Curriculum Development
In the Fairfield Public Schools

FAIRFIELD PUBLIC SCHOOLS
FAIRFIELD, CONNECTICUT

ADVANCED PLACEMENT BIOLOGY

APPROVED 2/28/2006

ADVANCED PLACEMENT BIOLOGY

Statement Of Purpose
Advanced Placement Biology is offered to students with an intense interest in the science of Biology. It aims to provide students with the conceptual framework, factual knowledge, and analytical skills necessary to deal critically with the rapidly changing science of biology.

Audience
Advanced Placement Biology a full-year, two-credit course designed for academically motivated, high achieving grade 11 or 12 students with an intense interest in Biology.

Prerequisites
Recommendation by science teacher
"B" or better in Biology 21 and Chemistry 31

Design and Description
Advanced Placement Biology is designed to be the equivalent of a two-semester college introductory course for Biology majors. The course meets seven periods per week including two double lab periods. The main topics of the course are molecules and cells, heredity and evolution, and organisms and populations. Students are strongly encouraged to take the Advanced Placement examination in May. Students also have the opportunity to earn up to eight college Biology major credits through the UCONN ECE program. The Advanced Placement Biology course is a college-level laboratory course. It explores the following topics: biochemistry, cellular biology, cellular energetics, heredity, molecular genetics, evolutionary biology, the diversity of organisms, the structure and function of plants and animals, and ecology. The laboratory component includes vertebrate anatomy as well as all of the Advanced Placement Biology labs recommended in the AP syllabus. Students are expected to do extensive reading outside of class including the summer prior to taking the course. Students are expected to analyze, synthesize, and think critically, be self-motivated, and see more than one way to solve a problem.

Course Objectives
Students will be able to:

- apply science as a process that includes repeatable observations and testable hypothesis.
- design an experiment that is scientifically valid and explain its validity.
- identify biological levels of organization and distinguish emergent properties at each level.
- distinguish evolution as the core theme of biology.
- conclude that organisms are open systems that interact with the environment.
- debate the important biological environmental and ethical questions in today's society.
- identify the major themes in biology:
    1. Science as a process

2. Evolution
3. Energy transfer
4. Continuity and change
5. Relationship of structure to function
6. Regulation
7. Interdependence in nature
8. Science, society and technology

- relate how the unique chemical and physical properties of water make life on Earth possible.
- relate the structure of the carbon atoms and biochemicals and account for their functions.
- analyze how cells synthesize and break down macromolecules
- predict how the laws of thermodynamics are related to biochemical processes that provide energy to living systems.
- explain how the feedback mechanisms at the chemical level regulate reactions in living systems.
- investigate the role of ATP coupling in metabolic pathways.
- explain how enzyme structure results in specificity and regulation mechanisms that relate to metabolic control
- evaluate the evolutionary relationships between prokaryotic and eukaryotic cell
- decide how variations in the structure of the cell membrane account for functional differences among membranes and compare the processes by which substances cross membranes.
- measure the role of water potential in passive transport.
- differentiate the types of communication by comparing and contrasting signal transduction pathways.
- relate the structure of cell organelles and cell compartmentalization to cell function.
- illustrate how the cell cycle assures genetic continuity
- explain how the cell cycle is regulated and predict how aberrations in the cell cycle lead to tumor formation
- compare and contrast chemiosmosis in cellular respiration and photosynthesis.
- compare ATP generation in anaerobic and aerobic energy yielding pathways including oxidation-reduction reactions in the electron transport chain
- explain how the chemical products of the light-dependent reactions are coupled to the synthesis of carbohydrates.
- discuss photosynthetic adaptations via pathways in different environmental conditions.
- derive the interactions between photosynthesis and cellular respiration.
- explain the features of meiosis that are important in sexual reproduction and heredity
- illustrate how meiosis is related to gametogenesis
- compare and contrast the similarities and differences in gametogenesis in plants and animals
- distinguish the levels of organization of genetic information in eukaryotes

- explain how levels of organization relate to continuity and variability in eukaryotes
- investigate how Mendel's work laid the foundation for modern genetics
- solve problems using principle patterns of inheritance
- measure the reliability of scientific experimentation using statistical techniques on genetic predictions
- relate the structure of nucleic acids to the functional properties of information storage and protein synthesis
- compare and contrast the similarities and differences of prokaryotic and eukaryotic genomes
- differentiate between the three major processes of genetic recombination in prokaryotes and their implications for prokaryotic modification
- explain how scientists concluded that nucleic acids are the genetic material
- explain how genetic information can be altered and analyze the effects of these alterations
- describe the role of viruses in the transfer of genetic material between cells
- categorize some current DNA technologies and measure their effects
- debate legal and ethical questions arising from applications of nucleic acid technology
- explain current biological models for the origin of macromolecules and the origin of prokaryotic and eukaryotic cells
- debate the evidence that supports the evolutionary theory of life
- explain how heredity and natural selection are involved in the evolutionary process
- compare and contrast the mechanisms that account for speciation and natural selection
- discuss the patterns that are present in evolution and the mechanisms responsible for these patterns
- compare and contrast the major body plans in plants and animals
- discuss the evolution of higher classifications of bacteria, archaebacteria, protista, fungi, animals and plants
- interpret how scientists study evolutionary relationships among organisms
- discuss the techniques used in biosystematics
- construct a cladogram using techniques of cladistics
- investigate the life cycles of bacteria, protists, and fungi
- interpret the evolution of major animal phyla and plant divisions
- explain the patterns and regulation of reproduction and development in plants and animals
- investigate the organization, relatedness, and interaction of cells, tissues, and organ systems in plants and animals
- differentiate between the adaptive features of plants and animals and their responses to their environmental cues contribute to their success
- demonstrate knowledge of structure and function in actual mammalian specimens
- explain how hormones mediate responses of organisms to their environment
- interpret the use of models in measuring population size and growth

- explain how energy flow through an ecosystem relates to trophic structure
- derive the effect of organisms on element and water cycles
- explain how population size, community structure, and ecosystem function are related by biotic and abiotic factors
- debate the impact of humans on ecological structure of the biosphere

Science Standards

Scientific Inquiry (used in units)

- Scientific inquiry is a thoughtful and coordinated attempt to search out, describe, explain and predict natural phenomena.
- Scientific inquiry progresses through a continuous process of questioning, data collection, analysis and interpretation.
- Scientific inquiry requires the sharing of findings and ideas for critical review by colleagues and other scientists.

Scientific Literacy (used in all units)

- Scientific literacy includes the ability to read, write, discuss and present coherent ideas about science.
- Scientific literacy also includes the ability to search for and assess the relevance and credibility of scientific information found in various print and electronic media.

Scientific Numeracy

Scientific numeracy includes the ability to use mathematical operations and procedures to calculate, analyze and present scientific data and ideas.

Students will communicate about science in different formats, using relevant science vocabulary, supporting evidence and clear logic.

Cell Biology

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

Genetics

Mutation and sexual reproduction lead to genetic variation in a population.

A multi-cellular organism develops from a single zygote, and its phenotype depends on its genotype, which is established at fertilization.

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.

The genetic composition of cells can be altered by incorporation of exogenous DNA into the cells

Evolution
The frequency of an allele in a gene pool of a population depends on many factors and may be stable or unstable over time.

Evolution is the result of genetic changes that occur in constantly changing environments.

Physiology
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.

Organisms have a variety of mechanisms to combat disease.

Ecology
Stability in an ecosystem is a balance between competing effects

Information and Technology Standards (to be added)

Essential Questions

- How is the understanding of biological processes essential to societal issues?
- Why are biochemical properties the basis of life processes?
- How do cells carry out life processes?
- How are organisms structured to ensure efficiency and survival?
- What are the processes responsible for life's unity and diversity?
- How do science and technology affect the quality of our lives?
- Why is knowledge of the interactions of organisms with each other and their environment significant to understanding life on Earth?

Focus Questions

- How do levels of structure affect levels of function in biological systems?
- How do biochemical processes relate to cellular structure and function?
- How are cellular processes based on physical and chemical changes?
- How do cells operate as the structural and functional units of life?
- How are cellular processes based on physical and chemical changes?
- How is energy usage essential for functioning of living systems?
- What controls the passage of structural and functional information from one generation to the next?
- How does DNA function as the carrier of genetic information?
- How and why do organisms change over time?
- How are organisms structured to ensure efficiency and survival?
- How do body tissue, organs and systems interact to function in organisms?
- How is total biological success related to integration at the tissue, organ, and system levels?
- How does animal behavior relate to evolutionary success?

- How does energy flow determine the interactions of organisms and their environment?
- How does cycling determine the structure and function of the biosphere?

UNITS OF STUDY

1. INTRODUCTION – BIOLOGICAL THEMES

Science Standards

Scientific Inquiry

Scientific inquiry is a thoughtful and coordinated attempt to search out, describe, explain and predict natural phenomena.

Scientific inquiry progresses through a continuous process of questioning, data collection, analysis and interpretation.

Scientific inquiry requires the sharing of findings and ideas for critical review by colleagues and other scientists.

Scientific Literacy

Scientific literacy includes the ability to read, write, discuss and present coherent ideas about science.
Scientific literacy also includes the ability to search for and assess the relevance and credibility of scientific information found in various print and electronic media.

Scientific Numeracy

Scientific numeracy includes the ability to use mathematical operations and procedures to calculate, analyze and present scientific data and ideas.

Students will communicate about science in different formats, using relevant science vocabulary, supporting evidence and clear logic.

Essential Question

- How is the understanding of biological processes essential to societal issues?

Focus Question

- How do levels of structure affect levels of function in biological systems?

Core Topics

- Science as a process
- Energy transfer
- Relationship of structure to function
- Interdependence in nature
- Science, technology and Society

Unit Objectives

Students will be able to:

- apply science as a process that includes repeatable observations and testable hypothesis.
- design an experiment that is scientifically valid and explain its validity.

- identify biological levels of organization and distinguish emergent properties at each level.
- distinguish evolution as the core theme of biology.
- conclude that organisms are open systems that interact with the environment.
- debate the important biological environmental and ethical questions in today's society.
- identify the major themes in biology:
    - Science as a process
    - Evolution
    - Energy transfer
    - Continuity and change
    - Relationship of structure to function
    - Regulation
    - Interdependence in nature
    - Science, society and technology

Sample Assessment
(incorporated throughout the course)

Pacing
1 week

2. BIOLOGICAL CHEMISTRY

Science Standards

Cell Biology

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

Essential Question

- Why are biochemical properties the basis of life processes?

Focus Questions

- How do biochemical processes relate to cellular structure and function?
- How are cellular processes based on physical and chemical changes?

Core Topics

- Energy Transfer
- Relationship of structure to function
- Regulation

Unit Objectives

Students will be able to:

- relate how the unique chemical and physical properties of water make life on Earth possible.
- relate the structure of the carbon atoms and biochemicals and account for their functions.
- analyze how cells synthesize and break down macromolecules
- predict how the laws of thermodynamics are related to biochemical processes that provide energy to living systems.
- explain how the feedback mechanisms at the chemical level regulate reactions in living systems.
- investigate the role of ATP coupling in metabolic pathways.
- explain how enzyme structure results in specificity and regulation mechanisms that relate to metabolic control

Sample Assessment

Design an experiment to show enzyme regulation of chemical reaction rates

Pacing

2.5 weeks

3. CELLS

Science Standards

Cell Biology

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

Essential Question

- How do cells carry out life processes?

Focus Questions

- How do cells operate as the structural and functional units of life?
- How are cellular processes based on physical and chemical changes?

Core Topics

- Science as a process
- Continuity and change
- Relationship of structure to function
- Regulation

Unit Objectives

Students will be able to:

- evaluate the evolutionary relationships between prokaryotic and eukaryotic cell
- decide how variations in the structure of the cell membrane account for functional differences among membranes and compare the processes by which substances cross membranes.
- measure the role of water potential in passive transport.
- differentiate the types of communication by comparing and contrasting signal transduction pathways.
- relate the structure of cell organelles and cell compartmentalization to cell function.
- illustrate how the cell cycle assures genetic continuity
- explain how the cell cycle is regulated and predict how aberrations in the cell cycle lead to tumor formation

Sample Assessment

Measure the rates of stages in mitosis

Pacing

2.5 weeks

4. CELLULAR ENERGETICS

Science Standards

Cell Biology

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

Essential Question

- How are organisms structured to ensure efficiency and survival?

Focus Question

- How is energy usage essential for functioning of living systems?

Core Topics

- Energy transfer
- Continuity and change
- Relationship of structure to function
- Regulation

Unit Objectives

Students will be able to:

- compare and contrast chemiosmosis in cellular respiration and photosynthesis.
- compare ATP generation in anaerobic and aerobic energy yielding pathways including oxidation-reduction reactions in the electron transport chain
- explain how the chemical products of the light-dependent reactions are coupled to the synthesis of carbohydrates.
- discuss photosynthetic adaptations via pathways in different environmental conditions.
- derive the interactions between photosynthesis and cellular respiration.

Sample Assessment

Measure the rates of photosynthesis and respiration under controlled conditions

Pacing

2.5 weeks (end marking period 1)

5. HEREDITY

Science Standards

Genetics

Mutation and sexual reproduction lead to genetic variation in a population.

Essential Question

- What are the processes responsible for life's unity and diversity?

Focus Question

- What controls the passage of structural and functional information from one generation to the next?

Core Topics

- Science as a process
- Continuity and change

Unit Objectives

Students will be able to:

- explain the features of meiosis that are important in sexual reproduction and heredity
- illustrate how meiosis is related to gametogenesis
- compare and contrast the similarities and differences in gametogenesis in plants and animals
- distinguish the levels of organization of genetic information in eukaryotes
- explain how levels of organization relate to continuity and variability in eukaryotes
- investigate how Mendel's work laid the foundation for modern genetics
- solve problems using principle patterns of inheritance
- measure the reliability of scientific experimentation using statistical techniques on genetic predictions

Sample Assessment

Biology Online – Fly lab

Pacing

2 weeks

6. MOLECULAR GENETICS

Science Standards

Genetics

A multi-cellular organism develops from a single zygote, and its phenotype depends on its genotype, which is established at fertilization.

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.

The genetic composition of cells can be altered by incorporation of exogenous DNA into the cells

Essential Questions

- What are the processes responsible for life's unity and diversity?
- How do science and technology affect the quality of our lives?

Focus Question

- How does DNA function as the carrier of genetic information?

Core Topics

- Science as a process
- Evolution
- Continuity and change
- Relationship of structure to function
- Regulation
- Science, technology and society

Unit Objectives

Students will be able to:

- relate the structure of nucleic acids to the functional properties of information storage and protein synthesis
- compare and contrast the similarities and differences of prokaryotic and eukaryotic genomes
- differentiate between the three major processes of genetic recombination in prokaryotes and their implications for prokaryotic modification
- explain how scientists concluded that nucleic acids are the genetic material
- explain how genetic information can be altered and analyze the effects of these alterations
- describe the role of viruses in the transfer of genetic material between cells
- categorize some current DNA technologies and measure their effects
- debate legal and ethical questions arising from applications of nucleic acid technology

Sample Assessment

Transformation lab

Pacing
3 weeks

7. EVOLUTION

Science Standards

Evolution

The frequency of an allele in a gene pool of a population depends on many factors and may be stable or unstable over time.

Evolution is the result of genetic changes that occur in constantly changing environments.

Essential Question

- What are the processes responsible for life's unity and diversity?

Focus Question

- How and why do organisms change over time?

Core Topics

- Science as a process
- Evolution
- Continuity and change
- Science, technology and society

Unit Objectives

Students will be able to:

- explain current biological models for the origin of macromolecules and the origin of prokaryotic and eukaryotic cells
- debate the evidence that supports the evolutionary theory of life
- explain how heredity and natural selection are involved in the evolutionary process
- compare and contrast the mechanisms that account for speciation and natural selection
- discuss the patterns that are present in evolution and the mechanisms responsible for these patterns

Sample Assessment

Released AP free response essay – Natural selection and speciation

Pacing

3 weeks **(MID-TERM COMPLETION POINT)**

8. DIVERSITY OF ORGANISMS

Science Standards

Evolution

The frequency of an allele in a gene pool of a population depends on many factors and may be stable or unstable over time.

Evolution is the result of genetic changes that occur in constantly changing environments.

Essential Question

- How are organisms structured to ensure efficiency and survival?

Focus Question

- How are the evolutionary relationships between higher taxa determined?

Core Topics

- Science as a process
- Evolution
- Energy transfer

Unit Objectives

Students will be able to:

- compare and contrast the major body plans in plants and animals
- discuss the evolution of higher classifications of bacteria, archaebacteria, protista, fungi, animals and plants
- interpret how scientists study evolutionary relationships among organisms
- discuss the techniques used in biosystematics
- construct a cladogram using techniques of cladistics
- investigate the life cycles of bacteria, protists, and fungi

Sample Assessment

Cladistics activity

Pacing

1.5 weeks

9. STRUCTURE AND FUNCTION OF PLANTS AND ANIMALS

Science Standards

Physiology

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.

Organisms have a variety of mechanisms to combat disease.

Essential Question

- How are organisms structured to ensure efficiency and survival?

Focus Questions

- How do body tissue, organs and systems interact to function in organisms?
- How is total biological success related to integration at the tissue, organ, and system levels?
- How does animal behavior relate to evolutionary success?

Unit Objectives

Students will be able to:

- interpret the evolution of major animal phyla
- explain the patterns and regulation of reproduction and development in animals
- investigate the organization, relatedness, and interaction of cells, tissues, and organ systems in animals
- differentiate between the adaptive features of animals and their responses to their environmental cues contribute to their success
- demonstrate knowledge of structure and function in actual mammalian specimens
- explain how hormones mediate responses of organisms to their environment

Core Topics

- Evolution
- Continuity and change
- Relationship of structure to function

Sample Assessment

Physiology of the circulatory system lab

Pacing

7 weeks (end marking period #3)

10. STRUCTURE AND FUNCTION OF PLANTS AND ANIMALS

Science Standards

Physiology

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.

Organisms have a variety of mechanisms to combat disease.

Essential Question

- How are organisms structured to ensure efficiency and survival?

Focus Questions

- How do body tissue, organs and systems interact to function in organisms?
- How is total biological success related to integration at the tissue, organ, and system levels?
- How does animal behavior relate to evolutionary success?

Unit Objectives

Students will be able to:

- interpret the evolution of major plant divisions
- explain the patterns and regulation of reproduction and development in plants investigate the organization, relatedness, and interaction of cells, tissues, and organ systems in plants
- differentiate between the adaptive features of plants and their responses to their environmental cues contribute to their success
- explain how hormones mediate responses of organisms to their environment

Core Topics

- Evolution
- Continuity and change
- Relationship of structure to function

Sample Assessment

Transpiration lab

Pacing

5 weeks

11. ECOLOGY

Science Standards

Ecology

Stability in an ecosystem is a balance between competing effects

Essential Question

- Why is knowledge of the interactions of organisms with each other and their environment significant to understanding life on Earth?

Focus Questions

- How does energy flow determine the interactions of organisms and their environment?
- How does cycling determine the structure and function of the biosphere?

Unit Objectives

Students will be able to:

- interpret the use of models in measuring population size and growth
- explain how energy flow through an ecosystem relates to trophic structure
- derive the effect of organisms on element and water cycles
- explain how population size, community structure, and ecosystem function are related by biotic and abiotic factors
- debate the impact of humans on ecological structure of the biosphere

Core Topics

- Energy transfer
- Continuity and change
- Relationship of structure to function
- Interdependence in nature
- Science, technology and society

Sample Assessment

Dissolved oxygen and aquatic primary productivity lab

Pacing

2 weeks

12. INDEPENDENT PROJECT

(students will engage in independent projects after the AP exam in May)

Unit Objectives

Students will be able to:

- Apply knowledge gained during the Advanced Placement Biology course to solve problems related to biology

Sample Assessment

Oral and written presentation based on individual interest of student and STS connection

Pacing

3 weeks