Course No. S 976

Orange Unified School District

ADVANCED PLACEMENT BIOLOGY

Year Course

GRADE LEVEL: 10 - 12

PREREQUISITES : Biology with a grade of A and/or teacher recommendation. Completion of chemistry is highly recommended.

INTRODUCTION TO THE SUBJECT:
The Advanced Placement Biology course is a second year course designed for those highly motivated students who have a desire to do college-level work. Emphasis will be placed on passing the Advanced Placement test for biology in May. Passing of this test may enable the student to earn college credit for this course. The course will include the three major areas of biological sciences: molecular and cellular; organismic; ecological and evolutionary. Regular testing, both essay and objective, will take place during the course. Due to the extensive quantity of material to be covered, it is expected that students will study much of the material on an independent basis. Laboratory work will be an important part of the course and will emphasize quantitative measurements made with biological systems.

COURSE OBJECTIVES:

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

Design a controlled experiment and implement it.

Identify assumptions made, independent and dependent variables, controls, and experimental errors found within experiments performed.

Collect, organize, and analyze data.

Provide example of evolution as a unifying theme in biology.

Identify energy storage, usage, and transfer processes at biochemical, organismal, and ecological levels.

Describe the structure and function of DNA.

Identify DNA's importance in providing both continuity and change in life forms over time.

Give examples of the relationship of structure to function at the biochemical, cellular, organ, system, and organismal level.

Define homeostasis and explain its importance in regulating cellular, organismal, and ecological systems.

Explain the unity, diversity, and interdependence of life.

Discuss the application of biological concepts to new situations including those involving man and society .

COURSE OVERVIEW AND APPROXIMATE UNIT TIME ALLOTMENTS:

FIRST SEMESTER

	TOPICS	**WEEKS**
I.	Molecules and Cells	2
	A. Chemistry of Life	
	1. Basic chemistry	
	2. Chemistry of water	
	3. Organic molecules: structure and function of carbohydrates, lipids, proteins, nucleic acids	
	4. Energetics: free energy change and entropy	
	5. Enzymes	
	a. Enzyme-substrate complex	
	b. Factors affecting the rate and/or direction of enzyme reactions	
	B. Cells	3
	1. Prokaryotic versus eukaryotic cells	
	2. Structure and function of cell organelles	
	3. Movement of materials across cell membranes	
	4. Cell cycle and regulation: growth, DNA replication, mitosis, and cytokinesis	

		WEEKS
C.	Cellular Energetics	2
1.	Structure and function of ATP	
2.	Chemiosmosis	
3.	Aerobic cellular respiration: glycolysis, Kreb's cycle, electron transport	
4.	Fermentation	
D.	Photosynthesis	2
1.	Light reactions: photolysis, chemiosmosis	
2.	Dark reactions/Calvin cycle	
3.	C_3 versus C_4 plants, CAM plants	
4.	Plant leaf structure and photosynthesis	
II.	Heredity and Evolution	3
A.	Heredity	
1.	Meiosis and gametogenesis	
2.	Sources of genetic variation	
3.	Mendel's laws of inheritance	
4.	Variations of genetic inheritance to include non-Mendelian genetics	
B.	Molecular Genetics	3
1.	DNA and RNA structure and function	
2.	DNA replication	
3.	Gene expression and regulation	
4.	Prokaryotic versus eukaryotic gene expression and reproduction	
5.	DNA technology	
a.	Recombinant DNA	
b.	Legal and ethical problems	
C.	Evolutionary Biology	3
1.	Organic evolution	
2.	Models for the origins of prokaryotic and eukaryotic cells	
3.	Evidence for evolution	
4.	Mechanisms of evolution	
a.	Factors affecting Hardy-Weinberg equilibrium and microevolution	
b.	Modes of speciation	
	Total:	18

WEEKS

SECOND SEMESTER

III. Organisms and Populations

A. Survey and characteristics of major kingdoms: Monera, Protista, Fungi, Animalia, and Plantae — 3

B. Structure and Function of plants — 5

1. Alternation of generations in mosses, ferns, gymnosperms, angiosperms, and its evolutionary significance
2. Plant structure and growth: roots, stems, and leaves
3. Seed formation, structure, and development
4. Hormonal control of plant activities
5. Mechanisms influencing transport of water, minerals, and food

C. Animals — 6

1. Survey and characteristics of major phyla of animals
2. Embryology
   a. stages of embryological development, germ layer formation, and derivatives
   b. Coelom formation and taxonomies
3. Comparative anatomy and physiology of vertebrate systems, to include:
   a. Reproductive
   b. Circulatory
   c. Respiratory
   d. Endocrine
   e. Digestive
   f. Skeletal
   g. Nervous
   h. Neuro-muscular interactions

D. Ecology — 4

1. Factors affecting population growth
   a. Abiotic
   b. Biotic - density dependent and density independent

WEEKS

2. Communities, ecosystems, and biomes
   a. Energy flow: food chains, webs, and pyramids
   b. Differentiation of major biomes
3. Cycling of elements through ecosystems
4. Ecological succession
5. Symbiotic relationships
6. Science, technology, and society

Total: 18

This course meets and exceeds the Biology/Life Sciences California State Content Standards which follow in the Appendix.

DATE OF CONTENT REVISION: February 1999

DATE OF BOARD APPROVAL: April 15, 1999

APPENDIX

BIOLOGY / LIFE SCIENCES

Cell Biology

1. Fundamental life processes of plants and animals depend on a variety of chemical reactions that are carried out in specialized areas of the organism's cells. As a basis for understanding this concept, students know:

    a. Cells are enclosed within semi-permeable membranes that regulate their interaction with their surroundings.
    b. Enzymes are proteins and catalyze biochemical reactions without altering the reaction equilibrium. The activity of enzymes depends on the temperature, ionic conditions and pH of the surroundings.
    c. How prokaryotic cells, eukaryotic cells (including those from plants and animals), and viruses differ in complexity and general structure.
    d. The Central Dogma of molecular biology outlines the flow of information from transcription of RNA in the nucleus to translation of proteins on ribosomes in the cytoplasm.
    e. The role of the endoplasmic reticulum and Golgi apparatus in secretion of proteins.
    f. Usable energy is captured from sunlight by chloroplasts, and stored via the synthesis of sugar from carbon dioxide.
    g. The role of the mitochondria in making stored chemical bond energy available to cells by completing the breakdown of glucose to carbon dioxide.
    h. Most macromolecules (polysaccharides, nucleic acids, proteins, lipids) in cells and organisms are synthesized from a small collection of simple precursors.
    i.* How chemosmotic gradients in the mitochondria and chloroplast store energy for ATP production.
    j.* How eukaryotic cells are given shape and internal organization by a cytoskeleton and/or cell wall.

Genetics

2. Mutation and sexual reproduction lead to genetic variation in a population. As a basis for understanding this concept, students know:

    a. 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. Only certain cells in a multicellular organism undergo meiosis.
c. How random chromosome segregation explains the probability that a particular allele will be in a gamete.
d. New combinations of alleles may be generated in a zygote through fusion of male and female gametes (fertilization).
e. Why approximately half of an individual's DNA sequence comes from each parent.
f. The role of chromosomes in determining an individual's sex.
g. 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, students know:

a. 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. The genetic basis for Mendel's laws of segregation and independent assortment.
c.* How to predict the probable mode of inheritance from a pedigree diagram showing phenotypes.
d* How to use data on frequency of recombination at meiosis to estimated 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, students know:

a. The general pathway by which ribosomes synthesize proteins, using tRNAs to translate genetic information in mRNA.
b. How to apply the genetic coding rules to predict the sequence of amino acids from a sequence of codons in RNA.
c. How mutations in the DNA sequence of a gene may or may not affect the expression of the gene, or the sequence of animo acids in an encoded protein.
d. Specialization of cells in multicellular organisms is usually due to different patterns of gene expression rather than to differences of the genes themselves.
e. Proteins can differ from one another in the number and sequence of amino acids.
f.* 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, students know:

a. The general structures and functions of DNA, RNA, and protein.
b. How to apply base-pairing rules to explain precise copying of DNA during semi-conservative replication, and transcription of information from DNA into mRNA.
c. How genetic engineering (biotechnology) is used to produce novel biomedical and agricultural products.
d.* How basic DNA technology (restriction digestion by endonucleases, gel electrophoresis, ligation, and transformation) is used to construct recombinant DNA molecules.
e.* How exogenous DNA can be inserted into bacterial cells in order 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, students know:

a. Biodiversity is the sum total of different kinds of organisms, and is affected by alterations of habitats.
b. How to analyze changes in an ecosystem resulting from changes in climate, human activity, introduction of non-native species, or changes in population size.
c. How fluctuations in population size in an ecosystem are determined by the relative rates of birth, immigration, emigration, and death.
d. How water, carbon, and nitrogen cycle between abiotic resources and organic matter in the ecosystem and how oxygen cycles via photosynthesis and respiration.
e. A vital part of an ecosystem is the stability of its producers and decomposers.
f. At each link in a food web, some energy is stored in newly made structures but much is dissipated into the environment as heat and this can be represented in a food pyramid.
g.* 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, students know:

a. Why natural selection acts on the phenotype rather than the genotype of an organism.

b. Why alleles that are lethal in a homozygous individual may be carried in a heterozygote, and thus maintained in a gene pool.
c. New mutations are constantly being generated in a gene pool.
d. Variation within a species increases the likelihood that at least some members of a species will survive under changed environmental conditions.
e.* The conditions for Hardy-Weinberg equilibrium in a population, and why these conditions are not met in nature.
f.* How to solve the Hardy-Weinberg equation to determine the predicted 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, students know:

a. How natural selection determines the differential survival of groups of organisms.
b. A great diversity of species increases the chance that at least some organisms survive large changes in the environment.
c. The effects of genetic drift on the diversity of organisms in a population.
d. Reproductive or geographic isolation affects speciation.
e. How to analyze fossil evidence with regard to biological diversity, episodic speciation, and mass extinction.
f.* How to use comparative embryology, DNA or protein sequence comparisons, and other independent sources to create a branching diagram (cladogram) that shows probable evolutionary relationships.
g.* How several independent molecular clocks, calibrated against each other and using evidence from the fossil record, can help to estimate how long ago various groups of organisms diverged evolutionarily from each other.

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, students know:

a. How the complementary activity of major body systems provides cells with oxygen and nutrients, and removes toxic waste products such as carbon dioxide.
b. How the nervous system mediates communication between different parts of the body and interactions with the environment.
c. How feedback loops in the nervous and endocrine systems regulate conditions within the body.
d. The functions of the nervous system, and the role of neurons in transmitting electrochemical impulses.

e. The roles of sensory neurons, interneurons, and motor neurons in sensation, thought, and response.
f.* The individual functions and sites of secretion of digestive enzymes (amylases, proteases, nucleases, lipases), stomach acid, and bile salts.
g.* The homeostatic role of the kidneys in the removal of nitrogenous wastes, and of the liver in blood detoxification and glucose balance.
h.* The cellular and molecular basis of muscle contraction, including the roles of actin, myosin, Ca^{+2}, and ATP.
i.* 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, students know:

a. The role of the skin in providing nonspecific defenses against infection.
b. The role of antibodies in the body's response to infection.
c. How vaccination protects an individual from infectious diseases.
d. There are important differences between bacteria and viruses, with respect to their requirements for growth and replication, the primary defense of the body against them, and effective treatment of infections they cause.
e. Why an individual with a compromised immune system (for example, a person with AIDS) may be unable to fight off and survive infections of microorganisms that are usually benign.
f.* The roles of phagocytes, B-lymphocytes, and T-lymphocytes in the immune system.

These are the ten major parts of the Biology/Life Sciences standards.

*Standards without asterisks represent those that all students are expected to achieve in the course of their studies. Standards with asterisks represent those that all students should have the opportunity to learn.