



Course Outcome Summary

Course Information: (SCAPEN) AP Environmental Science

Description: A challenging course, AP Environmental Science is designed to provide students with the scientific theories, models, and techniques that will allow them to analyze local, regional and global environmental issues. A strong emphasis is placed on science, stewardship and sustainability. Students will utilize critical, creative, logical and reflective thinking to study and evaluate natural and human induced environmental problems. The course requires an interdisciplinary view that ranges across the social sciences, ethics, politics and many scientific fields. Labs, field trips and special assignments are important aspects of the environmental science curriculum. Additional topics will include: cell growth, genetics, evolution, and earth history. This course meets most college entrance requirements for three natural science courses (Biology, Chemistry, and Physics).

Instruction Level: 9th Grade

Total Credits: 2 Credits

Textbooks: *Environmental Science for AP 2nd Edition* – Friedland and Relyea

Course Standards:

1. Explain how biological systems (e.g. atmosphere, water resources, soil) interact, and how their interactions possess complex properties.
2. Give examples of instances when specific organisms impact their local environment, and describe how other organisms are affected by environmental change.
3. Predict what will happen to the number of organisms of a given species in an ecosystem following a temporary biotic (living) or abiotic (non-living) change in that ecosystem (e.g., a very cold winter or a disease that kills large numbers of one of the species in the ecosystem) and what will happen after conditions return to what they were before the disruption.
4. Explain similarities and differences between populations (e.g., dogs, horses, crops) undergoing artificial selection and populations undergoing natural selection. Describe the roles that humans play in artificial selection and how these roles are similar to the natural processes that take place in natural selection.
5. Formulate a scientific question that addresses the relationship between the number of organisms in a population and the physical (abiotic) factors of their environment.
6. Analyze a graphical representation of population data to make claims concerning short and long term trends in the population.

7. Construct a representation that illustrates the benefits and consequences of humans' use. Claims are of a specific resource(e.g. water, land, air) and identify both the impacts that can result from the extraction, transport and use of the resources, as well as the systems on Earth that are affected by these human activities.
8. Describe the advantages and disadvantages of renewable and non-renewable energy resources.
9. Construct a representation that illustrates the impact of human activities that release key greenhouse gases and aerosols.
10. Give examples, using information gathered from print and electronic resources, of human-induced disruptions to an ecosystem that can affect the composition of that ecosystem. Explain, using evidence of the relationships among different organisms and using knowledge of the interaction of organisms with the physical (abiotic) environment, why one disruption can impact the composition of the ecosystem.
11. Explain, based on knowledge of how sex cells form in sexually reproducing organisms, why there is variation among offspring, even within the same family.

Units

1. **Earth Systems and Resources**
2. **The Living World**
3. **Population**
4. **Land and Water Use**
5. **Energy Resources and Consumption**
6. **Pollution**
7. **Global Change**
8. **Cells: Structure and Function**
9. **Central Dogma and Genetics**
10. **Earth History and Evolution**

Unit Outlines

1. Earth Systems and Resources

Standards:

- Explain how biological systems interact, and how their interactions possess complex properties.

Essential Question:

- What are systems and how do they respond to change?

Essential Knowledge:

Earth Science Concepts

- List identifying characteristics about each major geologic time period
- Describe the mechanics of plate tectonics.

- Identify the types of borders between tectonic plates and the formations/events that happen at those borders
- Connect plate tectonic activities to events in the geologic time scale.
- Explain the processes that result in seasons
- Describe the relationship between solar intensity and latitude

The Atmosphere

- Describe the composition and structure of the atmosphere
- Differentiate between weather and climate
- Explain environmental impacts of the Coriolis Effect.
- Write about the interactions between the atmosphere and ocean.

Global Water Resources and Use

- Differentiate between organisms in saltwater and freshwater ecosystems
- Track global circulations of ocean currents
- Describe effects of ocean circulation
- Provide examples and relative amounts of water used for agricultural, industrial, and domestic purposes
- Analyze causes and effects of global water problems
- Outline a list of water conservation strategies

Soil and Soil Dynamics

- Follow the path of a particle through the rock cycle
- Describe process that form and break down rocks
- Compare compositions of different soil types
- Experiment with different physical and chemical properties of soil
- Examine erosion and other soil problems.
- Describe methods of soil conservation and their impact on ecosystems and agriculture

2. The Living World

Standards:

- Give examples of instances when specific organisms impact their local environment, and describe how other organisms are affected by environmental change.
- Predict what will happen to the number of organisms of a given species in an ecosystem following a temporary biotic (living) or abiotic (non-living) change in that ecosystem (e.g., a very cold winter or a disease that kills large numbers of one of the species in the

ecosystem) and what will happen after conditions return to what they were before the disruption.

- Explain similarities and differences between populations (e.g., dogs, horses, crops) undergoing artificial selection and populations undergoing natural selection. Describe the roles that humans play in artificial selection and how these roles are similar to the natural processes that take place in natural selection.

Essential Question:

- What is Biodiversity and why it important to the global environment?

Essential Knowledge:

Ecosystem Structure

- Distinguish between organism, population, species, community, ecosystem, biome, and biosphere
- Provide examples of different ecological niches that populations can have in an ecosystem
- Act out different types of interactions among species
- Contrast major terrestrial and aquatic biomes

Energy Flow

- Describe how energy from the sun is captured and transformed on earth
- Diagram the flow of energy

Ecosystem Diversity

- Differentiate between the different types of biodiversity
- Classify biomes from high-low biodiversity
- Discuss survival of the fittest and evolution by natural selection
- Present an explanation of different ecosystem services

Evolution

- Connect evolutionary changes in a population over time to a change in the environment.
- Evaluate scientific hypothesis about the origin of life on Earth.
- Make predictions about the effects of genetic drift, migration and artificial selection on the genetic makeup of a population.
- Justify the scientific claim that organisms share many conserved core processes and features that evolved and are widely distributed among organisms today.

Natural Selection

- Evaluate evidence provided by data to qualitatively and/or quantitatively investigate the role of natural selection in evolution.

- Apply mathematical methods to data from a real or simulated population to predict what will happen to the population in the future.
- Pose scientific questions about a group of organisms whose relatedness is described by a phylogenetic tree or cladogram in order to (1) identify shared characteristics, (2) make inferences about the evolutionary history of the group, and (3) identify character data that could extend or improve the phylogenetic trees.

Natural Ecosystem Change (Climate shifts; species movement; ecological succession)

- Predict how climate shifts may impact an ecosystem
- Describe possible effects of species moving into or out of an ecosystem
- Explain the process of ecological succession and the different communities that result

Natural Biogeochemical Cycles (Carbon, nitrogen, phosphorus, sulfur, water, conservation of matter)

- Describe the cycles of carbon, nitrogen, phosphorus, sulfur, and water
- Explain how humans impact each biogeochemical cycle
- Illustrate how biogeochemical cycles demonstrate the Law of Conservation of Matter

3. Population

Standards:

- Formulate a scientific question that addresses the relationship between the number of organisms in a population and the physical (abiotic) factors of their environment.
- Analyze a graphical representation of population data to make claims concerning short and long term trends in the population.

Essential Question:

- What are the relationships between populations and their environment?

Essential Knowledge:

Population Biology Concepts (Population ecology; carrying capacity; reproductive strategies; survivorship)

- Interpret effects of the dynamics of species populations
- Provide examples of different reproductive and survival strategies that organisms have evolved over time

Human Population

- Describe the changes in human population growth throughout history
- Interpret population statistics using demographic vocabulary
- Use case studies to examine different methods of sustainable population sizes
- Evaluate impacts of population growth

4. Land and Water Use

Standards:

- Construct a representation that illustrates the benefits and consequences of humans' use. Claims are of a specific resource, and identify both the impacts that can result from the extraction, transport and use of the resources, as well as the systems on Earth that are affected by these human activities.

Essential Question:

- How do land and water use affect earth's natural processes?

Essential Knowledge:

Agriculture

- Break down human nutritional requirements
- Analyze costs and benefits of agricultural strategies developed to feed a growing human population
- Evaluate causes and effects of deforestation
- Compare and contrast different irrigation strategies
- Construct a model farm using sustainable agriculture strategies
- Compare and contrast pest management strategies
- Summarize relevant laws regarding the use of pesticides

Forestry (Tree plantations; old growth forests; forest fires; forest management; national forests)

- Discuss the pros and cons of tree plantations
- Explain the benefits of old growth forests
- Analyze the benefits of forest fires
- Describe different forest management practices
- Create a travel flyer to a national forest

Rangelands (Overgrazing; deforestation; desertification; rangeland management; federal rangelands)

- Discuss the value of rangelands
- Analyze problems that face rangelands
- Describe rangeland management
- Summarize laws and regulations directing rangeland management

Other Land Use

- Support the land site choice for a new structure
- Describe environmental impacts of suburban sprawl and urbanization

- Analyze the ecosystem impact of different transportation infrastructures-federal highway systems, canals and channels, road less areas, etc;
- Discuss how public and federal lands are managed
- Describe types of federal and public lands wilderness areas, national parks, wildlife refuges, forests, wetlands, etc;
- Analyze use of land conservation options preservation, remediation, mitigation, restoration

Mining (Mineral formation; extraction; global reserves; relevant laws and treaties)

- Describe how minerals form
- Compare different mineral extraction processes
- Identify major global reserves of minerals
- Summarize relevant laws and treaties regarding mineral extraction

Fishing (Fishing techniques; overfishing; aquaculture; relevant laws and treaties)

- Compare different fishing techniques
- Analyze potential problems of overfishing
- Describe the mechanism, pros, and cons of aquaculture
- Summarize relevant laws and treaties regarding fishing

Global Economics (Globalization; World Bank; Tragedy of the Commons; relevant laws and treaties)

- Analyze environmental impacts of globalization
- Provide examples of Tragedy of the Commons
- Describe the role of the World Bank in international affairs and its impact on local ecosystems
- Summarize relevant laws and treaties regarding global economics

5. Energy Resources and Consumption

Standards:

- Describe the advantages and disadvantages of renewable and non-renewable energy resources.

Essential Question:

- Why is energy efficiency an important to ensuring earths sustainability?

Essential Knowledge:

Energy Concepts (Energy forms; power; units; conversions; Laws of Thermodynamics)

- List different forms of energy
- Describe the relationship between work, energy, and power
- Use appropriate units when describing energy
- Describe the Laws of Thermodynamics

Energy Consumption

- Diagram the history of energy consumption
- Analyze current global energy use
- Outline future energy needs

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)

- Describe the process of coal, oil, and natural gas formation
- Compare extraction/purification methods for fossil fuels
- Identify locations of major reserves and global demand
- Analyze advantages/disadvantages of sources

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)

- Explain the processes of nuclear fission and nuclear fusion
- Describe how nuclear energy is used to produce electricity
- Compare types of nuclear reactors
- Examine environmental advantages/disadvantages
- Interpret safety issues with nuclear power reactor safety, radiation and human health, radioactive wastes, etc;

Hydroelectric Power (Dams; flood control; salmon; silting; other impacts)

- Discuss the mechanism of dams
- Analyze impact of dams on ecosystems silting, flooding, thermal changes, salmon, recreational use, etc;
- List flood control strategies

Energy Conservation (Energy efficiency; CAFE standards; hybrid electric vehicles; mass transit)

- Provide examples of efforts to increase energy efficiency

- Summarize regulations and standards related to fuel economy of motor vehicles
- Defend various energy conservation efforts-hybrid electric vehicles, mass transit, etc;

Renewable Energy (Solar energy; solar electricity; hydrogen fuel cells; biomass; wind energy; small-scale hydroelectric; ocean waves and tidal energy; geothermal; environmental advantages/disadvantages)

- Compare environmental advantages/disadvantages of different types of renewable energy sources-solar energy, solar electricity, hydrogen fuel cells, biomass, wind energy, small-scale hydroelectric, ocean waves and tidal energy, and geothermal energy

6. Pollution

Standards:

- Construct a representation that illustrates the impact of human activities that release key greenhouse gases and aerosols.

Essential Question:

- What factors influence global environmental change?

Essential Knowledge:

Pollution Types

- Identify sources-primary and secondary
- Identify major air pollutants
- Use appropriate measurement units
- Differentiate between different types of smog and how they are formed
- Identify causes and effects of acid deposition
- Provide examples of heat islands and temperature inversions and describe their effects
- Describe remediation and reduction strategies
- Summarize the Clean Air Act and other relevant laws
- Identify sources of noise pollution
- Describe effects of noise pollution
- Identify measures put in place to control noise pollution
- Identify types of water pollution
- Identify sources of water pollution
- Describe causes and effects of water pollution
- Outline measures used to maintain water quality-water purification, sewage treatment/septic systems, etc;

- Summarize the Clean Water Act and other relevant laws
- Identify types of solid waste
- Describe disposal of solid waste
- Explain efforts to reduce solid waste

Impacts on the Environment and Human Health

- Describe the components of environmental risk analyses
- Differentiate between acute and chronic health effects
- Explain dose-response relationships
- Create a PSA on the impacts of pollution on human health
- Identify types of hazardous waste
- Describe the treatment/disposal/cleanup of hazardous waste
- Explain biomagnification and give examples
- Summarize laws relevant to hazardous chemicals in the environment
- Examine a cost-benefit analysis example
- Provide examples of when a cost-benefit analysis would be useful
- Identify externalities of pollution
- Identify examples of marginal social cost of pollution
- Predict the economic impact of a more sustainable society
- Execute a project to make the school more sustainable (ongoing)

7. Global Change

Standards:

- Give examples, using information gathered from print and electronic resources, of human-induced disruptions to an ecosystem that can affect the composition of that ecosystem. Explain, using evidence of the relationships among different organisms and using knowledge of the interaction of organisms with the physical (abiotic) environment, why one disruption can impact the composition of the ecosystem.

Essential Question:

- What do we know about global climate changes over the course of earth's history and what does the future hold in terms of global climate change?

Essential Knowledge:

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)

- Describe how stratospheric ozone forms
- Explain the function of stratospheric ozone
- Describe the causes and effects of ozone depletion
- Compare strategies for reducing ozone depletion
- Summarize relevant laws and treaties

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

- Identify greenhouse gases
- Paraphrase the greenhouse effect
- Explain the impacts and consequences of global warming
- Evaluate methods to reduce climate change
- Summarize relevant laws and treaties

Loss of Biodiversity

- Describe different ways biodiversity is reduced
- Provide examples of how to maintain biodiversity through conservation
- Paraphrase major laws and treaties designed to protect biodiversity

8. Cells: Structure and Function

Standards:

- Describe the structure and function of cellular structures in prokaryotes and eukaryotes
- Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.
- Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis

Essential Question:

- How does the structure of a cell help it in the goal of maintaining homeostasis?

Essential Knowledge:

Cell Structure and Function HS-LS1-2

- Compare cellular structures and their functions in prokaryotic and eukaryotic cells

- Compare cellular structures and functions in plant and animal cells

Cell Transport HS-LS1-3

- Describe how the structure of the plasma membrane allows it to function as a regulatory structure and/or protective barrier for a cell
- Compare the mechanisms that transport materials across the plasma membrane (i.e. passive transport - diffusion, osmosis, facilitated diffusion; and active transport – pumps, endocytosis, exocytosis)

Cell Cycle- HS-LS1-4

- Describe the events that occur in the cell cycle
- Make predictions about natural phenomena occurring during the cell cycle
- Describe the impacts of cancer on the cell cycle

Mitosis- HS-LS1-4

- Evaluate evidence provided by data sets to support the claim that heritable information is passed from one generation to another generation through mitosis, or meiosis followed by fertilization.

9. Central Dogma and Genetics

Standards:

- Explain, based on knowledge of how sex cells form in sexually reproducing organisms, why there is variation among offspring, even within the same family.
- Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.
- Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population

Essential Question:

- How is hereditary information inherited and expressed?

Essential Knowledge:

Meiosis- HS-LS3-2

- Describe the differences between mitosis and meiosis
- Represent the connection between meiosis and increased genetic diversity necessary for evolution.

Genetics- HS-LS3-1, HS-LS3-3

- Describe representations and models that illustrate how genetic information is copied for transmission between generations.

- Represent the connection between meiosis and increased genetic diversity necessary for evolution.

Central Dogma- HS-LS1-1.

- Construct scientific explanations that use the structures and mechanisms of DNA and RNA to support the claim that DNA and, in some cases, RNA are the primary sources of heritable information.
- Describe representations and models illustrating how genetic information is translated into polypeptides.
- Explain how mutations in the DNA strand can cause changes in the phenotype of an organism

10. Earth History and Evolution

Standards:

- Explain similarities and differences between populations (e.g., dogs, horses, crops) undergoing artificial selection and populations undergoing natural selection. Describe the roles that humans play in artificial selection and how these roles are similar to the natural processes that take place in natural selection.

Essential Question:

- How does evolution influence biodiversity?

Essential Knowledge:

Earth History- HS-LS4-5

- Analyze data related to questions of speciation and extinction throughout the Earth's history.
- Justify the selection of geological, physical, and chemical data that reveal early Earth conditions.

Evolution- HS-LS4-1, HS-LS4-2, HS-LS4-4, HS-LS4-5

- Connect evolutionary changes in a population over time to a change in the environment.
- Evaluate scientific hypothesis about the origin of life on Earth.
- Make predictions about the effects of genetic drift, migration and artificial selection on the genetic makeup of a population.
- Justify the scientific claim that organisms share many conserved core processes and features that evolved and are widely distributed among organisms today.

Natural Selection- HS-LS4-3, HS-LS4-5, HS-LS2-8

- Evaluate evidence provided by data to qualitatively and/or quantitatively investigate the role of natural selection in evolution.

- Apply mathematical methods to data from a real or simulated population to predict what will happen to the population in the future.
- Pose scientific questions about a group of organisms whose relatedness is described by a phylogenetic tree or cladogram in order to (1) identify shared characteristics, (2) make inferences about the evolutionary history of the group, and (3) identify character data that could extend or improve the phylogenetic trees.

