

YOSEMITE HIGH SCHOOL
50200 SCHOOL ROAD - OAKHURST, CA 93644
(559) 683-4667

COURSE TITLE: AP ENVIRONMENTAL SCIENCE
DEPARTMENT: SCIENCE

<u>REQUIREMENT SATISFIED:</u>		
High School:	X	Model Curriculum Standards:
State College:		Frameworks:
UC Approved:		

GRADE LEVEL: 11-12 LENGTH OF COURSE: 1 YEAR CREDITS: 10

PREREQUISITE: Successful completion of Biology and Chemistry with a grade of "B" or better or recommendation of previous Science instructor.

TEXTBOOKS: Living in the Environment: Principles, Connections and Solutions, G. Tyler Miller, Jr., 14th Edition

COURSE DESCRIPTION:

AP Environmental Science is designed to emphasize to the student the use of ecosystem concept to the student 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' ability 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. Only grades of A or B are weighted in IB/AP courses.

COURSE OUTLINE/ALIGNMENT TO CALIFORNIA STATE STANDARDS AND EXPECTED SCHOOLWIDE LEARNING RESULTS:

<u>Assignment</u>	<u>Standards</u>	<u>ESLRS:</u>
<u>Course Content/Objectives:</u>	<u>Addressed:</u>	
I. <u>Interdependence of Earth's Systems:</u> <u>Fundamental Principles and Concepts</u>		
a) The flow of energy	Physics 3a	1,4,5
1. Forms and quality of energy		
2. Energy units and measurements, conversion		
3. Sources and sinks (conservation)		
b) The cycling of matter	Biology 6d	1,4,5,6
1. Water		
2. Carbon		
3. Major nutrients		
a. Nitrogen		
b. Phosphorous		

COURSE OUTLINE/ALIGNMENT TO CALIFORNIA STATE STANDARDS AND EXPECTED SCHOOLWIDE LEARNING RESULTS: (Continued)

<u>Assignment</u> <u>Course Content/Objectives:</u>	<u>Standards</u> <u>Addressed:</u>	<u>ESLRS:</u>
4. Difference between cycling of major and trace elements		
c) The solid earth 1. Earth history and the geological time scale 2. Earth dynamics: plate tectonics, volcanism, the rock cycle	Earth Sci. 3a-f	1,4
d) The atmosphere 1. Atmospheric history: origin, evolution, composition, and structure 2. Atmospheric dynamics: weather and climate	Earth Sci. 4a-c	1,4,5
e) The biosphere 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	Biology 6b,7d,8b	1,3,4,5,6
II. <u>Human Population Dynamics</u> 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	Biology 6b,6d	1,3,4,6
III. <u>Renewable and Nonrenewable Resources: Distribution, Ownership, Use, Degradation</u> a) Water 1. Fresh: agricultural, industrial, domestic 2. Oceans: fisheries, industrial b) Minerals c) Soils 1. Soil types 2. Erosion and conservation d) Biological 1. Natural areas 2. Genetic diversity 3. Food and other agricultural products e) Energy 1. Conventional sources 2. Alternative sources	Earth Sci. 9c Earth Sci. 9a Chemistry 6a-c Biology 6a,7d,8b,8c	1,3,4,5,6

COURSE OUTLINE/ALIGNMENT TO CALIFORNIA STATE STANDARDS AND EXPECTED SCHOOLWIDE LEARNING RESULTS: (Continued)

<u>Assignment</u> <u>Course Content/Objectives:</u>	<u>Standards</u> <u>Addressed:</u>	<u>ESLRS:</u>
f) Land <ol style="list-style-type: none"> 1. Residential and commercial 2. Agricultural and forestry 3. Recreational and wilderness 		
IV. <u>Environmental Quality</u>	Biology 6a-b	1,3,4,5,6
a) <u>Air/Water/Soil</u> <ol style="list-style-type: none"> 1. Major pollutants <ol style="list-style-type: none"> a. Types, such as SO₂, Nox, and pesticides b. Thermal pollution c. Measurement and units of measure such as ppm, pH, ug/L d. Point and nonpoint sources (domestic, industrial, agriculture) b) Effects of pollutant on: <ol style="list-style-type: none"> 1. Aquatic systems 2. Vegetation 3. Natural features, buildings, and structures 4. Wildlife c) Pollution reduction, remediation, and control <ol style="list-style-type: none"> 1. Solid waste <ol style="list-style-type: none"> a. Types, sources, and amounts b. Current, disposal methods and their limitations c. Alternative practices in solid waste management d) Impact on Human Health <ol style="list-style-type: none"> 1. Agents: chemical and biological 2. Effects: acute and chronic, dose-response relationships 3. Relative risks: evaluation and response 	Chemistry 5d,6d	1,3,4,5,6
V. <u>Global Changes and Their Consequences</u>	Earth Sci. 4c,5a, 6a-d	1,3,4,5,6
a) <u>First order effects (changes)</u> <ol style="list-style-type: none"> 1. Atmosphere: CO₂, CH₄, stratospheric O₃ 2. Oceans: surface temperatures, currents 3. Biota: habitat destruction, introduced exotics, over harvesting 	Earth Sci. 5c	
b) <u>Higher-order interactions (consequences)</u> <ol style="list-style-type: none"> 1. Atmosphere: global warming, increasing ultraviolet radiation 2. Oceans: increasing sea level, long-term climate change 3. Impact on El Nino 4. Biota: loss of biodiversity 	Earth Sci. 5d Earth Sci. 5g Biology 6a-b	1,3,4,5,6

COURSE OUTLINE/ALIGNMENT TO CALIFORNIA STATE STANDARDS AND EXPECTED SCHOOLWIDE
LEARNING RESULTS: (Continued)

<u>Assignment</u> <u>Course Content/Objectives:</u>	<u>Standards</u> <u>Addressed:</u>	<u>ESLRS:</u>
VI. <u>Environment and Society: Trade-Offs and Decision Making</u> 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)		1,2,3,4,5,6
VII. <u>Careers in the Field</u>		
VIII. <u>Research Project</u> 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	Investigation and Experimentation 1a,11-m	1,3,4

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

DISTRICT/STATE CONTENT STANDARDS ADDRESSED:

Science: Physics (Grades 9-12):

Motion & Forces

1. Newton's laws predict the motion of most objects. As a basis for understanding this concept, students know:
 - 1.1 How to solve problems involving constant speed and average speed.
 - 1.2 When forces are balanced, no acceleration occurs, and thus an object continues to move at a constant speed or stays at rest (Newton's First Law).
 - 1.3 How to apply the law $F=ma$ to solve one-dimensional motion problems involving constant forces (Newton's Second Law).
 - 1.4 When one object exerts a force on a second object, the second object always exerts a force of equal magnitude and opposite direction (Newton's Third Law).
 - 1.5 The relationship between the universal law of gravitation and the effect of gravity on an object at the surface of the Earth.
 - 1.6 Applying a force to an object perpendicular to the direction of its motion causes the object to change direction but not speed (for example, the Earth's gravitational force causes a satellite in a circular orbit to change direction but not speed).
 - 1.7 Circular motion requires application of a constant force directed toward the center of the circle.
 - 1.8 Newton's Laws are not exact but they provide very good approximations unless an object is moving close to the speed of light or is small enough that the quantum effects are important.
 - 1.9 How to solve two-dimensional trajectory problems.
 - 1.10 How to resolve two-dimensional vectors into their components and calculate the magnitude and direction of a vector from its components.
 - 1.11 How to solve two-dimensional problems involving balanced forces (statics).
 - 1.12 How to solve problems in circular motion, using the formula for centripetal acceleration in the following form: $a=v^2/r$.
 - 1.13 How to solve problems involving the forces between two electric charges at a distance (Coulomb's Law) or the forces between two masses at a distance (Universal gravitation).

Conservation of Energy and Momentum

2. The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects. As a basis for understanding this concept, students know:
 - 2.1 How to calculate kinetic energy using the formula $E=(1/2)mv^2$.
 - 2.2 How to calculate changes in gravitational potential energy near the Earth using the formula (change in potential energy)= mgh (change in the elevation).
 - 2.3 How to solve problems involving conservation of energy in simple systems such as falling objects.
 - 2.4 How to calculate momentum as product mv .
 - 2.5 Momentum is a separately conserved quantity, different from energy.
 - 2.6 An unbalanced force on an object produces a change in its momentum.
 - 2.7 How to solve problems involving elastic and inelastic collisions in one dimension using the principles of conservation of momentum and energy.
 - 2.8 How to solve problems involving conservation of energy in simple systems with the various sources of potential energy such as capacitors and springs.

Heat & 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, students know:
 - 3.1 Heat flow and work are two forms of energy transfer between systems.
 - 3.2 The work done by a heat engine that is working in a cycle is the difference between the heat flow into the engine at high temperature and the heat flow out at a low temperature (First Law of Thermodynamics) and that this is an example of the law of conservation of energy.
 - 3.3 Thermal energy (commonly called heat) consists of random motion and the vibrations and rotations of atoms and molecules. The higher the temperature, the greater the atomic or molecular motion.
 - 3.4 Most processes tend to decrease the order of a system over time, and energy levels are eventually distributed uniformly.
 - 3.5 Entropy is a quantity that measures the order or disorder of a system, and is larger for a more disordered system.

- 3.6 The statement "entropy tends to increase" is a law of statistical probability that governs all closed systems (Second law of Thermodynamics).
- 3.7 How to solve problems involving heat flow, work, and efficiency in a heat engine and know that all real engines have some heat flow out.

Waves

4. Waves have characteristic properties that do not depend on the type of wave. As a basis for understanding this concept, students know:
 - 4.1 Waves carry energy from one place to another.
 - 4.2 How to identify transverse and longitudinal waves in mechanical media such as springs, ropes, and the Earth (seismic waves).
 - 4.3 How to solve problems involving wavelength, frequency, and wave speed.
 - 4.4 Sound is a longitudinal wave whose speed depends on the properties of the medium in which it propagates.
 - 4.5 Radio waves, light and x-rays are different wavelength bands in the spectrum of electromagnetic waves whose speed in vacuum is approximately 3×10^8 m/s (186,000 miles/second).
 - 4.6 How to identify the characteristic properties of waves: interference (beats), diffraction, refraction, Doppler effect, and polarization.

Electronic and Magnetic Phenomena

5. Electric and magnetic phenomena are related and have many practical applications. As a basis for understanding this concept, students know:
 - 5.1 How to predict the voltage or current in simple direct current electric circuits constructed from batteries, wires, resistors, and capacitors.
 - 5.2 How to solve problems involving Ohm's law.
 - 5.3 Any resistive element in a DC circuit dissipates energy which heats the resistor. Students can calculate the power (rate of energy dissipation) in any resistive circuit element by using the formula: $\text{Power} = (\text{potential difference } IR) \text{ times } (\text{current } I) = I^2R$.
 - 5.4 The properties of transistors and their role in electric circuits.
 - 5.5 Charged particles are sources of electric fields and experience forces due to the electric fields from other charges.
 - 5.6 Magnetic materials and electric currents (moving electric charges) are sources of magnetic fields and experience forces due to magnetic fields of other sources.

- 5.7 How to determine the direction of a magnetic field produced by a current flowing in a straight wire or in a coil.
- 5.8 Changing magnetic fields produce electric fields, thereby inducing currents in nearby conductors.
- 5.9 Plasmas, the fourth state of matter, contain ions and/or free electrons and conduct electricity.
- 5.10 Electric and magnetic fields contain energy and act as vector force fields.
- 5.11 The force on a charged particle in an electric field is qE , where E is the electric field at the position of the particle and q is the charge of the particle.
- 5.12 How to calculate the electric field resulting from a point charge.
- 5.13 Static electric fields have as their source some arrangement of electric charges.
- 5.14 The force on a moving particle (with charge q_0 in a magnetic field is $qvB \sin(\alpha)$ where α is the angle between v and B (v and B are the magnitudes of vectors v and B , respectively), and students use the right-hand rule to find the direction of the force.
- 5.15 How to apply the concepts of electrical and gravitational potential energy to solve problems involving conservation of energy.

Science: Chemistry (Grades 9-12):

Atomic and Molecular

1. The Periodic Table displays the elements in increasing atomic number and shows how periodicity of the physical and chemical properties of the elements relates to atomic structure. As a basis for understanding this concept, students know:
 - a. How to relate the position of an element in the Periodic Table as its atomic number and atomic mass.
 - b. How to use the Periodic Table to identify metals, semimetals, nonmetals, and halogens.
 - c. How to use the Periodic Table to identify alkali metals, alkaline earth metals, and transition metals, and trends in ionization energy, electronegativity, and the relative sizes of ions and atoms.
 - d. How to use the Periodic Table to determine the number of electrons available for bonding.
 - e. The nucleus is much smaller in size than the atom yet contains most of its mass.
 - f. How to use the Periodic Table to identify the lanthanides and actinides, and transactinide elements, and know that the transuranium elements were man made.

- g. How to relate the position of an element in the Periodic Table to its quantum electron configuration, and reactivity with other elements in the table.
- h. The experimental basis for Thomson's discovery of the electron, Rutherford's nuclear atom, Millikan's oil drop experiment, and Einstein's explanation of the photoelectric effect.
- i. The experimental basis for the development of the quantum theory of atomic structure and the historical importance of the Bohr model of the atom.
- j. Spectral lines are a result of transitions of electrons between energy levels. Their frequency is related to the energy spacing between levels using Planck's relationship ($E=h\nu$).

Chemical Bonds

- 2. Biological, chemical, and physical properties of matter result from the ability of atoms to form bonds based on electrostatic forces between electrons and protons, and between atoms and molecules. As a basis for understanding this concept, students know:
 - a. Atoms combine to form molecules by sharing electrons to form covalent or metallic bonds, or by exchanging electrons to form ionic bonds.
 - b. Chemical bonds between atoms in molecules such as H_2 , CH_4 , NH_3 , H_2CCH_2 , N_2 , C_{12} , and many large biological molecules are covalent.
 - c. Salt crystals such as $NaCl$ are repeating patterns of positive and negative ions held together by electrostatic attraction.
 - d. In a liquid the intermolecular forces are weaker than in a solid so that the molecules can move in a random pattern relative to one another.
 - e. How to draw Lewis dot structure.
 - f. How electronegativity and ionization energy relate to bond formation.
 - g. How to identify solids and liquids held together by Van der Waals forces or hydrogen bonding and relate these forces to volatility and boiling/melting point temperatures.

Conservation of Matter and Stoichiometry

- 3. The conservation of atoms in chemical reactions leads to the principle of conservation of matter and the ability to calculate the mass of products and reactants. As a basis for understanding this concept, students know:
 - a. How to describe chemical reactions by writing balanced equations.
 - b. The quantity one mole is defined so that one mole of carbon 12 atoms has a mass of exactly 12 grams.

- c. One mole equals 6.02×10^{23} particles (atoms or molecules).
- d. How to determine molar mass of a molecules from its chemical formula and a table of atomic masses, and how to convert the mass of a molecular substance to moles, number of particles or volume of gas at standard temperature and pressure.
- e. How to calculate the masses of reactants and products in a chemical reaction from the mass of one of the reactants or products, and the relevant atomic masses.
- f. How to calculate percent yield in a chemical reaction.
- g. How to identify reactions that involve oxidation and reduction and how to balance oxidation-reduction reactions.

Gases and Their Properties

- 4. The Kinetic Molecular theory describes the motion of atoms and molecules and explains the properties of gases. As a basis for understanding this concept, students know:
 - a. The random motion of molecules and their collisions with a surface create the observable pressure on that surface.
 - b. The random motion of molecules explains the diffusion of gases.
 - c. How to apply the gas laws to relations between the pressure, temperature, and volume of any amount of an ideal gas or any mixture of ideal gases.
 - d. The values and meanings of standard temperature and pressure (STP).
 - e. How to convert between Celsius and Kelvin temperature scales.
 - f. There is no temperature lower than 0 Kelvin.
 - g. The kinetic theory of gases relates the absolute temperature of a gas to the average kinetic energy of its molecules or atoms.
 - h. How to solve problems using the ideal gas law in the form $PV=nRT$.
 - i. How to apply Dalton's Law of Partial Pressures to describe the composition gases, and Graham's Law to describe diffusion of gases.

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, students know:
 - a. The observable properties of acids, bases, and salt solutions.
 - b. Acids are hydrogen-ion-donating and bases are hydrogen-ion-accepting substances.

- c. Strong acids and bases fully dissociate and weak acids and bases partially dissociate.
- d. How to use the pH scale to characterize acid and base solutions.
- e. The Arrhenius, Bronsted-Lowry acid-base definitions.
- f. How to calculate pH from hydrogen ion concentration.
- g. Buffers stabilize pH in acid-base reactions.

Solutions

- 6. Solutions are homogenous mixture of two or more substances. As a basis for understanding this concept, students know:
 - a. Definitions of solute and solvent.
 - b. How to describe the dissolving process as a result of random molecular motion.
 - c. Temperature, pressure, and surface area affect the dissolving process.
 - d. How to calculate the concentration of a solute in terms of grams per liter, molarity, parts per million and percent composition.
 - e. The relationship between the molarity of solute in a solution, and the solution's depressed freezing point or elevated boiling point.
 - f. How molecules in solution are separated or purified by the methods of chromatography and distillation.

Chemical Thermodynamics

- 7. Energy is exchanged or transformed in all chemical reactions and physical changes of matter. As a basis for understanding this concept, students know:
 - a. How to describe temperature and heat flow in terms of the motion of molecules (or atoms).
 - b. Chemical processes can either release (exothermic) or absorb (endothermic) thermal energy.
 - c. Energy is released when a material condenses or freezes and absorbed when a material evaporates or melts.
 - d. How to solve problems involving heat flow and temperature changes, using known values of specific heat, and latent heat of phase change.
 - e. How to apply Hess' Law to calculate enthalpy change in a reaction.
 - f. How to use the Gibbs free energy equation to determine whether a reaction would be spontaneous.

Reaction Rates

8. Chemical reaction rates depend on factors that influence the frequency of collision of reactant molecules. As a basis for understanding this concept, students know:
- The rate of reaction is the decrease in concentration of reactants or the increase in concentration of products with time.
 - How reaction rates depend on such factors as concentration, temperature, and pressure.
 - The role a catalyst plays in increasing the reaction rate.
 - The definition and role of activation energy in a chemical reaction.

Chemical Equilibrium

9. Chemical equilibrium is a dynamic process at the molecular level. As a basis for understanding this concept, students know:
- How to use LeChatelier's Principle to predict the effect of changes in concentration, temperature, and pressure.
 - Equilibrium is established when forward and reverse reaction rates are equal.
 - How to write and calculate an equilibrium constant expression for a reaction.

Organic and Biochemistry

10. The bonding characteristics of carbon lead to many different molecules with varied sizes, shapes, and chemical properties, providing the biochemical basis of life. As a basis for understanding this concept, students know:
- Large molecules (polymers) such as proteins, nucleic acids, and starch are formed by repetitive combinations of simple sub-units.
 - The bonding characteristics of carbon lead to a large variety of structures ranging from simple hydrocarbons to complex polymers and biological molecules.
 - Amino acids are the building blocks of proteins.
 - The system for naming the ten simplest linear hydrocarbons and isomers containing single bonds, simple hydrocarbons with double and triple bonds, and simple molecules containing a benzene ring.
 - How to identify the functional groups which form the basis of alcohols, ketones, ethers, amines, esters, aldehydes, and organic acids.
 - The R-group structure of amino acids and how they combine to form the polypeptide backbone structure of proteins.

Nuclear Processes

11. *Nuclear processes are those in which an atomic nucleus changes, including radioactive decay of naturally occurring and man-made isotopes, nuclear fission, and nuclear fusion. As a basis for understanding this concept, students know:*
 - a. *Protons and neutrons in the nucleus are held together by strong nuclear forces which are stronger than the electromagnetic repulsion between the protons.*
 - b. *The energy release per gram of material is much larger in nuclear fusion or fission reactions than in chemical reactions: change in mass (calculated by $E=mc^2$) is small but significant in nuclear reactions.*
 - c. *Many naturally occurring isotopes of elements are radioactive, as are isotopes formed in nuclear reactions.*
 - d. *The three most common forms of radioactive decay (alpha, beta, gamma) and how the nucleus changes in each type of decay.*
 - e. *Alpha, beta, and gamma radiation produce different amounts and kinds of damage in matter and have different penetrations.*
 - f. *How to calculate the amount of a radioactive substance remaining after an integral number of half lives have passed.*
 - g. *Protons and neutrons have substructure and consist of particles called quarks.*

Science: Chemistry (Grades 9-12):

Atomic and Molecular

1. *The Periodic Table displays the elements in increasing atomic number and shows how periodicity of the physical and chemical properties of the elements relates to atomic structure. As a basis for understanding this concept, students know:*
 - a. *How to relate the position of an element in the Periodic Table as its atomic number and atomic mass.*
 - b. *How to use the Periodic Table to identify metals, semimetals, nonmetals, and halogens.*
 - c. *How to use the Periodic Table to identify alkali metals, alkaline earth metals, and transition metals, and trends in ionization energy, electronegativity, and the relative sizes of ions and atoms.*
 - d. *How to use the Periodic Table to determine the number of electrons available for bonding.*
 - e. *The nucleus is much smaller in size than the atom yet contains most of its mass.*

- f. How to use the Periodic Table to identify the lanthanides and actinides, and transactinide elements, and know that the transuranium elements were man made.
- g. How to relate the position of an element in the Periodic Table to its quantum electron configuration, and reactivity with other elements in the table.
- h. The experimental basis for Thomson's discovery of the electron, Rutherford's nuclear atom, Millikan's oil drop experiment, and Einstein's explanation of the photoelectric effect.
- i. The experimental basis for the development of the quantum theory of atomic structure and the historical importance of the Bohr model of the atom.
- j. Spectral lines are a result of transitions of electrons between energy levels. Their frequency is related to the energy spacing between levels using Planck's relationship ($E=h\nu$).

Chemical Bonds

- 2. Biological, chemical, and physical properties of matter result from the ability of atoms to form bonds based on electrostatic forces between electrons and protons, and between atoms and molecules. As a basis for understanding this concept, students know:
 - a. Atoms combine to form molecules by sharing electrons to form covalent or metallic bonds, or by exchanging electrons to form ionic bonds.
 - b. Chemical bonds between atoms in molecules such as H_2 , CH_4 , NH_3 , H_2CCH_2 , N_2 , C_{12} , and many large biological molecules are covalent.
 - c. Salt crystals such as $NaCl$ are repeating patterns of positive and negative ions held together by electrostatic attraction.
 - d. In a liquid the intermolecular forces are weaker than in a solid so that the molecules can move in a random pattern relative to one another.
 - e. How to draw Lewis dot structure.
 - f. How electronegativity and ionization energy relate to bond formation.
 - g. How to identify solids and liquids held together by Van der Waals forces or hydrogen bonding and relate these forces to volatility and boiling/melting point temperatures.

Conservation of Matter and Stoichiometry

- 3. The conservation of atoms in chemical reactions leads to the principle of conservation of matter and the ability to calculate the mass of products and reactants. AS a basis for understanding this concept, students know:

- a. How to describe chemical reactions by writing balanced equations.
- b. The quantity one mole is defined so that one mole of carbon 12 atoms has a mass of exactly 12 grams.
- c. One mole equals 6.02×10^{23} particles (atoms or molecules).
- d. How to determine molar mass of a molecules from its chemical formula and a table of atomic masses, and how to convert the mass of a molecular substance to moles, number of particles or volume of gas at standard temperature and pressure.
- e. How to calculate the masses of reactants and products in a chemical reaction from the mass of one of the reactants or products, and the relevant atomic masses.
- f. How to calculate percent yield in a chemical reaction.
- g. How to identify reactions that involve oxidation and reduction and how to balance oxidation-reduction reactions.

Gases and Their Properties

4. The Kinetic Molecular theory describes the motion of atoms and molecules and explains the properties of gases. As a basis for understanding this concept, students know:
 - a. The random motion of molecules and their collisions with a surface create the observable pressure on that surface.
 - b. The random motion of molecules explains the diffusion of gases.
 - c. How to apply the gas laws to relations between the pressure, temperature, and volume of any amount of an ideal gas or any mixture of ideal gases.
 - d. The values and meanings of standard temperature and pressure (STP).
 - e. How to convert between Celsius and Kelvin temperature scales.
 - f. There is no temperature lower than 0 Kelvin.
 - g. The kinetic theory of gases relates the absolute temperature of a gas to the average kinetic energy of its molecules or atoms.
 - h. How to solve problems using the ideal gas law in the form $PV=nRT$.
 - i. How to apply Dalton's Law of Partial Pressures to describe the composition gases, and Graham's Law to describe diffusion of gases.

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, students know:

- a. The observable properties of acids, bases, and salt solutions.
- b. Acids are hydrogen-ion-donating and bases are hydrogen-ion-accepting substances.
- c. Strong acids and bases fully dissociate and weak acids and bases partially dissociate.
- d. How to use the pH scale to characterize acid and base solutions.
- e. The Arrhenius, Bronsted-Lowry acid-base definitions.
- f. How to calculate pH from hydrogen ion concentration.
- g. Buffers stabilize pH in acid-base reactions.

Solutions

6. Solutions are homogenous mixture of two or more substances. As a basis for understanding this concept, students know:
 - a. Definitions of solute and solvent.
 - b. How to describe the dissolving process as a result of random molecular motion.
 - c. Temperature, pressure, and surface area affect the dissolving process.
 - d. How to calculate the concentration of a solute in terms of grams per liter, molarity, parts per million and percent composition.
 - e. The relationship between the molarity of solute in a solution, and the solution's depressed freezing point or elevated boiling point.
 - f. How molecules in solution are separated or purified by the methods of chromatography and distillation.

Chemical Thermodynamics

7. Energy is exchanged or transformed in all chemical reactions and physical changes of matter. As a basis for understanding this concept, students know:
 - a. How to describe temperature and heat flow in terms of the motion of molecules (or atoms).
 - b. Chemical processes can either release (exothermic) or absorb (endothermic) thermal energy.
 - c. Energy is released when a material condenses or freezes and absorbed when a material evaporates or melts.
 - d. How to solve problems involving heat flow and temperature changes, using known values of specific heat, and latent heat of phase change.

- e. How to apply Hess' Law to calculate enthalpy change in a reaction.
- f. How to use the Gibbs free energy equation to determine whether a reaction would be spontaneous.

Reaction Rates

- 8. Chemical reaction rates depend on factors that influence the frequency of collision of reactant molecules. As a basis for understanding this concept, students know:
 - a. The rate of reaction is the decrease in concentration of reactants or the increase in concentration of products with time.
 - b. How reaction rates depend on such factors as concentration, temperature, and pressure.
 - c. The role a catalyst plays in increasing the reaction rate.
 - d. The definition and role of activation energy in a chemical reaction.

Chemical Equilibrium

- 9. Chemical equilibrium is a dynamic process at the molecular level. As a basis for understanding this concept, students know:
 - a. How to use LeChatelier's Principle to predict the effect of changes in concentration, temperature, and pressure.
 - b. Equilibrium is established when forward and reverse reaction rates are equal.
 - c. How to write and calculate an equilibrium constant expression for a reaction.

Organic and Biochemistry

- 10. The bonding characteristics of carbon lead to many different molecules with varied sizes, shapes, and chemical properties, providing the biochemical basis of life. As a basis for understanding this concept, students know:
 - a. Large molecules (polymers) such as proteins, nucleic acids, and starch are formed by repetitive combinations of simple sub-units.
 - b. The bonding characteristics of carbon lead to a large variety of structures ranging from simple hydrocarbons to complex polymers and biological molecules.
 - c. Amino acids are the building blocks of proteins.
 - d. The system for naming the ten simplest linear hydrocarbons and isomers containing single bonds, simple hydrocarbons with double and triple bonds, and simple molecules containing a benzene ring.

- e. How to identify the functional groups which form the basis of alcohols, ketones, ethers, amines, esters, aldehydes, and organic acids.
- f. The R-group structure of amino acids and how they combine to form the polypeptide backbone structure of proteins.

Nuclear Processes

- 11. Nuclear processes are those in which an atomic nucleus changes, including radioactive decay of naturally occurring and man-made isotopes, nuclear fission, and nuclear fusion. As a basis for understanding this concept, students know:
 - a. Protons and neutrons in the nucleus are held together by strong nuclear forces which are stronger than the electromagnetic repulsion between the protons.
 - b. The energy release per gram of material is much larger in nuclear fusion or fission reactions than in chemical reactions: change in mass (calculated by $E=mc^2$) is small but significant in nuclear reactions.
 - c. Many naturally occurring isotopes of elements are radioactive, as are isotopes formed in nuclear reactions.
 - d. The three most common forms of radioactive decay (alpha, beta, gamma) and how the nucleus changes in each type of decay.
 - e. Alpha, beta, and gamma radiation produce different amounts and kinds of damage in matter and have different penetrations.
 - f. How to calculate the amount of a radioactive substance remaining after an integral number of half lives have passed.
 - g. Protons and neutrons have substructure and consist of particles called quarks.

Science: Biology/Life Sciences (Grades 9-12):

Cell Biology

- 1. The fundamental life processes of plants and animals depend on a variety of chemical reactions that occur in specialized areas of the organism's cells. As a basis for understanding this concept:
 - a. Students know cells are enclosed within semipermeable membranes that regulate their interaction with their surroundings.
 - b. Students know enzymes are proteins that catalyze biochemical reactions without altering the reaction equilibrium and the activities of enzymes depend on the temperature, ionic conditions, and the pH of the surroundings.
 - c. Students know how prokaryotic cells, eukaryotic cells (including those from plants and animals), and viruses differ in complexity and general structure.

- d. Students know the central dogma of molecular biology outlines the flow of information from transcription of ribonucleic acid (RNA) in the nucleus to translation of proteins on ribosomes in the cytoplasm.
- e. Students know the role of the endoplasmic reticulum and Golgi apparatus in the secretion of proteins.
- f. Students know usable energy is captured from sunlight by chloroplasts and is stored through the synthesis of sugar from carbon dioxide.
- g. Students know the role of the mitochondria in making stored chemical-bond energy available to cells by completing the breakdown of glucose to carbon dioxide.
- h. Students know most macromolecules (polysaccharides, nucleic acids, proteins, lipids) in cells and organisms are synthesized from a small collection of simple precursors.
- i. Students know how chemiosmotic gradients in the mitochondria and chloroplast store energy for ATP production.
- j* Students know how eukaryotic cells are given shape and internal organization by a cytoskeleton or cell wall or both.

Genetics

- 2. Mutation and sexual reproduction lead to genetic variation in a population. As a basis for understanding this concept:
 - a. Students know meiosis is an early step in sexual reproduction in which the pairs of chromosomes separate and segregate randomly during cell division to produce gametes containing one chromosome of each type.
 - b. Students know only certain cells in a multicellular organism undergo meiosis.
 - c. Students know how random chromosome segregation explains the probability that a particular allele will be in a gamete.
 - d. Students know new combinations of alleles may be generated in a zygote through the fusion of male and female gametes (fertilization).
 - e. Students know why approximately half of an individual's DNA sequence comes from each parent.
 - f. Students know the role of chromosomes in determining an individual's sex.
 - g. Students know how to predict possible combinations of alleles in a zygote from the genetic makeup of the parents.
- 3. A multicellular organism develops from a single zygote, and its phenotype depends on its genotype, which is established at fertilization. As a basis for understanding this concept:

- a. *Students know how to predict the probable outcome of phenotypes in a genetic cross from the genotypes of the parents and mode of inheritance (autosomal or X-linked, dominant or recessive).*
 - b. *Students know the genetic basis for Mendel's laws of segregation and independent assortment.*
 - c. *Students know how to predict the probable mode of inheritance from a pedigree diagram showing phenotypes.*
 - d. *Students know how to use data on frequency of recombination at meiosis to estimate genetic distances between loci and to interpret genetic maps of chromosomes.*
4. *Genes are a set of instructions encoded in the DNA sequence of each organism that specify the sequence of amino acids in proteins characteristic of that organism. As a basis for understanding this concept:*
- a. *Students know the general pathway by which ribosomes synthesize proteins, using tRNAs to translate genetic information in mRNA.*
 - b. *Students know how to apply the genetic coding rules to predict the sequence of amino acids from a sequence of codons in RNA.*
 - c. *Students know how mutations in the DNA sequence of a gene may or may not affect the expression of the gene or the sequence of amino acids in an encoded protein.*
 - d. *Students know specialization of cells in multicellular organisms is usually due to different patterns of gene expression rather than to differences of the genes themselves.*
 - e. *Students know proteins can differ from one another in the number and sequence of amino acids.*
 - f. *Students know why proteins having different amino acid sequences typically have different shapes and chemical properties.*
5. *The genetic composition of cells can be altered by incorporation of exogenous DNA into the cells. As a basis for understanding this concept:*
- a. *Students know the general structures and functions of DNA, RNA, and protein.*
 - b. *Students know how to apply base-pairing rules to explain precise copying of DNA during semiconservative replication and transcription of information from DNA into mRNA.*
 - c. *Students know how genetic engineering (biotechnology) is used to produce novel biomedical and agricultural products.*
 - d.* *Students know how basic DNA technology (restriction digestion by endonucleases, gel electrophoresis, ligation, and transformation) is used to construct recombinant DNA molecules.*
 - e. *Students know how exogenous DNA can be inserted into bacterial cells to alter their genetic makeup and support expression of new protein products.*

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.*
 - c. *Students know how fluctuations in population size in an ecosystem are determined by the relative rates of birth, immigration, emigration, and death.*
 - 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.*
 - e. *Students know a vital part of an ecosystem is the stability of its producers and decomposers.*
 - f. *Students know at each link in a food web some energy is stored in newly made structures but much energy is dissipated into the environment as heat. This dissipation may be represented in an energy pyramid.*
 - g. *Students know how to distinguish between the accommodation of an individual organism to its environment and the gradual adaptation of a lineage of organisms through genetic change.*

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:*
 - a. *Students know why natural selection acts on the phenotype rather than the genotype of an organism.*
 - b. *Students know why alleles that are lethal in a homozygous individual may be carried in a heterozygote and thus maintained in a gene pool.*
 - c. *Students know new mutations are constantly being generated in a gene pool.*
 - d. *Students know variation within a species increases the likelihood that at least some members of a species will survive under changed environmental conditions.*
 - e. *Students know the conditions for Hardy-Weinberg equilibrium in a population and why these conditions are not likely to appear in nature.*
 - f. *Students know how to solve the Hardy-Weinberg equation to predict the frequency of genotypes in a population, given the frequency of phenotypes.*

8. *Evolution is the result of genetic changes that occur in constantly changing environments. As a basis for understanding this concept:*
- a. *Students know how natural selection determines the differential survival of groups of organisms.*
 - 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.*
 - d. *Students know reproductive or geographic isolation affects speciation.*
 - e. *Students know how to analyze fossil evidence with regard to biological diversity, episodic speciation, and mass extinction.*
 - f. *Students know how to use comparative embryology, DNA or protein sequence comparisons, and other independent sources of data to create a branching diagram (cladogram) that shows probable evolutionary relationships.*
 - g. *Students know how several independent molecular clocks, calibrated against each other and combined with evidence from the fossil record, can help to estimate how long ago various groups of organisms diverged evolutionarily from one another.*

Physiology

9. *As a result of the coordinated structures and functions of organ systems, the internal environment of the human body remains relatively stable (homeostatic) despite changes in the outside environment. As a basis for understanding this concept:*
- a. *Students know how the complementary activity of major body systems provides cells with oxygen and nutrients and removes toxic waste products such as carbon dioxide.*
 - b. *Students know how the nervous system mediates communication between different parts of the body and the body's interactions with the environment.*
 - c. *Students know how feedback loops in the nervous and endocrine systems regulate conditions in the body.*
 - d. *Students know the functions of the nervous system and the role of neurons in transmitting electrochemical impulses.*
 - e. *Students know the roles of sensory neurons, interneurons, and motor neurons in sensation, thought, and response.*
 - f. *Students know the individual functions and sites of secretion of digestive enzymes (amylases, proteases, nucleases, lipases), stomach acid, and bile salts.*
 - g. *Students know the homeostatic role of the kidneys in the removal of nitrogenous wastes and the role of the liver in blood detoxification and glucose balance.*

- h. *Students know the cellular and molecular basis of muscle contraction, including the roles of actin, myosin, Ca^{+2} , and ATP.*
 - i. *Students know how hormones (including digestive, reproductive, osmoregulatory) provide internal feedback mechanisms for homeostasis at the cellular level and in whole organisms.*
10. *Organisms have a variety of mechanisms to combat disease. As a basis for understanding the human immune response:*
- a. *Students know the role of the skin in providing nonspecific defenses against infection.*
 - b. *Students know the role of antibodies in the body's response to infection.*
 - c. *Students know how vaccination protects an individual from infectious diseases.*
 - d. *Students know there are important differences between bacteria and viruses with respect to their requirements for growth and replication, the body's primary defenses against bacterial and viral infections, and effective treatments of these infections.*
 - e. *Students know why an individual with a compromised immune system (for example, a person with AIDS) may be unable to fight off and survive infections by microorganisms that are usually benign.*
 - f. *Students know the roles of phagocytes, B-lymphocytes, and T-lymphocytes in the immune system.*

Science: Earth Sciences (Grades 9-12):

Earth's Place in the Universe

- 1. *Astronomy and planetary exploration reveal the structure, scale, and change of our solar system over time. As a basis for understanding this concept, students know:*
 - 1.1 *How the differences and similarities among the sun, the terrestrial planets and the gas planets may have been established during the formation of the solar system.*
 - 1.2 *Evidence from Earth and moon rocks for the solar system's formation from a nebular cloud of dust and gas approximately 4.6 billion years ago.*
 - 1.3 *Evidence from geological studies of the Earth and other planets that the early Earth was very different from today.*
 - 1.4 *Evidence that the planets are much closer than the stars.*
 - 1.5 *The sun is a typical star and is powered by nuclear reactions primarily the fusion of hydrogen to form helium.*
 - 1.6 *Evidence for the dramatic effects of asteroid impacts in shaping the surface of planets and their moons, and in mass extinctions of life on Earth.*
 - 1.7 *Evidence for the existence of planets orbiting other stars.*

2. *Earth-based and space-based astronomy reveals the structure, scale, and change over time of stars, galaxies and the universe. As a basis for understanding this concept, students know:*
 - 2.1 *The solar system is located in an outer edge of the disc-shaped Milky Way galaxy which spans 100,000 light year.*
 - 2.2 *Galaxies are made of billions of stars and form most of the visible mass of the universe.*
 - 2.3 *Evidence that all elements with an atomic number greater than that of Lithium have been formed by nuclear fusion in stars.*
 - 2.4 *Stars differ in their life cycles, and visual, radio, and x-ray telescopes collect data that reveal these differences.*
 - 2.5 *Accelerators boost subatomic particles to energy levels that simulate conditions in the stars and in early history of the universe before stars formed.*
 - 2.6 *Evidence that the color, brightness, and evolution of a star are determined by a balance between gravitational collapse and nuclear fusion.*
 - 2.7 *How the red-shift from distant galaxies and the cosmic background radiation provide evidence for the "big bang" model that suggests that the universe has been expanding for 10 to 20 billion years.*

Dynamic Earth Processes

3. *Plate tectonics operating over geologic time has changed the patterns of land, sea, mountains on the Earth's surface. As the basis for understanding this concept, students know:*
 - 3.1 *Features of the ocean floor (magnetic patterns, age, and sea floor topography) provide evidence for plate tectonics.*
 - 3.2 *The principal structures that form at the three different kinds of plate boundaries.*
 - 3.3 *How to explain the properties of rocks based on the physical and chemical conditions in which they formed, including plate tectonic processes.*
 - 3.4 *Why and how earthquakes occur, and the scales used to measure their intensity and magnitude.*
 - 3.5 *Two kinds of volcanoes, one with violent eruptions producing steep slopes and the other with voluminous lava flows producing gentle slopes.*
 - 3.6 *Explanation for the location and properties of volcanoes that are due to hot spots and 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, students know:*

- 4.1 The relative amount of incoming solar energy compared with Earth's internal energy and the energy used by society.
 - 4.2 The fate of incoming solar radiation in terms of reflection, absorption, and photosynthesis.
 - 4.3 The different atmospheric gases that absorb the Earth's thermal radiation, and the mechanism and significance of the greenhouse effect.
 - 4.4 The different greenhouse conditions on Earth, Mars, and Venus, their origins and climatic consequences.
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, students know:
- 5.1 How differential heating of the Earth results in circulation patterns in the atmosphere and oceans that globally distribute the heat.
 - 5.2 The relationship between the rotation of the Earth and the circular motion of ocean currents and air in pressure centers.
 - 5.3 The origin and effects of temperature inversions.
 - 5.4 Properties of ocean water such as temperature and salinity can be used to explain the layered structure of the oceans, generation of horizontal and vertical ocean currents, and the geographic distribution of marine organisms.
 - 5.5 The distribution of rain forests and deserts on Earth in bands at specific latitudes.
 - 5.6 The interaction of wind patterns, ocean currents, and mountain ranges that results in the global pattern of latitudinal bands of rain forests and deserts.
 - 5.7 Features of the ENSO cycle (El Nino) in terms of sea-surface and air temperature variations across the Pacific and some climactic 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, students know:
- 6.1 Weather (in the short run) and climate (in the long run) involve the transfer of energy in and out of the atmosphere.
 - 6.2 Effects on climate of latitude, elevation, topography, as well as proximity to large bodies of water and cold or warm ocean currents.
 - 6.3 How the Earth's climate has changed over time, corresponding to changes in the Earth's geography, atmospheric composition and/or other factors (solar radiation, plate movements, etc.).

- 6.4 Use of computer models to predict the effects of increasing greenhouse gases on climate for the planet as a whole and for specific regions.

Biogeochemical Cycles

7. Each element on Earth moves among reservoirs in the solid Earth, oceans, atmosphere, and organisms as part of biogeochemical cycles. As a basis for understanding this concept, students know:
 - 7.1 The carbon cycle of photosynthesis and respiration, and the nitrogen cycle.
 - 7.2 The global carbon cycle in terms of the different physical and chemical forms of carbon in the atmosphere, oceans, biomass, and fossil fuels, and the movement of carbon among these reservoirs.
 - 7.3 Movement of matter among reservoirs is driven by the Earth's internal and external sources of energy.
 - 7.4 The relative residence times and flows of carbon in and out of its different reservoirs.

Structure and Composition of the Atmosphere

8. Life has changed Earth's atmosphere and changes in the atmosphere affect conditions for life. As a basis for understanding this concept, students know:
 - 8.1 The thermal structure and chemical composition of the atmosphere.
 - 8.2 How the composition of the Earth's atmosphere has evolved over geologic time including outgassing, the origin of atmospheric oxygen, and variations in carbon dioxide concentration.
 - 8.3 The location of the ozone layer in the upper atmosphere, its role in absorbing ultraviolet radiation and how it varies both naturally and in response to human activities.

California Geology

9. The geology of California underlies the state's wealth of natural hazards. As a basis for understanding this concept, students know:
 - 9.1 The resources of major economic importance in California and their relation to California's geology.
 - 9.2 The principal natural hazards in different California regions, and the geological basis of those hazards.
 - 9.3 The importance of water to society, the origins of California's fresh water, and the relationship between supply and need.
 - 9.4 How to analyze published geologic hazard maps of California and use the map information to identify evidence of geological events of the past and predict geological changes in the future.

Investigation and Experimentation

10. *Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept, and to address the content of the four other strands, students should develop their own questions and perform investigations. Students will:*
 - 10.1 *Select and use appropriate tools and technology (such as computer linked probes, spread sheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.*
 - 10.2 *Identify and communicate the sources of error inherent in experimental design.*
 - 10.3 *Identify discrepant results and identify possible sources of error or uncontrolled conditions.*
 - 10.4 *Formulate and revise explanations using logic and evidence.*
 - 10.5 *Apply mathematical relationships involving quadratic equations, simple trigonometric relationships, exponential growth and decay laws, and logarithmic relationships to scientific situations.*
 - 10.6 *distinguish between a guess, a hypothesis and a theory as these terms are used in science.*
 - 10.7 *Recognize the use and limitations of models and theories as scientific representations of reality.*
 - 10.8 *Read and interpret a topographic map, and a geologic map for evidence.*
 - 10.9 *Observe natural phenomena and analyze their location, sequence, or time intervals (e.g., relative ages of rocks, locations of planets over time, and succession of species in an ecosystem).*
 - 10.10 *Recognize the issues of statistical variability and the need for controlled tests.*
 - 10.11 *Recognize the cumulative nature of scientific evidence.*
 - 10.12 *Analyze situations and solve problems that require combining concepts from more than one topic area of science and applying these concepts.*
 - 10.13 *Investigate a science-based societal issue by researching the literature, analyzing data where appropriate and communicating their finding.*
 - 10.14 *Know that when an observation does not agree with an accepted scientific theory, sometimes the observation is mistaken or fraudulent (e.g., Piltdown Man fossil or unidentified flying objects), and sometimes the theory is wrong (e.g., Ptolemaic model of the movement of the sun, moon, and planets).*

OUTCOMES:

Students will be able to ...

1. Define and describe various ecological systems, both open and closed.
2. Identify biotic and abiotic factors of an ecosystem.
3. Develop and interpret environmental model systems.
4. Understand basic principles of photosynthesis and respiration and apply these models of energy flow, including the concepts of trophic levels and food webs.
5. Describe the main material cycles of nitrogen, carbon, oxygen, and phosphorous.
6. Utilize the concepts of succession in real and modeled ecological systems.
7. Describe factors of population growth and regulation.
8. Demonstrate an understanding of how human population growth and dynamics function in our biosphere.
9. Identify and understand humankind's impact on atmosphere, soils, and hydrological cycles.
10. Identify renewable and nonrenewable resources.
11. Demonstrate an understanding of the principles behind and proper procedures for:
 - soil and soil profile sampling
 - air quality sampling
 - water quality sampling
12. Demonstrate an ability to record, graph, and interpret experimental data.
13. Apply environmental principles in designing, setting-up, and monitoring both field and laboratory experiments.
14. Demonstrate competency in written and oral presentations of research data.
15. Gain an understanding of the interrelationships of environment, economics, and politics, in humankind's impact on the biosphere.
16. 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 principles and practices

INSTRUCTIONAL STRATEGIES:
(i.e., Lectures, discussions, class projects, etc.)

ASSESSMENT:
(i.e., Exams, Standards Master, Portfolios, etc.)

