

Fairfield Public Schools Science Curriculum

Draft
AP Environmental Science
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Advanced Placement Environmental Science: Description

The Advanced Placement Environmental Science course is designed to be the equivalent of a one-semester, introductory college course in environmental science. The AP Environmental Science course is a multi-disciplinary course that presents the processes and interrelationships of Earth's natural systems. The course investigates the environmental issues and problems that occur within that context, both natural and man-made. Information is presented with an analytical and interdisciplinary perspective in a classroom setting, as well as in a laboratory setting with extensive field experiences. Students in this college-level course will deepen their understanding of scientific principles and concepts studied in Biology, Chemistry and Earth Science. They will identify, discuss, and constructively develop alternative solutions to resolve and/or prevent a number of environmental problems.

****This AP Science course has not yet been re-designed and is not scheduled to be re-designed until after the 2018-2019 school year.**

Enduring Understandings

- Energy conversions underlie all ecological processes.
- The Earth itself is one interconnected system.
- Humans alter natural systems.
- Environmental problems have a cultural and social context.
- Human survival depends on developing practices that will achieve sustainable systems.

Course Essential Questions

- How do ecosystems function, and how do humans impact these functions?
- How do human populations change with location and time?
- How do humans use earth's natural resources and what are the impacts, ecologically and economically, of these actions?
- How has the natural world changed with location and time historically and what are the possible changes for the future?
- How can humans live more sustainably?

AP Environmental Science: Year-at-a Glance

Unit	Title	Unit Essential Questions
1	The Living World	<ul style="list-style-type: none"> ● How are ecosystems structured? ● How do species interact? ● How is biodiversity achieved and what does it offer? ● How do ecosystems change? ● How does matter cycle in ecosystems?
2	Populations	<ul style="list-style-type: none"> ● How are populations sustained? ● How does the human population change globally? ● What are the effects of increased global populations?
3	Earth Systems and Resources	<ul style="list-style-type: none"> ● How does solar intensity affect the Earth? ● How does plate movement affect the Earth? ● How is water used? ● How does matter cycle through the rock cycle?
4	Land and Water Use	<ul style="list-style-type: none"> ● By what means do we feed an ever-growing population? ● What are the benefits and drawbacks to integrated pest management? ● What are the characteristics of urban and suburban sprawl? ● How are preservation, remediation, mitigation, and restoration used to counteract the effects of urban/suburban sprawl? ● How can land be managed more sustainably? ● By what means are mineral extracted and what are the impacts of extraction? ● What are the characteristics and impacts of globalization? ● What are some noteworthy examples of the Tragedy of the Commons?

5	Energy Resources and Consumption	<ul style="list-style-type: none"> ● How has energy use changed over time? ● How will renewable energy technologies support our future energy needs? ● What are the advantages and disadvantages of biofuels? ● What are the environmental advantages/disadvantages of nuclear power? ● What are the environmental advantages/disadvantages of dams? ● What are the environmental advantages/disadvantages of alternative energy resources?
6	Pollution	<ul style="list-style-type: none"> ● How do the primary and secondary air pollutants cause environmental degradation? ● What factors affect indoor air pollution? ● How does the Clean Air Act help to reduce air and water pollution? ● What are the common causes for water pollution? ● How do scientists analyze environmental risk? ● How is the superfund used in the cleanup of contaminated sites?
7	Global Change	<ul style="list-style-type: none"> ● How is stratospheric ozone formed? ● What are the effects of ozone depletion? ● What are the common greenhouse gases? ● What are the impacts and consequences of climate change?

AP Science Practices

Science Practice 1: The student can use representations and models to communicate scientific phenomena and solve scientific problems.

- 1.1 The student can create representations and models of natural or manmade phenomena and systems in the domain.
- 1.2 The student can describe representations and models of natural or manmade phenomena and systems in the domain.
- 1.3 The student can refine representations and models of natural or manmade phenomena and systems in the domain.
- 1.4 The student can use representations and models to analyze situations or solve problems qualitatively and quantitatively.
- 1.5 The student can re-express key elements of natural phenomena across multiple representations in the domain.

Science Practice 2: The student can use mathematics appropriately

- 2.1 The student can justify the selection of a mathematical routine to solve problems.
- 2.2 The student can apply mathematical routines to quantities that describe natural phenomena.
- 2.3 The student can estimate numerically quantities that describe natural phenomena.

Science Practice 3: The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course.

- 3.1 The student can pose scientific questions.
- 3.2 The student can refine scientific questions.
- 3.3 The student can evaluate scientific questions.

Science Practice 4: The student can plan and implement data collection strategies appropriate to a particular scientific question.

- 4.1 The student can justify the selection of the kind of data needed to answer a particular scientific question.
- 4.2 The student can design a plan for collecting data to answer a particular scientific question.
- 4.3 The student can collect data to answer a particular scientific question.
- 4.4 The student can evaluate sources of data to answer a particular scientific question

Science Practice 5: The student can perform data analysis and evaluation of evidence.

- 5.1 The student can analyze data to identify patterns or relationships.
- 5.2 The student can refine observations and measurements based on data analysis.
- 5.3 The student can evaluate the evidence provided by data sets in relation to a particular scientific question.

Science Practice 6: The student can work with scientific explanations and theories.

- 6.1 The student can justify claims with evidence.
- 6.2 The student can construct explanations of phenomena based on evidence produced through scientific practices.
- 6.3 The student can articulate the reasons that scientific explanations and theories are refined or replaced.
- 6.4 The student can make claims and predictions about natural phenomena based on scientific theories and models.
- 6.5 The student can evaluate alternative scientific explanations.

Science Practice 7: The student is able to connect and relate knowledge across various scales, concepts and representations in and across domains.

- 7.1 The student can connect phenomena and models across spatial and temporal scales.
- 7.2 The student can connect concepts in and across domain(s) to generalize or extrapolate in and/or across enduring understandings and/or big ideas.

Unit 1: The Living World

Overview

The Living World Unit investigates the structure and functioning of ecosystems, including ecosystem diversity and change, as well as how energy and matter cycle through ecosystems.

Performance Expectations

At the conclusion of this unit, students will be able to evaluate why:

- Ecosystems are structured as they are and compare differences in ecosystems across the planet.
- Species interact both intraspecifically and interspecifically.
- The importance of biodiversity as well as methods by which biodiversity can be maintained.
- Ecosystems change.
- Matter cycles in ecosystems.

Unit Essential Question

- How are ecosystems structured?
- How do species interact?
- How is biodiversity achieved and what does it offer?
- How do ecosystems change?
- How does matter cycle in ecosystems?

College Board Unit Standards

AP Essential Knowledge

The Living World

- 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)

Unit 2: Populations

Overview

The Populations Unit investigates how populations are sustained naturally, as well as how human populations vary geographically and historically. Through this unit, conclusions are drawn about how human populations influence natural populations.

Performance Expectations

At the conclusion of this unit, students will be able to evaluate why:

- Different populations are sustained in the ecosystem.
- Human populations change globally.
- Increased human populations have effects on different parts of the Earth.

Unit Essential Questions

- How are populations sustained?
- How does the human population change globally?
- What are the effects of increased global populations?

College Board Unit Standards

AP Essential Knowledge:

Population

- a. Population Biology Concepts (Population ecology, carrying capacity, reproductive strategies, survivorship)
- b. Human Population
 - i. Human population dynamics (Historical population sizes, distribution, fertility rates, growth rates and doubling times, demographic transition, age-structure diagrams)
 - ii. Population Size (Strategies for sustainability, case studies, national policies)
 - iii. Impacts of population growth (Hunger, disease, economic effects, resource use, habitat destruction)

Unit 3: Earth Systems and Resources

Overview

The Earth Systems and Resources unit investigates the earth sciences including the basics of meteorology and geology, with a focus on how both are influenced by the hydrologic cycle. Human dynamics will be incorporated by examining how water is distributed and used, as well as the effects of humans on soil dynamics.

Performance Expectations

At the conclusion of this unit, students will be able to evaluate why:

- Solar intensity affects the Earth.
- Tectonic plate movement affects the Earth.
- Water is used differently in different parts of the world.
- Matter cycles through the rock cycle

Unit Essential Questions

- How does solar intensity affect the Earth?
- How does plate movement affect the Earth?
- How is water used?
- How does matter cycle through the rock cycle?

College Board Unit Standards

AP Essential Knowledge:

Earth Systems and Resources

- 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)

Unit 4: Land and Water Use

Overview

The Land and Water Use Unit examines how humans use, and therefore, manage the land. Topics include agriculture, forestry, rangelands, urbanization, fishing, as well as sustainable design and land management strategies. Globalization will also be investigated to determine how world economies influence land use.

Performance Expectations

At the conclusion of this unit, students will be able to evaluate why:

- Food is grown for human consumption in different societies, including the varied use of fertilizers and pesticides.
- Forests and rangelands are managed globally, and the effects of these practices on the resource.
- Mineral extraction techniques have different effects on economics and the environment.
- Globalization has impacted world economies and the environment.
- The Tragedy of the Commons is detrimental to our world.

Unit Essential Questions

- By what means do we feed an ever-growing population?
- What are the benefits and drawbacks to integrated pest management?
- What are the characteristics of urban and suburban sprawl?
- How are preservation, remediation, mitigation, and restoration used to counteract the effects of urban/suburban sprawl?
- How can land be managed more sustainably?
- By what means are mineral extracted and what are the impacts of extraction?
- What are the characteristics and impacts of globalization?
- What are some noteworthy examples of the Tragedy of the Commons?

College Board Unit Standards

AP Essential Knowledge:

Land and Water Use

- a. Agriculture
 - i. Feeding a growing population (Human nutritional requirements; types of agriculture; Green Revolution; genetic engineering and crop production; deforestation; irrigation; sustainable agriculture)
 - ii. 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
 - i. Urban land development (Planned development; suburban sprawl; urbanization)
 - ii. Transportation infrastructure (Federal highway system; canals and channels; roadless areas; ecosystem impacts)
 - iii. Public and federal lands (Management; wilderness areas; national parks; wildlife refuges; forests; wetlands)
 - iv. Land conservation options (Preservation; remediation; mitigation; restoration)
 - v. 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)

Unit 5: Energy Resources and Consumption

Overview

The Energy Resources and Consumption Unit will provide an overview of energy concepts, by examining how energy sources are formed naturally and how humans use these sources to enhance life. An overarching theme in this unit is the impacts of the use of energy resources on both the environment and the economies across the landscape of the globe.

Performance Expectations

At the conclusion of this unit, students will be able to evaluate why:

- Laws of Thermodynamics apply in the real world.
- Energy use has changed with time.
- Renewable and nonrenewable energy sources are formed.
- A multitude of energy sources (coal, oil, natural gas, nuclear, biofuels, hydro, geothermal, solar, hydrogen fuel cells) can be used to generate electricity but each has its pros and cons.

Unit Essential Questions

- How has energy use changed over time?
- How will renewable energy technologies support our future energy needs?
- What are the advantages and disadvantages of biofuels?
- What are the environmental advantages/disadvantages of nuclear power?
- What are the environmental advantages/disadvantages of dams?
- What are the environmental advantages/disadvantages of alternative energy resources?

College Board Unit Standards

AP Essential Knowledge:

Energy Resources and Consumption

- a. Energy Concepts (Energy forms; power; units; conversions; Laws of Thermodynamics)
- b. Energy Consumption
 - i. History (Industrial Revolution; exponential growth; energy crisis)
 - ii. Present global energy use
 - iii. Future energy needs
- c. Fossil Fuel Resources and Use (Formation of coal, oil, and natural gas; extraction/purification methods; world reserves and global demand; synthetic fuels; 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)

Unit 6: Pollution

Overview

The Pollution Unit looks at pollution in the air, water and land. Various types of pollutants are investigated, including noise pollution, to determine how human actions influence the overall health of the ecosystem, and therefore impact human populations as a consequence. The remediation of polluted sites is also examined in this unit.

Performance Expectations

At the conclusion of this unit, students will be able to evaluate why:

- Primary and secondary air pollutants affect our atmosphere.
- Different atmospheric characteristics affect air pollution formation.
- The major indoor air pollutants have effects on humans.
- There are many solutions to reducing indoor air pollution.
- The Clean Air Act helps to reduce air pollution.
- The Clean Water Act helps to reduce water pollution.
- Scientists analyze environmental risk.

Unit Essential Questions

- How do the primary and secondary air pollutants cause environmental degradation?
- What factors affect indoor air pollution?
- How does the Clean Air Act help to reduce air and water pollution?
- What are the common causes for water pollution?
- How do scientists analyze environmental risk?
- How is the superfund used in the cleanup of contaminated sites?

College Board Unit Standards

AP Essential Knowledge:

Pollution

a. Pollution Types

- i. 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)
- ii. Noise pollution (Sources; effects; control measures)
- iii. Water pollution (Types; sources, causes, and effects; cultural eutrophication; ground- water pollution; maintaining water quality; water purification; sewage treatment/septic systems; Clean Water Act and other relevant laws)
- iv. Solid waste (Types; disposal; reduction)

b. Impacts on the Environment and Human Health

- i. Hazards to human health (Environmental risk analysis; acute and chronic effects; dose-response relationships; air pollutants; smoking and other risks)
- ii. 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)

Unit 7: Global Change

Overview

The Global Change Unit looks at large-scale environmental change with impacts affecting the entire planet. The unit defines the causes of ozone depletion, global warming and loss of biodiversity, while also outlining current and long-term effects of these topics on the ecosystem and human populations.

Performance Expectations

At the conclusion of this unit, students will be able to evaluate why:

- Stratospheric ozone is formed.
- Ozone depletion affects the ecosystem, as well as human populations.
- Greenhouse gases and the greenhouse effect have an influence on our world.
- Climate change has effects on both the environment, as well as human societies.

Unit Essential Questions

- How is stratospheric ozone formed?
- What are the effects of ozone depletion?
- What are the common greenhouse gases?
- What are the impacts and consequences of climate change?

College Board Unit Standards

AP Essential Knowledge:

Global Change

- 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
 - i. Habitat loss; overuse; pollution; introduced species; endangered and extinct species
 - ii. Maintenance through conservation
 - iii. Relevant laws and treaties