Teaching Learning Succeeding

Subject: Science
Grade Level: High School
DI Strategy: Think Dots

Environmental Science Think Dots

Prior to the AP Exam in my AP Environmental class, I wanted to provide my student with a way to review the topics we had covered throughout the year that they were the weakest in. For this activity I wanted to differentiate based on content, not on level of difficulty for one topic/skill. To determine each student's biggest area of weakness, I administered a practice AP Exam. The results of this exam allowed me to appropriately group my students.

For the first part of the activity, students were assigned to a pair or group of three based upon their lowest scoring topic. Before the Think Dots activity, students picked one of several mini-lecture video clips to watch. This video clip covered a subsection within their lowest scoring topic. Students completed their own note outline on the clip of their choice. After the video clip, students completed the Think Dots activity for their specific question set. Student first decided who in their pair/group would roll first. That student would roll the dice to determine which of the six questions would be answered. All students in that pair/group would write down their own answer to the question. The student who rolled the dice would share their answer with their group. Their partner(s) provided feedback for the answer by providing additional supporting evidence in agreement with the answer or providing a correct response and evidence if they disagreed with answer. Each partnership/group continued taking turns rolling until all questions were answered. A key was posted for pairs/groups that struggled with individual questions. Students also identified one of the six questions that either they struggled with or felt others in the class may have difficulty answering. The pair was responsible for presenting this question and their explanation to the class after all groups were finished.

If a pair finished early, they completed a dice game activity to review topic-specific vocabulary.

Quick summary of the dice game:

- One pen or pencil per pair
- One dice per pair
- Person with dice rolls until they get a 6
- Person with pencil answers as many of the prompts (in this case, vocab) as possible until their partner rolls a 6 at which point the person with the dice snatches the pen or pencil and begins writing.

The dice game is normally quite high energy and makes it obvious who has finished.

Additional worksheets used during this activity can be found below.

Teaching Learning Succeeding

Main Topic: Earth Systems and Resources

Name: _____

Part 1

Directions:

1. Your main topic has been assigned to you.
2. Watch one of the mini-lecture videos under your main topic. Choose the sub-topic of which you are LEAST confident.
3. Record your notes below.
4. When finished move on to Part 2.

Part 2

Directions:

1. Form a pair or group of 3 with others in the same main topic.
2. Pick up one dice for your pair or group of 3.
3. Decide who in your pair/group of 3 will roll first.
4. Roll the dice to determine which of the 6 questions below you will answer. Share your answer with your group.
5. Partner(s) provide feedback for answer by:
    a. Providing additional supporting evidence in agreement with answer
    b. Provides a correct response and evidence if disagree with answer
6. Continue taking turns rolling until all questions are answered.
7. Circle the question number that was most challenging for your pair/group.
8. Be prepared to share your pair/group answer for this question to the rest of the class.
9. When finished, pick up the dice game activity and begin with you partner/group.

Questions

1. Identify the basic layers of the earth including their material composition and relative size.
2. Identify the basic composition, structure, and characteristics of layers of the atmosphere. Include temperature variations at each level and why they occur.
3. Identify 5 properties of water that make it important to live on Earth.
4. Distinguish between the particle size and permeability of gravel, sand, silt, and clay.
5. Describe the rock cycle and how each type of rock is formed and connected to other types of rock. Relate this process to soil formation.
6. Describe El Nino/La Nina/Southern Oscillation (ENSO) and its impacts on local and global conditions.

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Main Topic: The Living World

Name: _____

Part 1

Directions:

1. Your main topic has been assigned to you.
2. Watch one of the mini-lecture videos under your main topic. Choose the sub-topic of which you are LEAST confident.
3. Record your notes below.
4. When finished move on to Part 2.

Part 2

Directions:

1. Form a pair or group of 3 with others in the same main topic.
2. Pick up one dice for your pair or group of 3.
3. Decide who in your pair/group of 3 will roll first.
4. Roll the dice to determine which of the 6 questions below you will answer. Share your answer with your group.
5. Partner(s) provide feedback for answer by:
    a. Providing additional supporting evidence in agreement with answer
    b. Provides a correct response and evidence if disagree with answer
6. Continue taking turns rolling until all questions are answered.
7. Circle the question number that was most challenging for your pair/group.
8. Be prepared to share your pair/group answer for this question to the rest of the class.
9. When finished, pick up the dice game activity and begin with you partner/group.

Questions

1. Differentiate between individual, populations, communities, ecosystems, biomes, and biosphere.
2. Explain why data shown on climate graphs plays such an important role in the type of biome that is present at any given location.
3. Explain the connection between Gross Primary Productivity (GPP) and Net Primary Productivity and be able to calculate given each given numerical value
4. Explain how variations in biodiversity relate to evolution.
5. Provide examples of how species have moved in response to climate changes.
6. Differentiate between primary and secondary succession by describing the initial conditions, stages of succession, and time periods involved.

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Main Topic: Population

Name: _____

Part 1

Directions:

1. Your main topic has been assigned to you.
2. Watch one of the mini-lecture videos under your main topic. Choose the sub-topic of which you are LEAST confident.
3. Record your notes below.
4. When finished move on to Part 2.

Part 2

Directions:

1. Form a pair or group of 3 with others in the same main topic.
2. Pick up one dice for your pair or group of 3.
3. Decide who in your pair/group of 3 will roll first.
4. Roll the dice to determine which of the 6 questions below you will answer. Share your answer with your group.
5. Partner(s) provide feedback for answer by:
    a. Providing additional supporting evidence in agreement with answer
    b. Provides a correct response and evidence if disagree with answer
6. Continue taking turns rolling until all questions are answered.
7. Circle the question number that was most challenging for your pair/group.
8. Be prepared to share your pair/group answer for this question to the rest of the class.
9. When finished, pick up the dice game activity and begin with you partner/group.

Questions

1. Differentiate between type 1, 2, and 3 survivorship curves
2. Provide examples of past population policies throughout the world while describing the problems the policy was trying to address, the unintended consequences, and the long-term implications.
3. Explain how age structure diagrams can be used to identify population changes over time (provide examples).
4. Define the term carrying capacity, identify factors that affect carrying capacity, and explain how you would find this value experimentally.
5. Explain how the rule of 70 can be used to calculate doubling time.
6. Differentiate between k and r strategists.

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Main Topic: Land and Water

Name: _____

Part 1

Directions:

1. Your main topic has been assigned to you.
2. Watch one of the mini-lecture videos under your main topic. Choose the sub-topic of which you are LEAST confident.
3. Record your notes below.
4. When finished move on to Part 2.

Part 2

Directions:

1. Form a pair or group of 3 with others in the same main topic.
2. Pick up one dice for your pair or group of 3.
3. Decide who in your pair/group of 3 will roll first.
4. Roll the dice to determine which of the 6 questions below you will answer. Share your answer with your group.
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9. When finished, pick up the dice game activity and begin with you partner/group.

Questions

1. Explain the environmental impacts of various approaches to raising and harvesting meat.
2. Provide examples of how integrated pest management can be used in place of pesticides.
3. Explain the role fire plays in the succession of ecosystems.
4. Propose management strategies that actively prevent overgrazing, deforestation, and desertification for given real-world scenarios.
5. Explain the causes, consequences, and possible solutions to urban sprawl.
6. Compare and contrast a variety of aquatic food production and harvesting methods such as aquaculture, bottom trawling, drift nets, long lining, and purse seine

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Main Topic: Energy Resources

Name: _____

Part 1

Directions:

1. Your main topic has been assigned to you.
2. Watch one of the mini-lecture videos under your main topic. Choose the sub-topic of which you are LEAST confident.
3. Record your notes below.
4. When finished move on to Part 2.

Part 2

Directions:

1. Form a pair or group of 3 with others in the same main topic.
2. Pick up one dice for your pair or group of 3.
3. Decide who in your pair/group of 3 will roll first.
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7. Circle the question number that was most challenging for your pair/group.
8. Be prepared to share your pair/group answer for this question to the rest of the class.
9. When finished, pick up the dice game activity and begin with you partner/group.

Questions

1. Explain the process of converting a fossil fuel to electricity.
2. Evaluate the advantages and disadvantages of two contrasting energy sources (solar, wind, hydroelectric, geothermal, biomass, nuclear, and fossil fuels).
3. Explain the formation, benefits, and drawbacks of alternative fuels such as synfuels and biofuels.
4. Evaluate various storage methods of nuclear waste.
5. What are CAFE standards and how have the changed in recent years?
6. Identify what you believe will be the main way in which future human populations will meet their energy needs.

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AP Topics and Mini-Lecture Videos

I. **Earth Systems and Resources (10%–15%)**
   A. Earth Science Concepts (Geologic time scale; plate tectonics, earthquakes, volcanism; seasons; solar intensity and latitude)
   B. The Atmosphere (Composition; structure; weather and climate; atmospheric circulation and the Coriolis effect; atmosphere-ocean interactions; ENSO)
   C. Global Water Resources and Use (Freshwater/saltwater; ocean circulation; agricultural, industrial, and domestic use; surface and groundwater issues; global problems; conservation)
   D. Soil and Soil Dynamics (Rock cycle; formation; composition; physical and chemical properties; main soil types; erosion and other soil problems; soil conservation)

II. **The Living World (10%–15%)**
   A. Ecosystem Structure (Biological populations and communities; ecological niches; interactions among species; keystone species; species diversity and edge effects; major terrestrial and aquatic biomes)
   B. Energy Flow (Photosynthesis and cellular respiration; food webs and trophic levels; ecological pyramids)
   C. Ecosystem Diversity (Biodiversity; natural selection; evolution; ecosystem services)
   D. Natural Ecosystem Change (Climate shifts; species movement; ecological succession)
   E. Natural Biogeochemical Cycles (Carbon, nitrogen, phosphorus, sulfur, water, conservation of matter)

III. **Population (10%–15%)**
   A. Population Biology Concepts (Population ecology; carrying capacity; reproductive strategies; survivorship)
   B. Human Population
      1. Human population dynamics (Historical population sizes; distribution; fertility rates; growth rates and doubling times; demographic transition; age-structure diagrams)
      2. Population size (Strategies for sustainability; case studies; national policies)
      3. Impacts of population growth (Hunger; disease; economic effects; resource use; habitat destruction)

IV. **Land and Water Use (10%–15%)**
   A. Agriculture
      1. Feeding a growing population (Human nutritional requirements; types of agriculture; Green Revolution; genetic engineering and crop production; deforestation; irrigation; sustainable agriculture)

2. Controlling pests (Types of pesticides; costs and benefits of pesticide use; integrated pest management; relevant laws)

B. Forestry (Tree plantations; old growth forests; forest fires; forest management; national forests)
C. Rangelands(Overgrazing; deforestation; desertification; rangeland management; federal rangelands)
D. Other Land Use
    1. Urban land development (Planned development; suburban sprawl; urbanization)
    2. Transportation infrastructure (Federal highway system; canals and channels; roadless areas; ecosystem impacts)
    3. Public and federal lands (Management; wilderness areas; national parks; wildlife refuges; forests; wetlands)
    4. Land conservation options (Preservation; remediation; mitigation; restoration)
    5. Sustainable land-use strategies
E. Mining (Mineral formation; extraction; global reserves; relevant laws and treaties)
F. Fishing (Fishing techniques; overfishing; aquaculture; relevant laws and treaties)
G. Global Economics (Globalization; World Bank; Tragedy of the Commons; relevant laws and treaties)

V. **Energy Resources and Consumption (10%–15%)**
A. Energy Concepts (Energy forms; power; units; conversions; Laws of Thermodynamics)
B. Energy Consumption
    1. History (Industrial Revolution; exponential growth; energy crisis)
    2. Present global energy use
    3. Future energy needs
C. Fossil Fuel Resources and Use (Formation of coal, oil, and natural gas; extraction/purification methods; world reserves and global demand; synfuels; environmental advantages/disadvantages of sources)
D. Nuclear Energy (Nuclear fission process; nuclear fuel; electricity production; nuclear reactor types; environmental advantages/disadvantages; safety issues; radiation and human health; radioactive wastes; nuclear fusion)
E. Hydroelectric Power (Dams; flood control; salmon; silting; other impacts)
F. Energy Conservation (Energy efficiency; CAFE standards; hybrid electric vehicles; mass transit)
G. Renewable Energy (Solar energy; solar electricity; hydrogen fuel cells; biomass; wind energy; small-scale hydroelectric; ocean waves and tidal energy; geothermal; environmental advantages/disadvantages)

VI. **Pollution (25%–30%)**
A. Pollution Types (Air, water, solid waste)
    1. Air pollution (Sources — primary and secondary; major air pollutants; measurement units; smog; acid deposition — causes and effects; heat

islands and temperature inversions; indoor air pollution; remediation and reduction strategies; Clean Air Act and other relevant laws)
2. Noise pollution (Sources; effects; control measures)
3. Water pollution (Types; sources, causes, and effects; cultural eutrophication; groundwater pollution; maintaining water quality; water purification; sewage treatment/septic systems; Clean Water Act and other relevant laws)
4. Solid waste (Types; disposal; reduction)

B. Impacts on the Environment and Human Health
1. Hazards to human health (Environmental risk analysis; acute and chronic effects; dose-response relationships; air pollutants; smoking and other risks)
2. Hazardous chemicals in the environment (Types of hazardous waste; treatment/disposal of hazardous waste; cleanup of contaminated sites; biomagnification; relevant laws)

C. Economic Impacts (Cost-benefit analysis; externalities; marginal costs; sustainability)

VII. **Global Change (10%–15%)**

A. Stratospheric Ozone (Formation of stratospheric ozone; ultraviolet radiation; causes of ozone depletion; effects of ozone depletion; strategies for reducing ozone depletion; relevant laws and treaties)

B. Global Warming (Greenhouse gases and the greenhouse effect; impacts and consequences of global warming; reducing climate change; relevant laws and treaties)

C. Loss of Biodiversity
1. Habitat loss; overuse; pollution; introduced species; endangered and extinct species
2. Maintenance through conservation
3. Relevant laws and treaties

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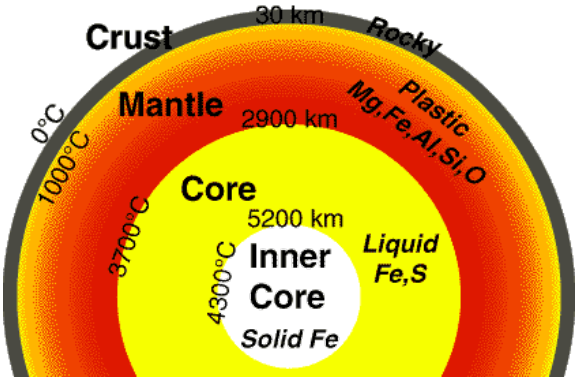
ANSWER KEY

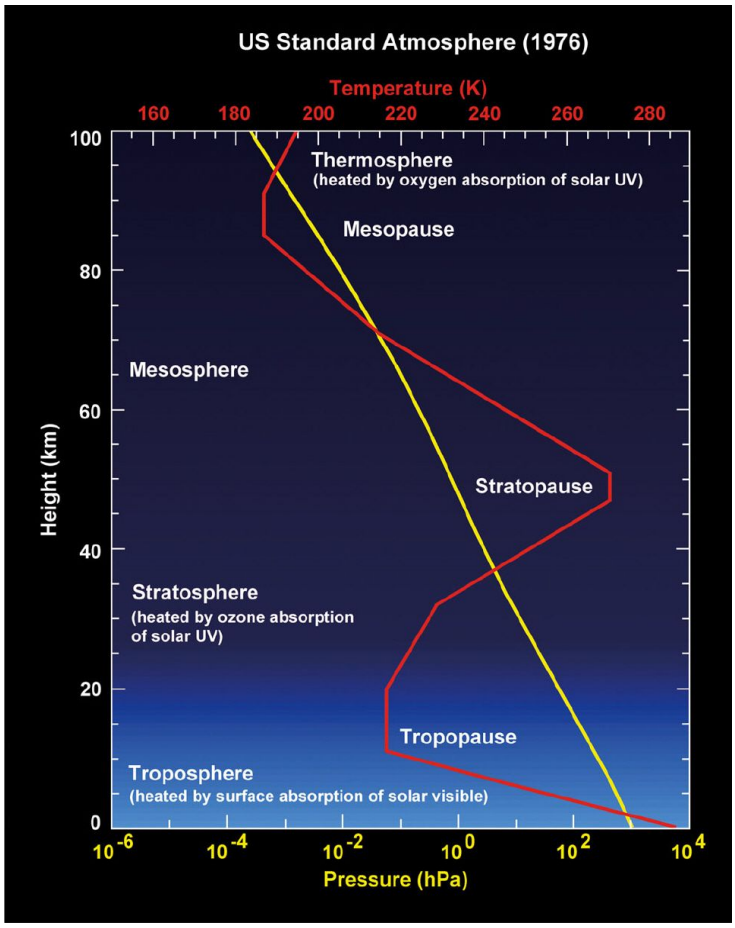
Main Topic: Earth Systems and Resources

Questions

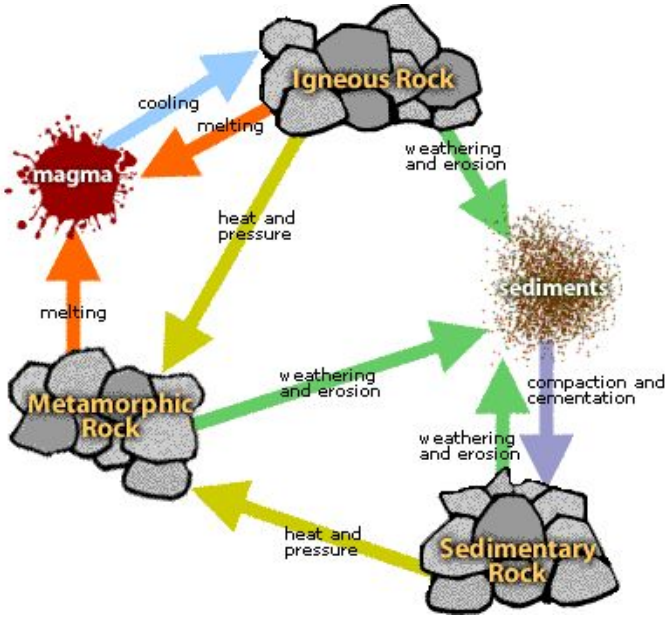
1. Identify the basic layers of the earth including their material composition and relative size.



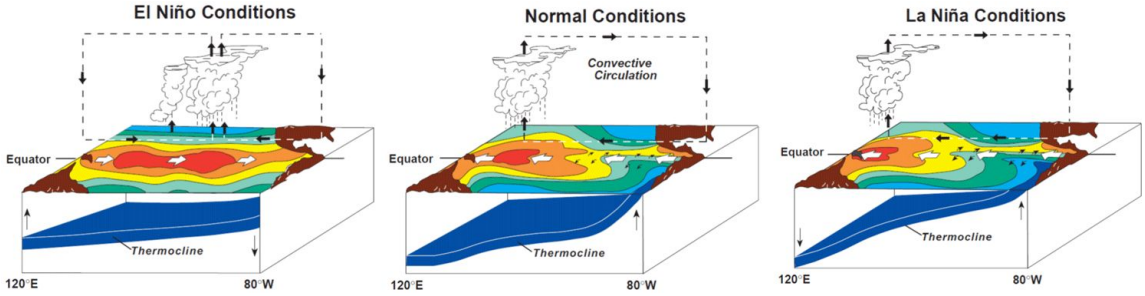
2. Identify the basic composition, structure, and characteristics of layers of the atmosphere. Include temperature variations at each level and why they occur.



3. Identify 5 properties of water that make it important to live on Earth.
    a. High heat capacity - helps control temperature of Earth and organisms
    b. Universal solvent - many things easily dissolve in water.
    c. Ice is less dense than water - lakes and oceans don't freeze solid
    d. Polarity - water is a polar molecule, therefore it forms H-bonds with itself and other objects (cohesion and adhesion
    e. Neutral pH - almost all organism are adapted to have some life stage (or cells) move through water.
4. Distinguish between the particle size and permeability of gravel, sand, silt, and clay.
    Largest to smallest - Gravel, sand, silt, clay
    Most to least permeable - gravel, sand, silt, clay (due to porosity or space between particles)
    This also directly relates to percent retention. Greater porosity/permeability lower percent retention
5. Describe the rock cycle and how each type of rock is formed and connected to other types of rock. Relate this process to soil formation.



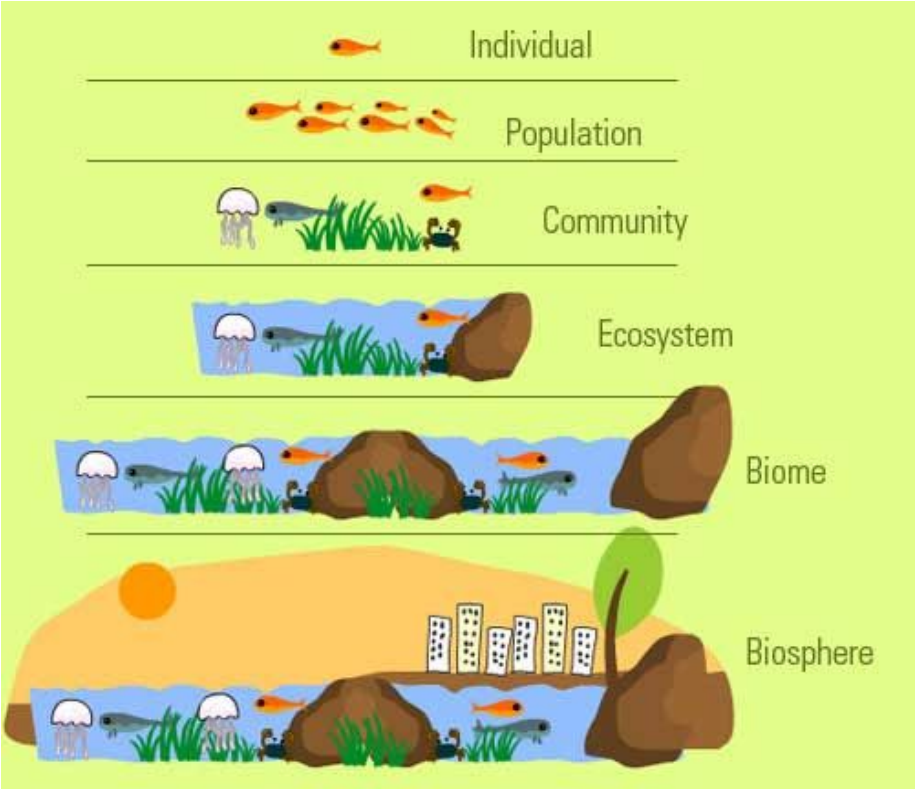
6. Describe El Nino/La Nina/Southern Oscillation (ENSO) and its impacts on local and global conditions.



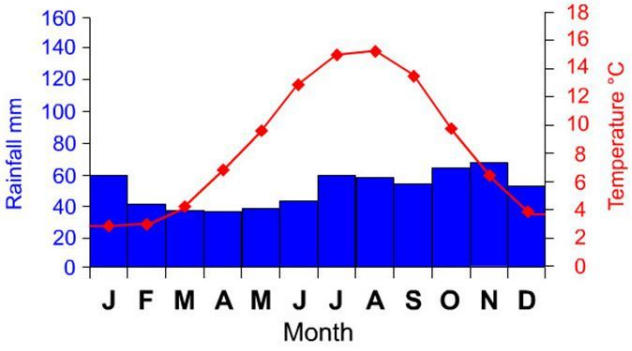
Main Topic: The Living World

Questions

1. Differentiate between individual, populations, communities, ecosystems, biomes, and biosphere.



2. Explain why data shown on climate graphs plays such an important role in the type of biome that is present at any given location.



Climate graphs show temperature and precipitation for a given location. These two factors play the biggest role in both the abiotic factors and primary production, and therefore energy available at other levels of the food chain.

3. Explain the connection between Gross Primary Productivity (GPP) and Net Primary Productivity and be able to calculate given each given numerical value.

NPP	=	GPP	-	R
Net Primary Productivity	=	Gross Primary Products	-	Respiration

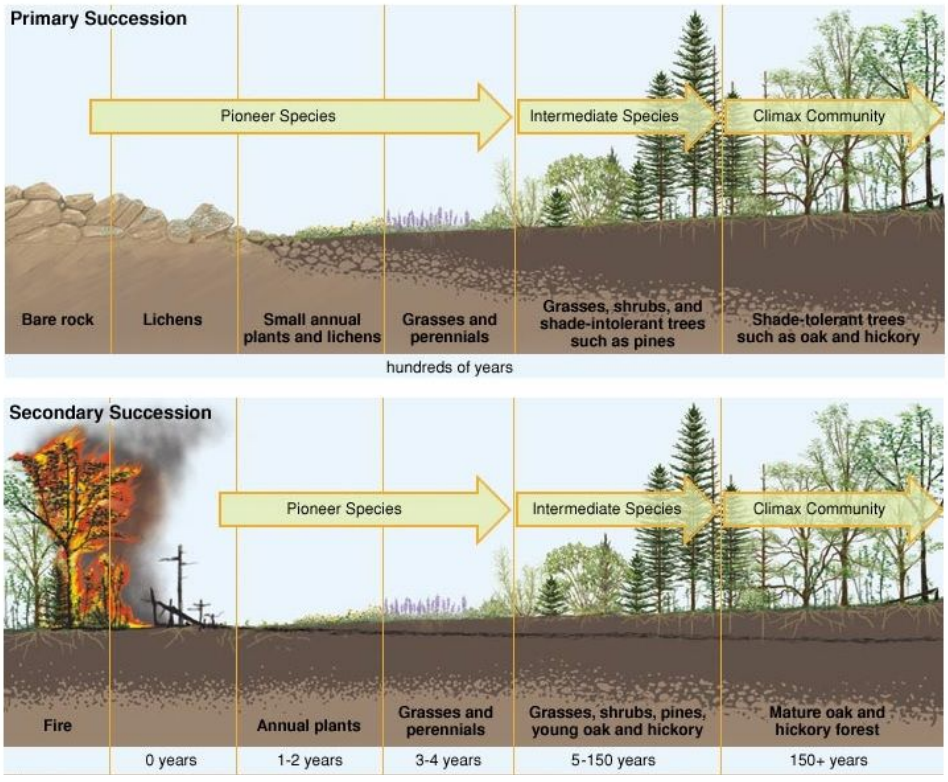
4. Explain how variations in biodiversity relate to evolution.

Increases in biodiversity in terms of richness (greater number of species) and genetic variation (within a population) provide communities/populations increased ability to respond to environmental changes. With more biodiversity, there is a higher probability that some portion of the community/population has individual characteristics that allow them to have increased fitness (make more offspring) under the new environmental conditions.

5. Provide examples of how species have moved in response to climate changes.

As temperatures warm, organisms move to higher latitudes and altitudes. Examples of the past are pine trees locations since the last ice age. Some organisms do not have the ability to respond in this way, especially when climates changes as rapidly as they are now.

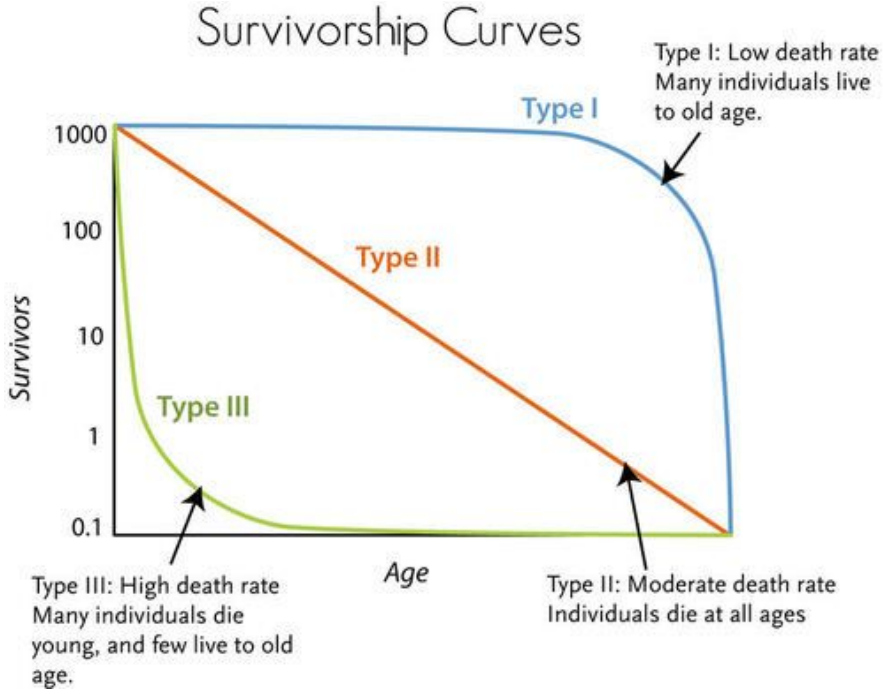
6. Differentiate between primary and secondary succession by describing the initial conditions, stages of succession, and time periods involved.



Main Topic: Population

Questions

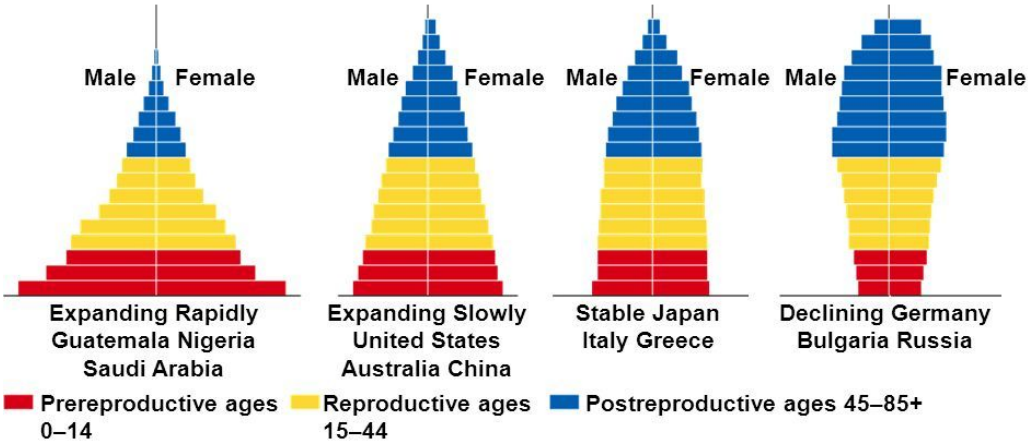
1. Differentiate between type 1, 2, and 3 survivorship curves



2. Provide examples of past population policies throughout the world while describing the problems the policy was trying to address, the unintended consequences, and the long-term implications.

China - One child policy; increased population growth and famine; much higher rates of males in population; younger population unable to support larger aging population.
Kenya - Increased education for women; decrease population growth; potential for increased women in workforce; continues to move country towards becoming more economically advanced (although population growth still continues)

3. Explain how age structure diagrams can be used to identify population changes over time (provide examples).



4. Define the term carrying capacity, identify factors that affect carrying capacity, and explain how you would find this value experimentally.

Carrying capacity is the maximum number of individuals an ecosystem can support. It is good to consider this value a range/estimation more so than a set finite number as many factors play a role. Carrying capacity can be found by monitoring populations under constant conditions over extended periods of time. In ideal situations, population growth will be observed until a relatively stable carrying capacity is reached. In reality, populatiossns may bounce above and below carrying capacity as individuals compete for resources (space, light, food, etc.)

5. Explain how the rule of 70 can be used to calculate doubling time.

"The rule of 70"

$$\text{Doubling Time} = \frac{70}{\text{Annual rate of growth}}$$

Example with a 14% of annual growth

$$\frac{70}{14} = 5 \text{ years}$$

6. Differentiate between k and r strategists.

	***r*-strategy**	***k*-strategy**
Offspring (per brood)	Many	Few
Parental care	Less	More
Mortality	High	Low
Body size	Small	Large
Onset of maturity	Early	Late
Reproduction	Once	Multiple times
Favoured environment	Unstable	Stable
Type of species	Pioneer species	Climax species
Population size	Variable	Stable

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Main Topic: Land and Water

Questions

1. Explain the environmental impacts of various approaches to raising and harvesting meat.

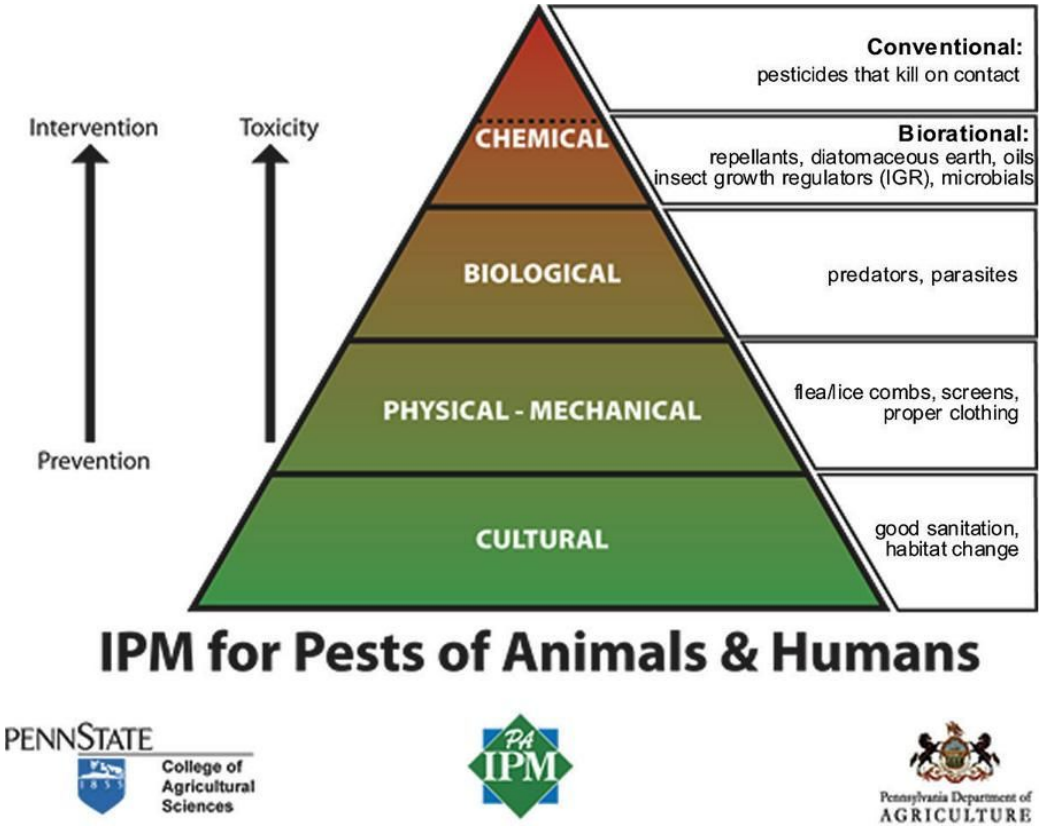
Industrial farming practices - high population density, likely increased use of antibiotics to fight increased infection risk (or even as stimulants for growth); growth hormone pellets in cattle ears (to avoid food supply), no growth hormones used for chickens; selective breeding of chickens has lead to rapid growth rates and enlarged size (specifically breast meat); likely uses corn as one of the main components of feed; runoff from feedlots may lead to increased phosphate and nitrate levels in surface waters.

Free-range chickens/grass fed beef - lower population densities, requires more land area for same meat production, high nutrient loads less likely in runoff but still possible, likely includes antibiotic use only to treat animals when sick.

2. Provide examples of how integrated pest management can be used in place of pesticides.

Integrated pest management (IPM) is a sustainable approach to managing pests by combining biological, cultural, physical and chemical.

- Understanding your pests.
- Setting action thresholds for key pests – knowing when to take action against key pests.
- Monitoring for pests, their locations and populations.
- Removing conditions that allow pest infestations.
- Using one or more effective pest control methods including sanitation, structural maintenance, and nonchemical methods in place or in combination with pesticides.



3. Explain the role fire plays in the succession of ecosystems.

Some species are fire tolerant (able to withstand fires) and some, such as the longleaf pine, are fire dependent (require fire for some portion of their lifecycle). Periodic ground fires remove ground debris and return nutrients to the soil increasing opportunities for new communities. They also help prevent heavily destructive crown fires. (See images below).

Crown Fires

In a forest where fires rarely happen, fuel builds up: There's **surface fuel** (grass, logs, woody debris, brush); **ladder fuel** (shrubs, small trees, snags); and **tree crowns**.

1. Surface fires spread quickly through brush and woody debris.
2. Ladder fuels allow the fire to move up toward the forest canopy.
3. Tree crown fires are so intense, they're difficult to control.

Ground Fires

The greater the distance between **surface fuel** (grass, logs, twigs, fallen branches and low-lying foliage) and **tree crowns**, the more difficult it is for crown fires to start.

1. Periodic fires spread through surface fuel.
2. The surface fire cannot make the leap to the tree crowns.
3. The fire consumes small plants, but taller trees escape with scorched bark.

4. Propose management strategies that actively prevent overgrazing, deforestation, and desertification for given real-world scenarios.

Overgrazing:
Pasture rotation - have fields set aside for grazing/other cover crops and rotating them over multiple seasons
Deforestation:
Selective harvesting of timber (instead of clear cutting) by removing the largest, most mature trees allows for younger individuals to receive more sunlight and grow. In most PA deciduous forests, these areas can recover completely within 30-40 years. Southern pine forests managed in similar ways would have an even more rapid full growth recovery rate.
Desertification:
Over-use of land thought nutrient depletion, overgrazing, and over-watering, especially in high sand soils, can lead to desertification (as a result of nutrient leaching). Drip irrigation methods, planting cover crops, or intercropping are prevention methods.

5. Explain the causes, consequences, and possible solutions to urban sprawl.

Urban sprawl is the result of urban areas spreading over larger and larger areas of land into rural areas. This maybe the result of the following:

Transportation

- Increased use of/reliance on automobiles
- Improved/expanded roads
- Low gas prices promote driving
- Telecommuting has made it possible to work remotely

Economic

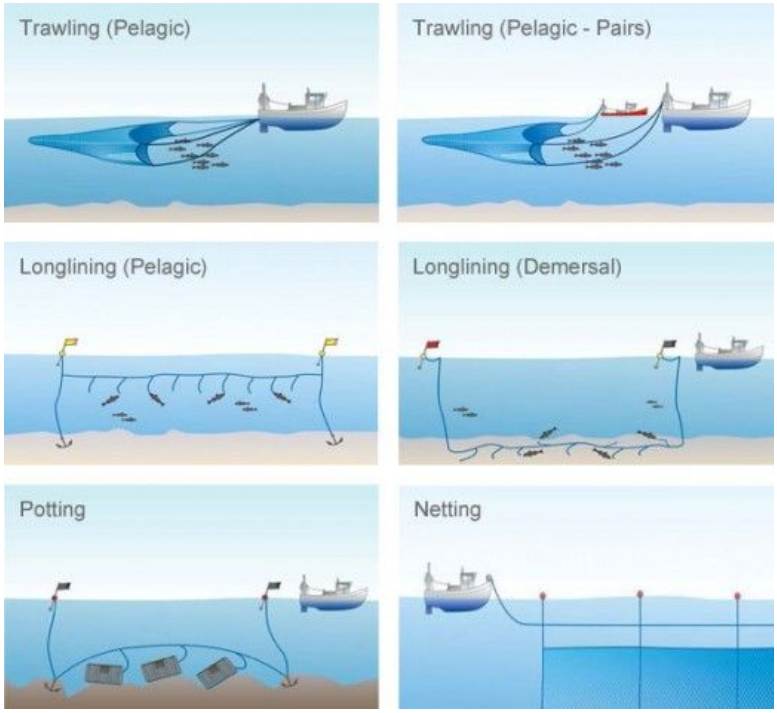
- Increasing wealth/affluence providing choice
- Higher taxes in inner city
- High land/property costs in city vs. less expensive land prices outside the city (cannot earn both)
- Tax deductions for home mortgages interest
- Jobs move out and employees follow
- Home buying subsidies/reduced interest rates e.g., GI Bill
- Lack of/poor city-regional planning: (urban centers plan in isolation; lack of cohesive plan for growth)
- Lower cost of living in suburbs

Quality of Life

- Desire for property/yard/lower density
- Better quality suburban schools
- Urban blight/declining infrastructure in inner cities
- High crime rates in inner cities
- Seek natural environments, aesthetics, cleaner air, less noise pollution, etc.

Urban sprawl can lead to decreased biodiversity as a result of habitat destruction, increased air (CO_2, VOCs, NO_2) and water pollution (from increased transportation needs). Possible solutions could include financial incentives to remain in the city, rural/suburban limits on development such as Montgomery counties farm preservation program.

6. Compare and contrast a variety of aquatic food production and harvesting methods such as aquaculture, bottom trawling, drift nets, long lining, and purse seine



Consider the bycatch (unintended species catch) for each method described above. Bottom trawling can also destroy aquatic vegetation and therefore habitat of species such as blue crab.

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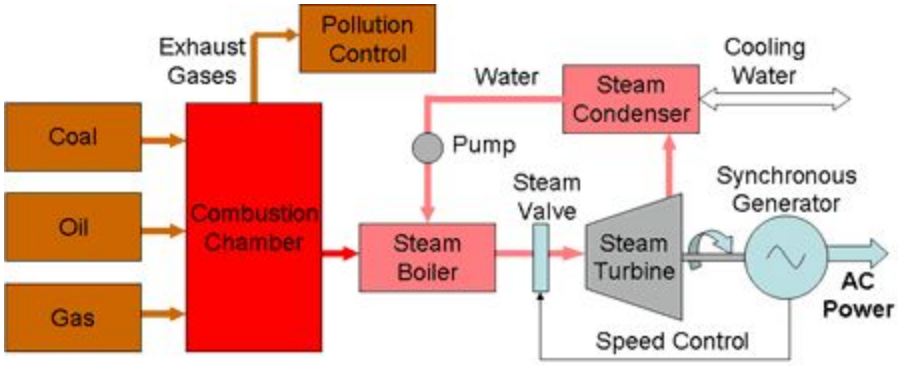
Main Topic: Energy Resources

Questions

1. Explain the process of converting a fossil fuel to electricity.



Fossil Fuel Powered Steam Turbine Electricity Generation

2. Evaluate the advantages and disadvantages of two contrasting energy sources (solar, wind, hydroelectric, geothermal, biomass, nuclear, and fossil fuels).
    a. Coal – Benefits: infrastructure in place (rail lines to move coal), relatively cheap, US availability

Drawbacks: releases CO_2, sulfur dioxide, particulates and mercury; coal ash waste produced and needs to be disposed of

b. Wind – Benefits: land based systems are currently one of the lowest cost energy sources; produces no direct CO_2 emissions during electricity production

Drawbacks: noise and aesthetic pollution; potential problem for migrating birds

c. Oil – Benefits: energy dense resource; infrastructure in place (pipelines, gas stations, etc.); multiple types of fuel (and products) can be created with refined crude oil

Drawbacks: releases CO_2, sulfur dioxide, and particulates when burned, accidents can have huge impacts on aquatic ecosystems

d. Hydroelectric – Benefits: no direct CO_2 emissions during electricity generation (only in building damn or system); huge potential energy source when coastal and tidal systems are considered.

Drawbacks: habitat destruction associated with building dams and flooding valleys; can impact migrating aquatic life (salmon)

e. Natural gas – Benefits: lowest CO_2 emissions of any fossil fuel, increased availability and price in recent years

Drawbacks: produces CO_2 emissions when burned, fracking process and pipeline construction have been known to contaminate freshwater ecosystems (and human drinking water systems)

f. Biomass – Benefits: biofuels supplement fossil fuels by using oil infrastructure; the CO_2 released was more recently in the atmosphere (as opposed to fossil fuels that captured CO_2 millions of years ago)

Drawbacks: CO_2 emissions when burned; potential impact of food commodity prices when corn or soybeans are used (instead of crop residues).

g. Nuclear – Benefits: no direct CO_2 emissions during electrical production; most energy dense resource (in terms of mass of uranium to amount of energy produced)

Drawbacks: thermal pollution in aquatic systems from power plants cooling systems (a drawback of all non-renewable power plants); nuclear waste produced that remains radioactive for thousands of years.

h. Solar – Benefits: no direct CO_2 emissions during electrical production (photovoltaic and concentrated solar power systems), most abundant energy resource on Earth

Drawbacks: high “soft” cost (permitting, connecting to power grid, installation, etc.), not economically feasible in all areas due to regulations

i. Geothermal – benefits: no direct CO_2 emissions from electrical production (lower CO_2 emissions from setup than solar), use less water than conventional power systems; smaller footprint than solar or wind

Drawbacks: only available in certain places, could supply only 10% of US energy needs even if untapped resources are used.

3. Explain the formation, benefits, and drawbacks of alternative fuels such as synfuels and biofuels.

The U.S. Energy Information Administration defines a synthetic fuel as any fuel "produced from coal, natural gas or biomass feedstocks through chemical conversion". That conversion creates substances that are chemically the same as crude oil or processed fuels, but were synthesized through artificial means. Conventional crude oil occurs naturally in the environment, and is used to produce a variety of fuels like gasoline and diesel. Synthetic fuel feedstocks, the raw materials used to make synfuels, have to be subjected to intense chemical and physical changes to be usable as crude oil or processed fuel.

Benefits: Less dependence on foreign sources of oil, potentially less mining/extraction of these resources (if biofuels are used) and therefore fewer environmental impacts from mining

Drawbacks: Still produce CO_2, chemical/industrial waste could be produced as a result of the conversion process.

4. Evaluate various storage methods of nuclear waste.

Currently stored at nuclear power stations, could be stored in a central location (such as Yucca Mountain), salt caverns are a potential alternative due to their naturally enclosing nature.

5. What are CAFE standards and how have the changed in recent years?

The Corporate Average Fuel Economy (CAFE) standards are regulations in the United States, first enacted by the United States Congress in 1975, after the 1973–74 Arab Oil Embargo, to improve the average fuel economy of cars and light trucks (trucks, vans and sport utility vehicles). Changes have occurred to these standards as a result of administration changes. Obama set high fuel economy standards that would bring the US closer to other industrialized countries throughout the world. These changes were withdrawn by the current administration.

6. Identify what you believe will be the main way in which future human populations will meet their energy needs.

Refer to the benefits/drawback list above to form your own opinion. Fusion would be great if we could solve the engineering problems.

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_____ an organism interaction in which one organism takes nourishment from another while it remains alive

_____ a trait or characteristic that helps an organism thrive in its environment

_____ an organism that kills another for energy and nutrients

_____ an organism that benefits from living in or on another organism

_____ the evolutionary process in which individuals with beneficial traits are more likely to survive and reproduce

_____ an organism interaction in which one organism benefits and the other is not impacted in any way

_____ an organism interaction in which both organisms benefit

_____ an organism interaction in which one organism kills another

_____ a genetic change in a population over time

_____ an organism that is killed as a result of predation

_____ an organism from which a parasite takes nourishment

_____ in interaction between organisms within an ecosystem

_____ the evolutionary process in which two individual species evolve in response to each other

_____the variety of life within a community, ecosystem, or in the biosphere

_____ the total number of species present in a community

_____ a measure of how the number of one population compares to the number of another population in a community

_____the sum of the two highest populations in a community divided by the total number of individuals in the community

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The Living World - Dice Game

adaptation	a trait or characteristic that helps an organism thrive in its environment
biodiversity	the variety of life within a community, ecosystem, or in the biosphere
coevolution	the evolutionary process in which two individual species evolve in response to each other
commensalism	an organism interaction in which one organism benefits and the other is not impacted in any way
community dominance index	the sum of the two highest populations in a community divided by the total number of individuals in the community
evolution	a genetic change in a population over time
host	an organism from which a parasite takes nourishment
mutualism	an organism interaction in which both organisms benefit
natural selection	the evolutionary process in which individuals with beneficial traits are more likely to survive and reproduce
parasite	an organism that benefits from living in or on another organism
parasitism	an organism interaction in which one organism takes nourishment from another while it remains alive
predation	an organism interaction in which one organism kills another
predator	an organism that kills another for energy and nutrients
prey	an organism that is killed as a result of predation
species evenness	a measure of how the number of one population compares to the number of another population in a community
species richness	the total number of species present in a community
symbiosis	in interaction between organisms within an ecosystem