**Course No. S 970**

Orange Unified School District

# ENVIRONMENTAL SCIENCE AP

Year Course

**GRADE LEVEL:** 11-12

**PREREQUISITES:** Completion of high school Biology and Chemistry with a grade of C or higher and/or teacher recommendation.

**INTRODUCTION TO THE SUBJECT:**

Advanced Placement Environmental Science is designed to emphasize to the student the use of ecosystem concept to the study of environmental problems. This will be accomplished by learning basic information regarding interrelations of the ecosystem and applying this information in problem solving. The importance of conservation and preservation will be discussed within the constraints dictated by human development and human needs. Environmental Science is an interdisciplinary science; it embraces a wide variety of disciplines, including geology, biology, earth science, environmental science, chemistry, and geography.

This course should contribute to the development of the students' abilities to think clearly and express their ideas, orally and in writing, with clarity and logic. Students will be expected to participate in the reviews and study sessions required by the instructor in preparation for the AP Environmental exam given in May. A minimum of seven hours per week is expected to be spent by the student in unsupervised reading and study, in addition to the assigned homework and calculations. Additional mandatory labs will be occasionally scheduled beyond the regular class period.

**COURSE OBJECTIVES:**

**BY THE END OF THE COURSE THE STUDENT WILL BE ABLE TO:**

Define and describe various ecological systems, both open and closed.

Identify biotic and abiotic factors of an ecosystem.

Develop and interpret environmental model systems.

Understand basic principles of photosynthesis and respiration and apply these models of energy flow, including the concepts of trophic levels and food webs.

Describe the main material cycles of nitrogen, carbon, oxygen, and phosphorous.

Utilize the concepts of succession in real and modeled ecological systems.

Describe factors of population growth and regulation.

Demonstrate an understanding of how human population growth and dynamics function in our biosphere.

Identify and understand humankind's impact on atmosphere, soils, and hydrological cycles.

Identify renewable and nonrenewable resources.

Assess quantitatively humankind's impact on terrestrial and marine ecosystems.

Demonstrate an understanding of the principles behind and proper procedures for:

- Soil and soil profile sampling.
- Air quality sampling.
- Water quality sampling.

Demonstrate an ability to record, graph, and interpret experimental data.

Apply environmental principles in designing, setting-up, and monitoring both field and laboratory experiments.

Demonstrate competency in written and oral presentations of research data.

Gain an understanding of the interrelationships of environment, economics, and politics, in humankind's impact on the biosphere.

Demonstrate:

- An awareness of employment opportunities in environmental fields and the ability to research them.
- An understanding of chemical safety procedures.
- An understanding of hazardous materials toxicology.
- An understanding of environmental regulations.
- An understanding of recycling principals and practices.

**COURSE OVERVIEW AND APPROXIMATE UNIT TIME ALLOTMENTS:**

| | | **WEEKS** |
|---|---|---|
| I. | Interdependence of Earth's Systems: Fundamental Principles and Concepts | 9 |
| | A. The flow of energy (Physics Science Standards 3a) | |
| | 1. Forms and quality of energy | |
| | 2. Energy units and measurements, conversion | |

**WEEKS**

3. Sources and sinks (conservation)

B. The cycling of matter (Biology Science Standards 6d)
   1. Water
   2. Carbon
   3. Major nutrients
      a. Nitrogen
      b. Phosphorous
   4. Difference between cycling of major and trace elements

C. The solid earth (Earth Science Standards 3a-f)
   1. Earth history and the geological time scale
   2. Earth dynamics: plate tectonics, volcanism, the rock cycle

D. The atmosphere (Earth Science Standards 4a-c)
   1. Atmospheric history: origin, evolution, composition, and structure
   2. Atmospheric dynamics: weather and climate

E. The biosphere (Biology Science Standards 6b, 7d, 8b)
   1. Organisms: adaptations to their environments
   2. Populations and communities: exponential growth, carrying capacity
   3. Ecosystems and change: biomass, energy transfer, succession
   4. Evolution of life: natural selection, extinction

II. Human Population Dynamics (Biology Science Standards 6b, 6d) — 3

A. History of global distribution
   1. Numbers
   2. Demographics, such as birth and death rates
   3. Patterns of resource utilization

B. Carrying capacity - local, regional, global

C. Cultural and economic influences

III. Renewable and Nonrenewable Resources: Distribution, Ownership, Use, Degradation — 4

A. Water (Earth Science Standards 9c)
   1. Fresh: agricultural, industrial, domestic
   2. Oceans: fisheries, industrial

B. Minerals (Earth Science Standards 9a)

C. Soils (Chemistry Science Standards 6a-c)
   1. Soil types
   2. Erosion and conservation

D. Biological (Biological Science Standards 6a, 7d, 8b, 8c)
   1. Natural areas
   2. Genetic diversity
   3. Food and other agricultural products

**WEEKS**

E. Energy
   1. Conventional sources
   2. Alternative sources

F. Land
   1. Residential and commercial
   2. Agricultural and forestry
   3. Recreational and wilderness

IV. Environmental Quality (Biology Standards 6a-b) 7

A. Air/Water/Soil
   1. Major pollutants
      a. Types, such as $SO_2$, NOx, and pesticides
      b. Thermal pollution
      c. Measurement and units of measure such as ppm, pH, ug/L (Chemistry Science Standards 5d, 6d)
      d. Point and nonpoint sources (domestic, industrial, agricultural)

B. Effects of pollutants on:
   1. Aquatic systems
   2. Vegetation
   3. Natural features, buildings and structures
   4. Wildlife

C. Pollution reduction, remediation, and control
   1. Solid waste
      a. Types, sources, and amounts
      b. Current, disposal methods and their limitations
      c. Alternative practices in solid waste management

D. Impact on Human Health
   1. Agents: chemical and biological
   2. Effects: acute and chronic, dose-response relationships
   3. Relative risks: evaluation and response

V. Global Changes and Their Consequences (Earth Science Standards 4c, 5a, 6a-d) 6

A. First order effects (changes)
   1. Atmosphere: $CO_2$, $CH_4$, stratospheric $O_3$ (Earth Science Standards 5c)
   2. Oceans: surface temperatures, currents
   3. Biota: habitat destruction, introduced exotics, over harvesting

B. Higher-order interactions (consequences)
   1. Atmosphere: global warming, increasing ultraviolet radiation
   2. Oceans: increasing sea level, long-term climate change, (Earth Science Standards 5d)
   3. Impact on El Niño (Earth Science Standards 5g)
   4. Biota: loss of biodiversity (Biology Science Standards 6a-b)

| | | WEEKS |
|---|---|---|
| VI. | Environment and Society: Trade-Offs and Decision Making | 3 |
| | A. Economic forces | |
| | 1. Cost-benefit analysis | |
| | 2. Marginal costs | |
| | 3. Ownership and externalized costs | |
| | B. Cultural and aesthetic considerations | |
| | C. Environmental ethics | |
| | D. Environmental laws and regulations (international, national and regional) | |
| | E. Issues and options (conservation, preservation, restoration, remediation, sustainability, mitigation) | |
| VII. | Careers in the Field | 1 |
| VIII. | Research Project (Investigation and Experimentation Standards 1a, 1l, 1m) | 4 |
| | A. Define local environment problems | |
| | B. Design and conduct a field study | |
| | C. Use appropriate techniques and instrumentation | |
| | D. Perform appropriate laboratory tests | |
| | E. Analyze and interpret data | |
| | F. Identify applicable environmental laws and regulations-local, regional and federal | |
| | G. Propose possible solutions to the problems | |

**SELECTED REQUIRED LABORATORY EXPERIMENTS**

1. Introductory Environmental Journal
2. The Dynamic of Plate Tectonics: Earthquakes and Volcanic Activity
3. The Rock Cycle and Soil Formation
4. Environmental Influences on Population Distribution
5. Population Studies in the Laboratory
6. Population Studies in the Field
7. Human Population Demographics
8. Soil Analysis
9. Energy Consumptions
10. Air Pollution
11. Toxicity Testing
12. Water-Quality Testing
13. Water/Wastewater Treatment
14. Solid Waste Management
15. The Greenhouse Effect
16. Acid Deposition
17. The Effects of Radiation on Growth

**DATE OF CONTENT REVISION:** NEW

**DATE OF BOARD APPROVAL:** April 24, 2004

## ADDENDUM

California Science Content Standards Included in AP Environmental Science

### PHYSICS

**Heat and Thermodynamics**

3. Energy cannot be created or destroyed, although in many processes energy is transferred to the environment as heat. As a basis for understanding this concept:

    a. *Students know* heat flow and work are two forms of energy transfer between systems.

### CHEMISTRY

**Acids and Bases**

5. Acids, bases, and salts are three classes of compounds that form ions in water solutions. As a basis for understanding this concept:

    d. *Students know* how to use the pH scale to characterize acid and base solutions.

**Solutions**

6. Solutions are homogenous mixtures of two or more substances. As a basis for understanding this concept:

    a. *Students know* the definitions of *solute* and *solvent.*
    b. *Students know* how to describe the dissolving process at the molecular level by using the concept of random molecular motion.
    c. *Students know* temperature, pressure, and surface area affect the dissolving process.
    d. *Students know* how to calculate the concentration of a solute in terms of grams per liter, molarity, parts per million, and percent composition.

### BIOLOGY/LIFE SCIENCES

**Ecology**

6. Stability in an ecosystem is a balance between competing effects. As a basis for understanding this concept:

    a. *Students know* biodiversity is the sum total of different kinds of organisms and is affected by alterations of habitats.

b. *Students know* how to analyze changes in an ecosystem resulting from changes in climate, human activity, introduction of nonnative species, or changes in population size.
d. *Students know* how water, carbon, and nitrogen cycle between abiotic resources and organic matter in the ecosystem and how oxygen cycles through photosynthesis and respiration.

**Evolution**

7. The frequency of an allele in a gene pool of a population depends on many factors and may be stable or unstable over time. As a basis for understanding this concept:

   d. *Students know* variation within a species increases the likelihood that at least some members of a species will survive under changed environmental conditions.

8. Evolution is the result of genetic changes that occur in constantly changing environments. As a basis for understanding this concept:

   b. *Students know* a great diversity of species increases the chance that at least some organisms survive major changes in the environment.
   c. *Students know* the effects of genetic drift on the diversity of organisms in a population.

**EARTH SCIENCES**

**Dynamic Earth Processes**

3. Plate tectonics operating over geologic time has changed the patterns of land, sea, and mountains on Earth's surface. As the basis for understanding this concept:

   a. *Students know* features of the ocean floor (magnetic patterns, age, and sea-floor topography) provide evidence of plate tectonics.
   b. *Students know* the principal structures that form at the three different kinds of plate boundaries.
   c. *Students know* how to explain the properties of rocks based on the physical and chemical conditions in which they formed, including plate tectonic processes.
   d. *Students know* why and how earthquakes occur and the scales used to measure their intensity and magnitude.
   e. *Students know* there are two kinds of volcanoes: one kind with violent eruptions producing steep slopes and the other kind with voluminous lava flows producing gentle slopes.
   f. *Students know* the explanation for the location and properties of volcanoes that are due to hot spots and the explanation for those that are due to subduction.

**Energy in the Earth System**

4. Energy enters the Earth system primarily as solar radiation and eventually escapes as heat. As a basis for understanding this concept:

    a. *Students know* the relative amount of incoming solar energy compared with Earth's internal energy and the energy used by society.
    b. *Students know* the fate of incoming solar radiation in terms of reflection, absorption, and photosynthesis.
    c. *Students know* the different atmospheric gases that absorb the Earth's thermal radiation and the mechanism and significance of the greenhouse effect.

5. Heating of Earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents. As a basis for understanding this concept:

    a. *Students know* how differential heating of Earth results in circulation patterns in the atmosphere and oceans that globally distribute the heat.
    g.* *Students know* features of the ENSO (El Niño southern oscillation) cycle in terms of sea-surface and air temperature variations across the Pacific and some climatic results of this cycle.

6. Climate is the long-term average of a region's weather and depends on many factors. As a basis for understanding this concept:

    a. *Students know* weather (in the short run) and climate (in the long run) involve the transfer of energy into and out of the atmosphere.
    b. *Students know* the effects on climate of latitude, elevation, topography, and proximity to large bodies of water and cold or warm ocean currents.
    c. *Students know* how Earth's climate has changed over time, corresponding to changes in Earth's geography, atmospheric composition, and other factors, such as solar radiation and plate movement.
    d.* *Students know* how computer models are used to predict the effects of the increase in greenhouse gases on climate for the planet as a whole and for specific regions.

**California Geology**

9. The geology of California underlies the state's wealth of natural resources as well as its natural hazards. As a basis for understanding this concept:

    a. *Students know* the resources of major economic importance in California and their relation to California's geology.
    c. *Students know* the importance of water to society, the origins of California's fresh water, and the relationship between supply and need.

**INVESTIGATION AND EXPERIMENTATION**

1. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop their own questions, and perform investigations. Students will:

    a. Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.
    l. Analyze situations and solve problems that require combining and applying concepts from more than one area of science.
    m. Investigate a science-based societal issue by researching the literature, analyzing data, and communicating the findings. Examples of issues include irradiation of food, cloning of animals by somatic cell nuclear transfer, choice of energy sources, and land and water use decisions in California.