

# AP Environmental Science Syllabus

## Course Description:

This AP course is designed to give junior and senior high school students an in-depth understanding of environmental science. Included in this is the specific goal of enhancing their awareness of, their roles in, and their responsibilities to local, regional, national and global environmental issues.

## Summer Assignment:

All students enrolled in the class are required to complete a summer assignment prior to starting the course. This assignment consists of textbook readings and research papers on well-known environmental tragedies. In addition the students are required to develop a glossary of basic terms and concepts fundamental to the understanding of Environmental Science. This assignment is due on the first day of the new school year.

## Application of Mathematical Principles to Environmental Science:

Students are instructed in and must apply various mathematical skills during the course of the school year. Each student receives instruction in, and are expected to master; a) basic statistical analysis, b) modeling, c) application of mathematical problem solving using chemical formulas and laws, and d) solving word based problems. In addition, each student is expected to be able to apply metric unit conversions in problem solving.

## Student Enrollment:

Enrollment in AP Environmental Science is generally open to all interested students. Pre-requisites are Freshman Biology, Sophomore Chemistry and Algebra II. All students enrolled in the class are required to take the AP test in May of each year.

## Outside Activities:

All AP Environmental Science students are provided with the opportunity to join and participate in the school's Earth Club. This club is student driven and is instrumental in instituting various environment-based activities and projects at school.

## Schedule:

### 1<sup>st</sup> Semester

#### Chapter 1: Introduction

##### General Topics:

- What is Environmental Science?
- History of the environmental movement
  - Case Study: Migratory waterfowl
- Conservation of land and wildlife
- Toxic substances and wastes
- Important figures in the environmental movement
- Assessing environmental literature
- Scientific Method

- Experimental design
  - Field experiments
  - Lab experiments
  - Modeling
  - Controlled experiments
  - Statistical analysis
- Justifications for protecting the environment
- Terms and Concepts
- Developing skills in writing free response answers

Labs:

- Observations in the Field
- Experimental Design
- Research Project: Case Studies (Summer Assignment)
  - Love Canal, N.Y.
  - Bhopal, India
  - Chernobyl, USSR
  - Three Mile Island, Penn.
  - Minamata, Japan

## **Chapter 2: Organisms and Environment**

Topics:

- Biomes, Ecosystems, Organism, Species, Genome
- Systematic nomenclature
- Population, community, niche, habitat
- Interactions: (Includes case studies of each)
  - Predator/Prey
  - Commensalism
  - Parasite/Host
  - Mutualism
    - Symbiosis
    - Non-symbiotic mutualism
    - Endosymbiosis
    - Obligate mutualism
    - Non-obligatory mutualism
    - Mutualistic Anachronisms
  - Herbivory w/ plant defensive strategies
  - Allelopathy
  - Competition
- Competitive Exclusion Principle
- Exotic Species
- Adaptation
- Coevolution
- Evolution
  - Evolution by Natural Selection
    - Darwin and Wallace
  - Mechanisms for Evolution

Labs:

Identifying Interrelationships in the Field  
Termite Microorganisms

Research Project:

Case studies of interactions (optional)

### **Chapter 3: Biological, Chemical and Geological Cycles**

Topics:

Biological Cycles  
Law of Conservation of Matter  
Laws of Thermodynamics  
Ecosystems  
    Producers, consumers, decomposers  
Trophic levels  
Efficiency of energy transfer  
Food chains  
Food webs  
Ecological pyramids  
Keystone species  
Photosynthesis and respiration  
Chemical cycles  
    Carbon cycle  
    Carbon-silicate cycle  
    Nitrogen  
        Nitrogen fixation  
        Nitrification  
        Denitrification  
        Eutrophication  
    Phosphorus  
    Sulfur  
    Calcium  
Geological Time and Time Scale  
    Radiometric dating  
    Relative dating  
Tectonic cycle  
    Tectonic plate boundaries  
    Environmental impact of the tectonic cycle  
    Earthquakes  
    Focus and epicenter  
    Seismic waves  
        p-waves  
        s-waves  
        Surface waves  
        Seismographs and seismograms  
    Richter and Modified Mercalli scales  
    Environmental impacts of earthquakes  
    Tsunamis

Rock types and the rock cycle

Labs:

Biomass and Trophic Levels in the Field

Nitrogen Fixation (optional)

The Rock Cycle

Research Project:

Keystone Species case studies

Map: Tectonic plates

## **Chapter 4: Types of Ecosystems**

Topics:

Primary and secondary succession

Succession and chemical cycles

Biomes

Ecosystems

Desert

Grasslands

Savanna

Chaparral

Tundra

Alpine

Boreal Forest

Deciduous Forest

Tropical Rainforest

Tropical Seasonal Forest

Temperate Forest

Vertical transitions of terrestrial ecosystems

Ponds and Lakes (+seasonal turnover)

Streams and Rivers (+ riparian zone)

Wetlands (swamps, wetlands, bogs, fens, prairie potholes)

Estuary

Salt marsh

Intertidal

Coral reef

Carbonate bank

Mangrove

Continental shelf

Deep (open) ocean

Hydrothermal vents and cold seeps

Ecosystem productivity

Ecosystems and human impact

Ecosystem edge effect

Landscape ecology

Patchiness and heterogeneity

Restoration ecology

Human intervention and natural processes

Ecosystem management

Labs:

- Succession in the Field
- Pond Ecosystem
- Coal Forming Ecosystems (optional)
- Determining Environments from Sand Samples (optional)

Research Projects:

- Map: Global distributions of ecosystems
- Selected Ecosystems

## Chapter 5: Water Resources

Topics:

- Distribution of water
- World's estimated water supply
- Distribution of water in the U.S.
- Properties of water
- Origin of water
- Hydrological cycle
- Water budget
- Human impacts on the hydrological cycle and water budget
- Average use of water in the U.S.
- Water shortages and water wars
- Misuse of water case studies
  - Aral Sea
  - Colorado River
  - Nile River and Tushki Canal
- Environmental problems created by dams w/ case studies
  - Aswan Dam
- Benefits of wetlands
- Groundwater
- Porosity and permeability
- Groundwater flow
- Aquifers and aquifer distribution
- Types of aquifers; unconfined, confined, perched and karst
- Overexploitation of aquifers
  - Ogallala Aquifer
- Water rights in the U.S.
- Water sustainability
- Ownership of oceans
- Ocean resources
- Fishing methods: bottom trawling, long line, drift net, purse seine
- Aquaculture

Labs:

- Porosity and Permeability (either demo or lab)
- Aquifers of Hamilton County

Research Projects:

- China's Three Gorges Dam
- Free Response: Georges Bank Groundfish Harvest

## Chapter 6: Water Pollution

### Topics:

- Point source and non-point source
- Types of pollutants
  - Pathogens
  - Organic matter
  - Organic chemicals
  - Inorganic chemicals
  - Physical agents
  - Radioactive wastes
- Methods for determining water pollution
  - Bioassay
  - Basic water quality testing
- Toxicology
  - Synergistic interactions
  - Bioaccumulation
  - Biological magnification
  - Response to toxins
  - Variability of toxins
  - Determining toxicity
    - Dose/response curves
  - Types of damage caused by toxins
  - How toxins work
  - Organohalogenes
  - Production of synthetic chemicals
- MSDS
- Risk analysis, risk assessment, risk communication
- Drinking water standards
- Safe Drinking Water Act
- Clean Water Act
- Other Federal regulations for water
- Freshwater pollution: Rivers and streams
  - Oxygen Sag Curve
- Vernal pools
- Freshwater pollution: Ponds and lakes
  - Eutrophication
  - Seasonal turnover
  - Case study: Great Lakes
- Freshwater pollution: Groundwater
  - Contaminate plume
- Groundwater well design
- Sources of groundwater pollution
- Acid mine drainage
- Ocean pollution
  - Dead zones
- Wastewater treatment
  - Septic systems

- Municipal wastewater treatment plants
  - Primary treatment
  - Secondary treatment
  - Advanced treatment
  - Solids processing
  - Failures of wastewater treatment plants

Labs:

- Assessing Toxins Using a Bioassay
- Basic Water Quality Testing: Macroinvertebrates, DO, BOD, FC, Turbidity, Total Solids, Nitrates, Phosphates, pH, Temperature
- LD 50 w/ copper sulfate
- The Effects of Heavy Metals on Enzyme Activity (optional)
- Remediating Contaminated Surface/Groundwater (optional)

Research Projects:

- LD 50 Free Response

## Chapter 7: Air Pollution

- Ambient air
- Classification of air pollutants
  - Physical
  - Origin
  - Sequential
  - Location
- History of air pollution
  - Case studies
- Thermal inversions
- Sources and health effects of particulates
- Source and health effects of gases
  - Sulfur dioxide, carbon monoxide, nitrogen oxide, carbon dioxide, hydrocarbons, CFC's, and ozone
- Photochemical smog
- Ozone and damage caused by ozone w/ EPA maps from Airnow
- Clean Air Act
- Attainment and non-attainment areas
- Air Quality Index
- Global air pollution
  - Case studies: China, India, Asian Brown Cloud
- Grasshopper Effect
- Hazardous Air Pollutants
- Combustion reaction
  - Vehicle emission testing
- Acid Rain
  - Effects of acid rain on aquatic ecosystems
  - Effects of acid rain on terrestrial ecosystems
  - Effects of acid rain on architecture
  - Effects of acid on human health
  - Trends in acid rain

Methyl mercury  
Indoor air pollution  
Sources of indoor air pollution  
Health risks of indoor air pollution  
Sick Building Syndrome  
Formaldehyde, mold, radon, asbestos  
Noise pollution

**Labs:**

Vehicle Emissions Testing and calculations using the Ideal Gas Law  
Microbiology of Indoor Air (optional)  
Indoor Air Pollution (Particulates)

**Research Projects:**

Ozone (optional)  
Acid Rain (optional)  
Coal Power Plants (optional)

## **2<sup>ND</sup> SEMESTER**

### **Chapter 8: Atmosphere and Climate**

**Topics:**

Composition of the atmosphere  
Principle functions of the atmosphere  
Early atmosphere  
Layers of the atmosphere  
Weather and climate  
Weather maps  
Weather fronts  
Atmospheric pressure  
Air masses  
Pressure gradient force  
Coriolis force  
Jet stream  
Climate  
    Latitude  
    Seasonal variations  
    Atmosphere and air circulation patterns  
    Ocean currents  
        Case Study: Gulf Stream  
    Local geography: rain shadows  
Air cells  
Changes in climate  
    Cyclic changes: Sun spots and Milankovitch cycle  
    Irregular changes: El Nino and La Nina  
        Characteristics of El Nino and La Nina  
        Global impacts  
        El Nino and La Nina and diseases  
Catastrophic events  
    Impacts, volcanic activity, hurricanes



## Hurricanes

- Global distribution

- Classification

- Formation

- Anatomy

- Frequency

## Changes in climate through geological history

- Cambrian to recent

- Last 800,000 years

- Last 140,000 years

- Last 18,000 years

## Greenhouse Effect and Global Warming

### Greenhouse gases

- Carbon dioxide

- Ice core data and deep sea sediment data

- Kyoto Summit

- Methods to reduce carbon dioxide

### Impacts of Global Warming

### Stratigraphic Ozone Layer

- CFC cycle

- CFC products

- Thinning Ozone Layer

- Effects of ozone depletion

- Efforts to reduce ozone depletion

### Labs:

- Design an Experiment to Test the Properties of Greenhouse Gases

### Research Projects:

- El Nino and La Nina (optional)

- Causes and Effects of Hurricanes (optional)

- Climate Changes Through Geological History (optional)

## Chapter 9: Land Use

### Topics:

- Current land use in the U.S.

- Urban areas, infrastructure, urbanization and urban crisis

- Suburban sprawl, why cities sprawl

- Land use and planning

- Burgess Model

- Smart Growth

- Wedge and Corridor Model

- Fundamentals of Smart Growth

- Federal regulations:

- CERCLA

- SARA

- Brownfields

- NEPA

- EPA Model Ordinances

## Soils

- Factors of Soil Formation

- Soil profiles

- Soil types

  - Prairie

  - Boreal forest

  - Desert

  - Rainforest

  - Deciduous forest

- Soils and development

- Ranking soils and agricultural usages

- History of American agriculture and population

- Environmental impact of agriculture

- Global soil loss and degradation

- Desertification

- Salinization

## Agriculture

- Green Revolution

- Soil conservation and farming practices

- Conventional vs. No-till

- Conservation practices

- Farm Act

- Pesticides

- Integrated Pest Management

- Food and food supply

## Genetically modified foods

- Current GMO's

- GMO distribution and traits

- How crops are modified

- What foods contain GMO's

- Benefits and controversies of GMO's

## Forestry

- Sustainable forestry

- Causes of deforestation

## Mineral resources and mining

- Basic mining practices

- Environmental impacts of mining

- Formation of ore bodies

## Government lands

- Distribution

- Agencies involved in government lands

- Wilderness Act

- National Landscape Monuments

- Federal Mining Act

## Labs:

- Soil Profiles in the Field

- Characteristics of Local Soils

- Soil Texture (optional)

Basic Soil Testing  
Microbiology of Soils (optional)  
Soil Invertebrates (optional)  
Ohio Minerals (optional)  
Ores and Minerals (optional)

Research Projects:

The Debate Over Smart Growth and Urban Sprawl (optional)  
The Urban Development of SW Ohio (optional)  
Model Ordinances to Protect Local Resources (optional)  
Ores and Mining (optional)  
National Parks (optional)

## Chapter 10: Energy

Topics:

History of energy  
Energy consumption in the U.S. and globally  
Energy units  
Energy loss  
Non-renewable resources  
    Oil  
        Geological settings and exploration  
        Resource depletion curve  
        Reserves vs. resources  
        Estimating resources, oil window, recovery  
        Projected global oil depletion curve and impacts  
        Energy usage and population  
        Products and fractional distillation  
        Environmental impacts  
    Natural Gas  
        Usage, reserves and resources  
        Global distribution  
        Recovery  
        Environmental impacts  
    Coal  
        Formation and types  
        Global distribution  
        Environmental impacts  
    Nuclear  
        Fission vs. fusion  
        Isotopes of uranium  
        Fission reactors and chain reaction  
        Burner and breeder reactors  
        Global distribution of nuclear power  
        Fusion reactors  
Renewable resources  
    Biomass  
        Types and fuels

- Biodiesel
- Hydropower
  - Dams
  - Tidal
  - Wave
  - Thermal-Electric generation
- Geothermal
  - High temperature
  - Low temperature
- Solar
  - Photovoltaic cells
  - Low temperature
    - Passive
    - Active
  - Solar ponds
  - High temperature
    - Power tower
    - Parabolic trough
  - Advantages and disadvantages of solar power
- Wind
  
- Fuel Cells and batteries
  - Basics of electric current
  - Voltaic cells
  - Rechargeable batteries
  - Fuel cells
    - Half cells
    - Liquid fuel cell
    - Hydrogen fuel cell
    - Fuel production

Labs:

- Electric Generation and Energy Loss (demo)
- Biomass Distillation and Use
- Alternative and Non-Conventional Energy and Fuels

Research Projects:

- The Environmental Impact of Petroleum Exploration and Production (optional)

## **Chapter 11: Solid and Hazardous Waste**

Topics:

- History of waste
- Waste types
- Classifying wastes
  - Non-Hazardous and Hazardous
- Federal regulations
  - RCRA
  - CERCLA
  - SARA

Solid wastes

Disposal

Landfill

Location

Design (sanitary)

Recycling centers

Incinerators

Design

What is not hazardous waste?

Selected industries that generate hazardous waste

Uncontrolled releases of hazardous waste

CAP

CERCLIS

NPL

Disposal and treatment options

Incineration

Secure landfills

Above ground storage

Injection

Detoxification

Biological treatment

Chemical treatment

Regulations covering special hazardous waste

Mercury-Containing and Rechargeable Battery Act

Nuclear wastes

High and low level wastes

Types of radiation

Health effects of radiation

Longevity of radioactive wastes

Storage and disposal

DOE and Yucca Mountain

Labs:

Bioremediation of Oil

Radiation Toxicity Using Radish Seeds

Research Projects:

Selected Superfund Sites

## **Chapter 12: Populations**

Topics:

Populations and population dynamics

Population growth

Population variations

Carrying capacity

Exponential growth

Doubling time

Logistic growth

- Population vs. carrying capacity
- Overshoot and reduced carrying capacity
- Fluctuations in carrying capacity
- Population density and population growth
- Population curves
- Predator-prey interactions
- Population strategies
  - r- select
  - K-select
- Survivorship curves
- Human impacts on wildlife populations
- Global warming on wildlife populations
- Human population
  - Growth of human population
  - Thomas Malthus
  - Population change
  - Fertility rates
  - Growth and birth rates
  - Trends in birth rates
  - Mortality rates
  - Infant mortality
  - Human diseases
    - Pandemics
  - Population age structure
  - Demographic transition
  - Global carrying capacity

Labs:

- Population growth in *Lemna minor* (optional)
- Factors affecting population growth in *Escherichia coli* (optional)

Research Projects:

- Free Response Question: Gypsy Moths and Lyme Disease
- Selected Invasive Species (optional)
- Trends in Human Population (optional)

### Chapter 13: Ethics and Economics

Topics:

- Economic forces
- Economy
- Economic decisions
- Economic resources
- Types of economies
  - Environmental economics
  - Command economic system
  - Free market
  - Capitalistic market economy
  - Survival economy
- Measuring economics

- GNP
- GDP
- Problems with GDP and GNP
- Supplementing GDP and GNP
- World Bank
- Economic forces
  - Cost benefit analysis
  - Internal costs
  - Externalized costs
  - Marginal costs
- Economic models
  - Unsustainable vs. Sustainable
- Limits to growth
- Environmental ethics
- Evolution of ethics
- The Land Ethic
- Conservation ethic
- Environmental treaties and laws
  - GATT
  - NAFTA
  - CITES
  - Kyoto Accord
- Federal regulations
  - CFR
- Regional, state and local regulations
- Reading Assignments:
  - A Sand County Almanac, Part IV, A. Leopold
  - The Steady State Economy in Outline*
  - China Growth Unstable on All Counts*, AFP, 2006
  - Does Globalization Help or Hurt the World's Poor*, Scientific American, 2006
- Video Reviews:
  - Borderline Cases*
  - China From The Inside: Episode 3: Shifting Nature*
  - ABC News: Land Grab* (optional)
- Assessments:
  - Combined with Chapter 14.

## **Chapter 14: Biodiversity Through Time**

Topics:

- Biodiversity and number of species
- Factors that influence biodiversity
- Estimating past biodiversity
- Review of Geologic Time
- Extinctions in the fossil record
- Causes of mass extinctions
- Human causes of extinctions
- Types of extinctions

Extinction and speciation  
Periodicity of extinctions and speciation  
Evolutionary rebounds after extinctions  
Lifespan of species  
Susceptibility to extinction  
Extinction rates  
Co-extinctions  
Endangered species  
ESA

Research Projects:  
Selected Endangered Species