impact an area for several years, 4) E. to W. currents slow and sometimes reverse to W. to E.
La Nina: cooling counterpart to El Nino; More hurricanes, colder winters in Canada/N.E., warmer/drier winters in S.E and S.W., wetter winters in Pacific N.W., torrential rains in S.E. Asia, lower wheat yields Argentina, more wildfires Florida
Greenhouse Effect: ~~UV converted to~~ IR (heat) by H_2O, CO_2, CH_4, N_2O, and CFCs; natural effect enhanced by Humans—alters precipitation patterns, shifts crop areas, raises average sea levels, shifts habitats
Ozone Layer: ~~$3O_2 + UV \rightarrow 2O_3$~~; prevents 95% harmful UV, creates thermal cap (preventing heat loss to stratosphere); being destroyed by human air pollution such as CFCs that react w/ O_3

biomes: not uniform, different local climate/vegetation, varied latitude/altitude; 4 categories & 3 sub-categories for each (desert, grassland, forest, mountain—tropical, temperate, cold)
ecotones: non-distinct boundaries between biomes
Desert: Tropical (*Sahara*—little rain, high temperatures), Temperate Desert (*Mojave*—low rain, hot summers, cold winters), Cold Desert (*Gobi*—same as temperate)
survival strategies: no trees/tall plants, succulent (fleshy) plants, open pores at night, store water, waxy-coated or no leaves, deep or widely spread roots, dormant or drop leaves in dry periods, store biomass in seeds—*saguaro cactus, mesquite/creosote plants, mosses/lichens*; animals small, hide in day, adaptations to conserve water, eat food for water, become dormant in drought—*reptiles, insects, spiders, insects, mice*
Semidesert: between desert and grassland (thorn trees and shrubs—long dry spells/brief heavy rains)
Grasslands: Tropical (*savanna*—moderate rain, high average temperatures), Temperate (*N. American prairies, S. American pampas, African veldt, C. Europe/Asia steppes*—sparse rain, hot summers, cold winters), Polar (*arctic tundra*— bitter cold, frigid winds, covered with ice/snow/permafrost)
survival strategies: seasonal drought/grazing by large herbivores, occasional fires keep competition from large trees down, thick-spongy-low growing plants conserve heat—*grasses, mosses, dwarf woody shrubs*; grazing/browsing herbivores minimize competition for food with adapted eating habits—*giraffes, elephants, gazelles/wildebeests, zebras, waterfowl, caribou, lemmings, hares, voles, ground squirrels*—and herbivores are food for predators that adapt thick fur coats, feathers, compact bodies, or live underground—*cheetahs, lions, hyenas, eagles, hawks, arctic fox, lynx, weasel, snowy owl*

Alpine Tundra: like arctic tundra, but above treeline, below snowline, no permafrost

Chaparral: temperate shrubland, coastal areas, Mediterranean climate, mild winters, moderate rain, long-hot-dry summers (*Pacific coast, southern Texas, N.E. Mexico, coastal hills Chile, Mediterranean, S.W. Africa, S.W. Australia*); dominated by dormant, dry, brittle vegetation, periodic fires

survival strategies: fire-resistant roots, seeds that sprout after hot fires that release nutrients for first rain

Forest: Tropical, near equator (*rain*—warm annual mean with no variation, high humidity, heavy daily rainfall, huge diversity holding 50-80% Earth's species in 2% area; *deciduous*—monsoon/seasonal, two seasons-wet and dry, both evergreen and deciduous; *scrub*—small deciduous trees/shrubs), Temperate, E. U.S. (*deciduous*—long warm summers, cold-not harsh-winters, abundant, dispersed rain; *coastal coniferous*—mild temperatures, moisture from oceans), Boreal (evergreen coniferous, long dry cold winters, shorter days, *N. America, N. Asia, N. Europe*)

survival strategies: broadleaf evergreen in rain forest (collect sunlight, radiate heat), broadleaf deciduous in cold winter (shed leaves and become dormant—*maple trees*), coniferous evergreen plants (keep needles year-round to slow down heat loss/evaporation in winter and be ready for brief summer—*pine, spruce, fir, redwood trees*); *deer, opossums, raccoons, robins, warblers*

Mountains: contain majority of world's forests, contain endemic species, serve as sanctuaries for animals driven from lowland areas, help regulate Earth's climate through snowy sunlight reflection, affect sea levels w/ changes in glacial ice, play critical role in H_2O cycle

Field Research: remote sensing (aircraft, satellites), GIS (geographic information systems—create maps forest cover/health, water resources, pollution emissions, coastal changes, cancer / health effect relationships, changes in global sea temps.
Lab Research: Simplify systems (culture tubes, bottles, aquarium tanks, greenhouses, etc.) for systems analysis (math models)
Ecosystem Sustainability: Natural ecosystems and biosphere 1. Use renewable solar energy, 2. Recycle chemical nutrients

Insects: Pests (food competition, diseases, territory invasion). Help (decomposition, plant reproduction). Adapt (rapidly evolve pesticide-resistant traits + new species in changing conditions to avoid extinction). Using pesticides contaminates air/water, harms beneficial insects, threatens wildlife / human health, accelerates pesticide-immunity among pests.
Microbes: Harmful minority (germs, skin diseases, malaria). Beneficial food (bread, cheese, yogurt, vinegar, tofu, soy, alcohol), decomposers, antibiotics (penicillin, erythromycin, streptomycin), plant disease / pest control, bioremediation, metal extraction
Deforestation and Nutrient Cycling: clear-cutting increases runoff/erosion so that water is undrinkable and increases in cyanobacteria / algae—effects were temporary as area recovered without intervention

Biodiversity: Genetic, Species, Ecological, Functional (processes).
Genetic Diversity: change in size, age distribution, density, genetic composition
Habitat: one species. Community: several species. Ecosystem: several species and abiotic environment.
Biomes: distinct climates—terrestrial (forests, deserts, grasslands), aquatic (Freshwater, Ocean or Marine).
Ecotone: non-distinct boundary between ecosystems.
Law of Tolerance: population distribution determined by physical/chemical factors.
Limiting Factor Principal: too much/little abiotic factor (temp, light, DO, nutrients, salinity) can limit/prevent population growth.
Producers (Autotrophs): "self-feeders" (plants, phytoplankton use CO_2, light, nutrients, etc.).
Anaerobic Respiration (Fermentation): no oxygen used (CH_4, C_2H_5OH, CH_3COOH, H_2S products).
Consumers (Heterotrophs): "other feeders" (herbivores, carnivores, omnivores, scavengers, detritivores (long-horn beetle), detritus feeders, decomposers.
Aerobic Respiration: oxygen used ($C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + energy)
Food Web or Chain: represent trophic levels of interacting species (primary consumers eaten by secondary and so forth.
Energy Pyramid: like food web but shows energy flow between tropic levels.
Ecological Efficiency: % usable energy transferred in biomass between trophic levels.
(Sun→Producers→Herbivores→Carnivores→Decomposers→Decomposers/detritivores).
Biomass Abandoned Field / Grassland: greatest to least (producers, primary, secondary, tertiary consumers).
Biomass Ocean / Forest: greatest to least (primary, secondary consumers, producers, tertiary consumers).
Absolute Humidity: g. H_2O / kg. Air Relative Humidity: [g. H_2O (temp.) / g H_2O max (temp.)] x 100%
Condensation Nuclei: ash, dust, smoke, sea salts, fossil fuel particulates.

Hydrologic or Water Cycle: **1. evaporation, 2. transpiration** (leaves), **3. condensation** (clouds), **4. precipitation, 5. infiltration** (above ground), **6. percolation** (under ground).
Human Activities Affecting: 1. withdrawing water, 2. clearing vegetation, 3. modifying water quality.

Carbon Cycle: **CO_2-driven.** Used in photosynthesis, $CaCO_3$ shells, and seawater conversion → CO_3^{2-}, HCO_3^{2-} ions. Produced by aerobic respiration, decomposition, volcanoes, combustion.
Human Activities Affecting: 1. clearing plants, 2. burning fossil fuels.

Nitrogen Cycle: $N_2 + 2O_2 \rightarrow^{\text{lightning}} \rightarrow 2NO_2$ AND: **1. fixation** by bacteria/agriculture ($N_2 + 3H_2 \rightarrow 2NH_3$), **2. nitrification** by aerobic bacteria ($NH_3 \rightarrow NO_2^-$ (toxic) + NO_3^- (nutrient), **3. assimilation** (roots convert N-inorganics → DNA + amino acids + proteins), **4. ammonification** (decomposers convert N-organics → NH_3 and NH_4^+), and **5. denitrification** (anaerobic bacteria convert $NH_3 + NH_4^+ \rightarrow NO_2^- + NO_3^- + NO_2 + N_2$).
Human Activities Affecting: 1. burning fuel causes acid, 2. adding N_2O (livestock wastes + fertilizers) contributes to global warming / O_3 depletion, 3. removing N from topsoil (harvesting/irrigating/burning), 4. adding N (agricultural runoff/sewage discharge) depletes DO, 5. accelerating acid deposition stimulates weedy plant species competition.

Phosphorus Cycle: 1-way (human lifetimes). All salts insoluble found in rock (mined) and sediment (runoff). PO_4^{3-} limiting factor plant growth (adding greatly increases biological activity). Autotrophs uptake salts / then return them upon decomposition. Heterotrophs return salts in guano/decomposition.
Human Activities Affecting: 1. mining rock, 2. reducing trees, 3. adding excess to aquatic ecosystems (livestock feedlot runoff, commercial fertilizers, sewage discharge).

Sulfur Cycle: Used by plants and animals (SO_4^{2-}). Produced by volcanoes + industry (H_2S, SO_2 and SO_3 → acid rain), sea spray (DMS), decaying plants / animals [$(NH_4)_2SO_4$].
Human Activities Affecting: 1. burning S-coal/oil for power, 2. refining S-petroleum for gas, 3. smelting metallic minerals.

NPP (net primary productivity) = GPP (gross primary productivity or rate producers store biomass from photosynthesis) – (rate producers use biomass from aerobic respiration)
NPP greatest in estuaries, swamps/marshes, tropical rain forests; least in open ocean, tundra (arctic/grasslands), desert. GPP greatest in shallow reefs, coral reefs, upwelling currents; least in deserts.

NPP maximum not used to feed world because estuaries, swamps, wetlands have little edible for humans (although much is used by aquatic life-forms that provide people protein) and phytoplankton are widely dispersed such that more fuel would be spent than gained to harvest (and harvesting would disrupt open ocean food chains).

Life on Earth: 1) right temperature for water, 2) rotation/spin for even temperature, 3) gravity for molten core and gases, 4) ozone layer for UV protection

Cockroaches: 350 million year generalists (4000 species) eat anything and live/breed everywhere but polar regions; antennae detect minute air movements, knee joints have vibration sensors, rapid response times, high reproductive rates (quickly develop genetic resistance), sample food before it enters mouth (poison avoidance), clean up after themselves (eat own dead—self-reliant); carry viruses/bacteria (hepatitis, polio, typhoid fever, plague, salmonella), cause allergies

Evolution: Change in a population's genetic makeup through successive generations

Misconceptions: 1) survival of fittest isn't strongest, it's reproductive strength 2) evolution not nature's perfect plan

Coevolution: changes in gene pool of one species leads to changes in gene pool of the other species

Microevolution: Small genetic changes Macroevolution: long-term/large-scale (species formed/lost)

Chemical Evolution (1 billion years): organic molecules (carbohydrates), biopolymers/protocells (DNA/RNA), rxns—meteorite impacts, radioactive heat, lightning, volcano heat, UV, hydrothermal vents

Biological Evolution (3.7 billion years): prokaryotic(H_2S, anaerobic)$\rightarrow^{\text{pop. crisis}}\rightarrow$(photosynthetic)$\rightarrow^{\text{pollution crisis, } O_3}\rightarrow$ multi-cellular/eukaryotic(aerobic); evidence in dating, rocks, ice cores, DNA today

Divergent evolution: mutation/natural selection operate independently during geographic isolation such that species cannot interbreed or produce fertile offspring (reproductive isolation)

gene pool: all genes in individuals of population's species alleles: different molecular forms same formula

mutations: random changes in structure or # DNA molecules (radioactivity, mutagens, random mistakes)

artificial selection: humans select desirable trait or use selective breeding (choose, examine, select)

natural selection: increased survival through variability, heritability, differential reproduction

directional: one end of normal more common than middle (peppered moths)

stabilizing: middle most common (snails) diversifying: both extremes (snails)

adaptation: beneficial change (adapt, migrate, or become extinct) habitat: physical living location

limits: 1) traits must be present for adaptation, 2) reproductive capacity, 3) individuals w/o trait would have to die/become sterile so favorable trait can predominate

ecological niche: affects survival/reproduction; tolerance range, resources, interactions, energy/matter flow role; understanding prevents extinction/allows assessment of environmental changes by humans

fundamental niche: full potential range of conditions/resources available with no competition

realized niche: part of fundamental niche used to avoid competition generalized species: broad niche

specialist species: narrow niche (tiger salamander—fishless ponds; red-cockaded woodpecker—longleaf pines; spotted owl—old growth forests)

speciation: two species arise from one (Arctic and Gray Fox) —
1) geographic isolation, 2) reproductive isolation (divergent evolution)

background extinction: low rate mass depletion: moderate rate mass extinction: high rate

factors: large-scale continental drift (gradual climate change), rapid climate change (catastrophic events)

adaptive radiations: ~5 million years, rebuilding of biological diversity after mass extinction/depletion

biodiversity = speciation – extinction

ENERGY FLOW THROUGH ECOSYSTEMS

I. Biogeochemical Cycles
- A. Carbon Cycle
  1. Gaseous
  2. Begins with photosynthesis
  3. Fixes the carbon in CO_2 into a useable form (glucose / carbohydrates)
  4. Replenished by respiration
- B. Oxygen Cycle
  1. Gaseous
  2. Released as a product of photosynthesis
  3. Consumed during aerobic respiration
  4. Comprises approximately 21 % of the atmospheric gases in the troposphere
- C. Nitrogen Cycle
  1. Gaseous
  2. Has to be fixed into a useable form
     a. Nitrogen Fixation – $N_2 \rightarrow NH_3$
     b. Nitrifying bacteria – $NH_3 \rightarrow NO_2^- \rightarrow NO_3^-$
  3. Assimilation
     a. Plants → ionic forms
     b. Animals → organic forms
  4. Denitrifying bacteria convert NH_3 and NO_3^- into N_2 or N_2O; typically by anaerobic bacteria
- D. Phosphorus Cycle
  1. Sedimentary
  2. Limiting factor for plant growth
  3. Required for teeth and bones

II. Laws That Govern Energy Flow
- A. First Law of Thermodynamics = Law of Conservation of Energy = Energy can neither be created nor destroyed, but it can be converted from one type to another.
- B. Second Law of Thermodynamics = Entropy = No conversion of energy is every 100 % efficient, that is; some energy is downgraded to a non useable form and is not available to do work (thermal pollution is always associated with energy conversions)
- C. Types of Energy
  1. Kinetic Energy
     a. Energy of moving particles $KE = \frac{1}{2} mv^2$
     b. Average KE = temperature of a substance (Temperature □ av. KE)
  2. Potential Energy = stored energy; the potential to do work; PE = mgh
- D. Thermal Gradient - heat moves along the thermal gradient from warmer bodies to cooler bodies
- E. Maximum Power Principle - Systems that get the most energy and use that energy most efficiently will survive in competition with others.
- F. Miscellaneous
  1. Law of Conservation of Matter (Lavosier) - The total amount of matter in a closed system remains constant, i.e., matter can neither be created or destroyed, but can be converted from one type to another. (There is no away - solid waste, pollution)
  2. Einstein - $E = mc^2$ - Energy is equal to mass times the speed of light in a vacuum squared. (Relates to the conversion of mass to energy, mass deficits, theory of relativity)

III. Feeding Associations I Energy and Materials Flow
- A. Food Chains - linear feeding associations
  1. Maximum number of levels = 6; generally limited to 4 or 5 due to energy losses
  2. Grazing Based
  3. Detrital Based (ex. Red Mangrove based food chain)
- B. Food Webs - sum total of all feeding relationships; helps provide stability in the system
- C. Types of Organisms
  1. Autotrophs = self feeding = producers
     a. Base for any food chain or web
     b. Photosynthetic organisms (ex. green plants)
     c. Chemoautotrophs = chemosynthetic organisms (ex. sulphur bacteria)

2. Heterotrophs = consumers = eat other living things
    a. Primary Consumers = herbivore – consumes only plant matter (strict vegetarian)
    b. Secondary Consumer = carnivore = consumes live animal matter.
    c. Top Carnivore = bas no natural predators (ex. lion)
    d. Omnivores = can eat at any trophic level
3. Saprotrophs = decomposers = recyclers of nature
    a. Bacteria and fungi
    b. Scavengers = consume carrion (dead animal matter)

D. Eating Habits
1. Generalist - wide variety of food in diet (ex. humans, cockroaches)
2. Specialist- single food source (ex.. pandas. everglades kite, monarch butterfly)

E. Biomagnification = process by which toxins accumulate the higher you go in a food chain or web

IV. Ecosphere = all living and nonliving components (regions) on rue planet

V. Biosphere = region composed of all living organisms on the earth

VI. Succession = series of changes through which the most ecologically stable community is reached
A. Seral stages - succession stages from the pioneer community to the climax community
B. Climax Community - self sufficient, diverse, ecologically stable
C. False Climax Community - community maintained by certain conditions, ex. Fire Climax Community

VII. Populations
A. Habitat - place where an organism lives
B. Niche - includes a species habitat and interactions with the environment (abiotic and biotic factors food, space, nutrient requirements. etc.)
1. Gausse's Law - No two species can occupy the same niche at the same time.
2. Competitive Exclusion Principle- If niche overlap occurs one of the following will take place
    a. Exclusion - one species will be excluded (crowded out) of the niche
    b. Character Displacement – when species occur sympatrically (together) they may develop different feeding adaptations that allow them to coexist (Darwin's Finches)
    c. Extinction

C. Interactions
1. Symbiotic - long term, usually beneficial relationship between species. Includes mutualism, commensalism and parasitism.
2. Predator - Prey Relationships
3. Competition - usually for a limited resource - food, space, mate
    a. Intraspecific - between the same species (over crowding may result in cannibalism)
    b. Interspecific - between two of more different species. Ex. Allelopathy - using a chemical inhibitor to prevent competition for resources.

D. Limiting Factor - any factor that may limit the size, growth, or existence of an organism.
E. Biotic Potential - maximum reproduction rate possible under ideal conditions
F. Carrying Capacity- Size of the population that is actually supported by available resources
G. Evolution
1. Mutation - spontaneous change in genes: fuel for evolution
2. Natural Selection - the best adapted species is able to survive and reproduce

VIII. General Population Dynamics
A. Current Global Population is about 7 billion; 1.2% growth rate; exponential growth (J-shaped curve)
B. When carrying capacity is reached: S-shaped curve
C. Developing countries have a higher growth rate than developed countries
D. Population Pyramid / histogram - based on age structure (or cohorts)
1. Pre - reproductive (0 - 14 years old)
2. Reproductive (15 - 48 years old)
3. Post Reproductive

E. Demographic Transition Model
F. Neo-Malthusian vs. Cornucopian view towards family planning
G. Leavers vs. takers (Ishmael (by Daniel Quinn) perspective)