Curriculum Development
In the Fairfield Public Schools

FAIRFIELD PUBLIC SCHOOLS

FAIRFIELD, CONNECTICUT

BIOLOGY 22

APPROVED 2/28/2006

BIOLOGY 22

Statement Of Purpose

Biology is the study of life in all its forms. It is concerned with the composition, structure and function of organisms and with their interdependence. An understanding of these concepts is essential for individuals to make informed choices with regard to the environment and advancing scientific technology.

Audience

Biology 22 is a full-year, two-credit course designed for grade 10 students.

Prerequisites

Successful completion of Earth Science and recommendation by science teacher

Design and Description

Biology 22 is a college preparatory class. The course meets six periods per week including one double lab period. The Biology 22 course takes an ecological approach to the topics of evolution, structure and function, energy relationships, reproduction and inheritance, unity and diversity, interdependence in nature, techniques and applications in biotechnology, and stability and patterns of change. This course will provide students with the key concepts in first year biology. Students must be able to handle abstract concepts and ideas.

Course Objectives

Students will be able to:

- distinguish those characteristics that make life different from non-life
- identify the themes of biology
- distinguish science from other ways of knowing and from other bodies of knowledge
- explain how scientists use empirical standards, logical arguments, and skepticism to strive for the best possible explanations about the natural world
- distinguish between the abiotic and biotic components in an ecosystem
- identify the interactions among populations of different species within a community (food webs, trophic levels)
- describe the steps in the major biogeochemical cycles (water and carbon-oxygen)
- identify the factors that effect population density and demographics
- analyze how technological advances have affected both human populations and the environment
- describe basic atomic structure
- distinguish between ionic and covalent bonding
- examine the central nature of the element carbon
- compare the structures and functions of biological organic compounds i.e.: carbohydrates, lipids, proteins, nucleic acids
- examine the structure and function of enzymes
- compare and contrast prokaryotic and eukaryotic cells

- relate the structure of the nucleus and cytoplasmic structures to their functions using digital microscopes
- describe the fluid mosaic model of the cell
- predict the outcome of the mechanisms of passive and active transport
- examine the energy transformations of life (for example photosynthesis and respiration)
- examine the ATP cycle
- compare the structure and function of mitochondria and chloroplasts
- distinguish between aerobic and anaerobic respiration
- Define pigments
- relate the light-dependent and light-independent reactions of photosynthesis
- describe the structure of a chromosome in both a prokaryotic and eukaryotic organisms
- describe the cell cycle including the steps of mitosis and meiosis
- differentiate mitosis in plant and animal cells
- explain crossing over in meiosis and how it contributes to genetic variation
- describe the processes of oogenesis and spermatogenesis
- describe chromosome mutations
- predict the outcome of various genetic crosses using Punnett squares
- identify inheritance patterns using pedigrees
- explain how probability is used to predict the results of genetic crosses
- apply chromosome theory to genetic traits
- explain the role of sex chromosomes in sex determination
- investigate DNA structure and replication
- compare and contrast the structures and functions of rRNA, mRNA, and tRNA
- describe the universal nature of the genetic code
- explain the processes of transcription and translation in eukaryotes
- categorize mutations at the molecular level in DNA
- describe how scientists use restriction enzymes in genetic engineering
- explain how DNA technology can be used in medicine, pharmacology, criminology, agriculture, classification
- describe the evidence to support the theory of evolution
- investigate the development of evolutionary theory
- compare and contrast patterns of convergent, divergent, and co-evolution
- explain evolution as a change in gene frequencies within populations
- recognize processes of allopatric speciation
- interpret taxonomic hierarchies
- examine developments in higher classification systems
- investigate the structure and function of subcellular parasites to include viruses, prions, and viroids
- define lysogenic and lytic cycles in viruses
- recognize variations in bacterial morphology, modes of respiration and modes of nutrition
- identify the role of microorganisms in our environment

- compare and contrast the structure of viruses, bacteria, protista, and yeast
- describe the use of microorganisms in medicine, pharmacology and agriculture
- explain the adaptations that made it possible for animals to move from water to land.
- explain the adaptations that made it possible for plants to move from water to land.

Science Standards

Scientific Inquiry (used in all 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 (used in all units)

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

Students will read, interpret and examine the credibility and validity of scientific claims in different sources of information.

Students will formulate a testable hypothesis and demonstrate logical connections between the scientific concepts guiding the hypothesis and the design of the experiment.

Students will design and conduct appropriate types of scientific investigations to answer different questions.

Students will assess the reliability of the data that was generated in the investigation.

Chemical Structures and Properties – Properties of Matter

Atoms react with one another to form new molecules.

Students will describe the general structure of the atom, and explain how the properties of the first 20 elements in the Periodic Table are related to their atomic structures.

Students will describe how atoms combine to form new substances by transferring

electrons (ionic bonding) or sharing electrons (covalent bonding).

Students will explain the chemical composition of acids and bases, and explain the change of pH in neutralization reactions.

Due to its unique chemical structure, carbon forms many organic and inorganic compounds.

Students will explain how the structure of the carbon atom affects the type of bonds it forms in organic and inorganic molecules.

Students will explain the general formation and structure of carbon-based polymers, including synthetic polymers, such as polyethylene, and biopolymers, such as carbohydrate.

Cell Chemistry and Biotechnology – Structure and Function
Fundamental life processes depend on the physical structure and the chemical activities of the cell.

Students will describe significant similarities and differences in the basic structure of plant and animal cells.

Students will describe the general role of DNA and RNA in protein synthesis.

Students will describe the general role of enzymes in metabolic cell processes.

Students will explain the role of the cell membrane in supporting cell functions.

Cell Chemistry and Biotechnology – Science and Technology in Society
Microorganisms have an essential role in life processes and cycles on Earth.

Students will describe the similarities and differences between bacteria and viruses.

Students will describe how bacterial and viral infectious diseases are transmitted, and explain the roles of sanitation, vaccination and antibiotic medications in the prevention and treatment of infectious diseases.

Students will explain how bacteria and yeasts are used to produce foods for human consumption.

Similarities in the chemical and structural properties of DNA in all living organisms allow the transfer of genes from one organism to another.

Students will describe, in general terms, how the genetic information of organisms can be altered to make them produce new materials.

Students will explain the risks and benefits of altering the genetic composition and cell products of existing organisms.

Genetics, Evolution and Biodiversity – Heredity and Evolution
In sexually reproducing organisms, each offspring contains a mix of characteristics inherited from both parents.

Students will explain how meiosis contributes to the genetic variability of organisms.

Students will use the Punnett Square technique to predict the distribution of traits in mono- and dihybrid crossings.

Students will deduce the probable mode of inheritance of traits (e.g. recessive/dominant, sex-linked) from pedigree diagrams showing phenotypes.

Describe the difference between genetic disorders and infectious diseases.

Genetics, Evolution and Biodiversity - Science and Technology in Society
Living organisms have the capability of producing populations of unlimited size, but the environment can support only a limited number of individuals from each species.

Students will describe the factors that affect the carrying capacity of the environment.

Students will explain how change in population density is affected by emigration, immigration, birth rate and death rate, and relate these factors to the exponential growth of human populations.

Students will explain how technological advances have affected the size and growth rate of human populations throughout history.

Information and Technology Standards (to be added)

Essential Questions

- How is scientific knowledge created and communicated?
- What is the role of energy in our world?
- How does the structure of matter affect the properties and uses of materials?
- How do materials cycle through the Earth's systems?
- How are organisms structured to ensure efficiency and survival?
- What processes are responsible for life's unity and diversity?
- How do science and technology affect the quality of our lives?

Focus Questions

- What are the distinguishing features of life?
- How does science function as a process?
- How do biologists use scientific inquiry in a search for biological knowledge?

- How do organisms interact with the biotic and abiotic components in the biosphere?
- What are the implications of parts of an ecosystem being dependent on each other?
- How are the principles of chemistry applied in biology?
- What are organic compounds and how do they form the basis of life?
- What is the relationship between structure and function?
- How does the cell function as a basic building block of life?
- How do living things maintain homeostasis?
- What are the similarities and differences between autotrophs and heterotrophs?
- How do organisms obtain, use and transfer energy to maintain homeostasis?
- What types of cells are produced by mitosis and meiosis?
- How is life perpetuated from generation to generation?
- How does genetic inheritance explain both the diversity and similarity of organisms?
- How do genes explain both the diversity and similarity of organisms?
- How are prokaryotes and eukaryotes regulated on a molecular level?
- What causes organisms to change over time?
- What impacts the survival of organisms?
- How do scientists classify organisms using “relatedness”?
- How does the structure and function of microbes influence their role in nature?
- What impacts, both positive and negative, do microorganisms have on human society?
- Why are microbes important?
- How has the study of Biology impacted human society?
- How does evolution shape the unity and diversity of life?
- What are the effects of water on the evolution of plants and animals?

UNITS OF STUDY
(ECOLOGICAL APPROACH)

1. Introduction: Biological Processes

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 read, interpret and examine the credibility and validity of scientific claims in different sources of information.

Students will formulate a testable hypothesis and demonstrate logical connections between the scientific concepts guiding the hypothesis and the design of the experiment.

Students will design and conduct appropriate types of scientific investigations to answer different questions.

Students will assess the reliability of the data that was generated in the investigation.

Essential Question

- How is scientific knowledge created and communicated?

Focus Questions

- What are the distinguishing features of life?
- How does science function as a process?
- How do biologists use scientific inquiry in a search for biological knowledge?

Core Topics

Major themes of biology:

- Genetics and evolution
- Interdependence of organisms
- Stability and homeostasis
- Reproduction and inheritance
- Cell structure and function
- Matter, energy and organization

- Objective thinking vs. subjective thinking
- Controlled experimentation

Unit Objectives

Students will be able to:

- distinguish those characteristics that make life different from non-life
- identify the themes of biology
- distinguish science from other ways of knowing and from other bodies of knowledge
- explain how scientists use empirical standards, logical arguments, and skepticism to strive for the best possible explanations about the natural world

Sample Assessment

Bean germination

Pacing

1 week

2. Ecology

Science Standards

Genetics, Evolution and Biodiversity - Science and Technology in Society

Living organisms have the capability of producing populations of unlimited size, but the environment can support only a limited number of individuals from each species.

Students will describe the factors that affect the carrying capacity of the environment.

Students will explain how change in population density is affected by emigration, immigration, birth rate and death rate, and relate these factors to the exponential growth of human populations.

Students will explain how technological advances have affected the size and growth rate of human populations throughout history.

Essential Questions

- How do materials cycle through the Earth's systems?
- How do science and technology affect the quality of our lives?
- What is the role of energy in our world?

Focus Questions

- How do organisms interact with the biotic and abiotic components in the biosphere?
- What are the implications of parts of an ecosystem being dependent on each other?

Core Topics

Advances in:

- Agriculture
- Medicine
- Construction
- Use of energy
- Population growth
- Consumption of resources

Unit Objectives

Students will be able to:

- distinguish between the abiotic and biotic components in an ecosystem
- identify the interactions among populations of different species within a community (food webs, trophic levels)
- describe the steps in the major biogeochemical cycles (water and carbon-oxygen)
- identify the factors that effect population density and demographics
- analyze how technological advances have affected both human populations and the environment

Sample Assessment
Owl pellet dissection

Pacing
2 weeks

3. Chemistry

Science Standards

Chemical Structures and Properties – Properties of Matter

Atoms react with one another to form new molecules.

Students will describe the general structure of the atom, and explain how the properties of the first 20 elements in the Periodic Table are related to their atomic structures.

Students will describe how atoms combine to form new substances by transferring electrons (ionic bonding) or sharing electrons (covalent bonding).

Students will explain the chemical composition of acids and bases, and explain the change of pH in neutralization reactions.

Essential Question

- How does the structure of matter affect the properties and uses of materials?

Focus Question

- How are the principles of chemistry applied in biology?

Core Topics

- Atomic structure-nucleus and electron cloud including sub-atomic particles and charge
- Bonding

Unit Objectives

Students will be able to:

- describe basic atomic structure
- distinguish between ionic and covalent bonding

Sample Assessment

Inorganic model building

Pacing

3 weeks

4. Biochemistry

Science Standards

Chemical Structures and Properties – Properties of Matter

Due to its unique chemical structure, carbon forms many organic and inorganic compounds.

Students will explain how the structure of the carbon atom affects the type of bonds it forms in organic and inorganic molecules.

Students will explain the general formation and structure of carbon-based polymers, including synthetic polymers, such as polyethylene, and biopolymers, such as carbohydrate.

Cell Chemistry and Biotechnology – Structure and Function

Fundamental life processes depend on the physical structure and the chemical activities of the cell.

Students will describe the general role of enzymes in metabolic cell processes.

Essential Questions

- How are organisms structured to ensure efficiency and survival?
- How does the structure of matter affect the properties and uses of materials?

Focus Questions

- What are organic compounds and how do they form the basis of life?
- What is the relationship between structure and function?

Core Topics

- Properties of carbon bonding
- Differences in carbohydrates, lipids, proteins

Unit Objectives

Students will be able to:

- examine the central nature of the element carbon
- compare the structures and functions of biological organic compounds i.e.: carbohydrates, lipids, proteins, nucleic acids
- examine the structure and function of enzymes

Sample Assessment

Apple Juice (CAPT embedded task with STS)

Pacing

3.5 weeks **(end quarter #1)**

5. Cell Structure and Function

Science Standards

Cell Chemistry and Biotechnology – Structure and Function

Fundamental life processes depend on the physical structure and the chemical activities of the cell.

Students will explain the role of the cell membrane in supporting cell functions.

Essential Question

- How are organisms structured to ensure efficiency and survival?

Focus Questions

- How does the cell function as a basic building block of life?
- How do living things maintain homeostasis?

Core Topics

- Fluid mosaic model
- Differences between cells with and without nuclei
- Mechanisms for materials to move in and out of cells
- Organelles and their functions

Unit Objectives

Students will be able to:

- compare and contrast prokaryotic and eukaryotic cells
- relate the structure of the nucleus and cytoplasmic structures to their functions using digital microscopes
- describe the fluid mosaic model of the cell
- predict the outcome of the mechanisms of passive and active transport

Sample Assessment

dialysis tube modeling

Pacing

3.5 weeks

6. Cell Energetics

Science Standards

Cell Chemistry and Biotechnology – Structure and Function

Fundamental life processes depend on the physical structure and the chemical activities of the cell.

Students will describe significant similarities and differences in the basic structure of plant and animal cells.

Essential Question

- What is the role of energy in our world?

Focus Questions

- What are the similarities and differences between autotrophs and heterotrophs?
- How do organisms obtain, use and transfer energy to maintain homeostasis?

Core Topics

- Energy producing organelles in plant and animal cells
- Phases of photosynthesis
- Aerobic vs. anaerobic respiration
- Relationship of absorption to color

Unit Objectives

Students will be able to:

- examine the energy transformations of life (for example photosynthesis and respiration)
- examine the ATP cycle
- compare the structure and function of mitochondria and chloroplasts
- distinguish between aerobic and anaerobic respiration
- Define pigments
- relate the light-dependent and light-independent reactions of photosynthesis

Sample Assessment

Yeast Populations (CAPT embedded task with STS)

Pacing

3 weeks

7. Cell Cycle and Meiosis

Science Standards

Genetics, Evolution and Biodiversity – Heredity and Evolution

In sexually reproducing organisms, each offspring contains a mix of characteristics inherited from both parents.

Students will explain how meiosis contributes to the genetic variability of organisms.

Essential Question

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

Focus Questions

- What types of cells are produced by mitosis and meiosis?
- How is life perpetuated from generation to generation?

Core Topics

- Differentiate between steps and end products in mitosis and meiosis
- Differentiate mitosis in plant and animal cells
- Effects of mutations (including crossing over) on genetic variation
- Differentiate between oogenesis and spermatogenesis
- Karyotypes

Unit Objectives

Students will be able to:

- describe the structure of a chromosome in both a prokaryotic and eukaryotic organisms
- describe the cell cycle including the steps of mitosis and meiosis
- differentiate mitosis in plant and animal cells
- explain crossing over in meiosis and how it contributes to genetic variation
- describe the processes of oogenesis and spermatogenesis
- describe chromosome mutations

Sample Assessment

Meiotic phases

Pacing

2 weeks (MID TERM COMPLETION POINT)

8. Classical and Applied Genetics

Science Standards

Genetics, Evolution and Biodiversity – Heredity and Evolution

In sexually reproducing organisms, each offspring contains a mix of characteristics inherited from both parents.

Students will use the Punnett Square technique to predict the distribution of traits in mono- and dihybrid crossings.

Students will deduce the probable mode of inheritance of traits (e.g. recessive/dominant, sex-linked) from pedigree diagrams showing phenotypes.

Essential Question

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

Focus Question

- How does genetic inheritance explain both the diversity and similarity of organisms?

Core Topics

- Punnett squares
- Dominant vs. recessive traits
- Genotype vs. phenotype
- Mono- and dihybrid crosses

Unit Objectives

Students will be able to:

- predict the outcome of various genetic crosses using Punnett squares
- identify inheritance patterns using pedigrees
- explain how probability is used to predict the results of genetic crosses
- apply chromosome theory to genetic traits
- explain the role of sex chromosomes in sex determination

Sample Assessment

Interpretation of pedigrees

Pacing

3.5 weeks

9. Nucleic Acids and Molecular Genetics

Science Standards

Cell Chemistry and Biotechnology – Structure and Function

Fundamental life processes depend on the physical structure and the chemical activities of the cell.

Students will describe significant similarities and differences in the basic structure of plant and animal cells.

Students will describe the general role of DNA and RNA in protein synthesis.

Cell Chemistry and Biotechnology – Science and Technology in Society

Similarities in the chemical and structural properties of DNA in all living organisms allow the transfer of genes from one organism to another.

Students will explain the risks and benefits of altering the genetic composition and cell products of existing organisms.

Essential Questions

- How do science and technology affect the quality of our lives?
- How are organisms structured to ensure efficiency and survival?

Focus Questions

- How do genes explain both the diversity and similarity of organisms?
- How are prokaryotes and eukaryotes regulated on a molecular level?

Core Topics

- Genetic engineering including cloning
- Bioethics
- Recombinant DNA

Unit Objectives

Students will be able to:

- investigate DNA structure and replication
- compare and contrast the structures and functions of rRNA, mRNA, and tRNA
- describe the universal nature of the genetic code
- explain the processes of transcription and translation in eukaryotes
- categorize mutations at the molecular level in DNA
- describe how scientists use restriction enzymes in genetic engineering
- explain how DNA technology can be used in medicine, pharmacology, criminology, agriculture, classification

Sample Assessment

Identifying a Criminal

Pacing
5 weeks (end marking period 3)

10. Evolution and Population Genetics

Science Standards

Genetics, Evolution and Biodiversity – Heredity and Evolution

Evolution and biodiversity are the result of genetic changes that occur over time in constantly changing environments.

Students will explain how the current theory of evolution provides a scientific explanation for fossil records of ancient life forms.

Essential Question

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

Focus Questions

- What causes organisms to change over time?
- What impacts the survival of organisms?

Core Topics

- Darwin, Lamarck, Wallace, Malthus, Lyell
- Genetic drift
- Punctuated equilibrium, gradualism

Unit Objectives

Students will be able to:

- describe the evidence to support the theory of evolution
- investigate the development of evolutionary theory
- compare and contrast patterns of convergent, divergent, and co-evolution
- explain evolution as a change in gene frequencies within populations
- recognize processes of allopatric speciation

Sample Assessment

Natural Selection

Pacing

1.5 weeks

11. Taxonomy and Systematics

Science Standards

Genetics, Evolution and Biodiversity – Heredity and Evolution

Evolution and biodiversity are the result of genetic changes that occur over time in constantly changing environments.

Students will explain how the processes of genetic mutation and natural selection are related to the evolution of species.

Essential Question

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

Focus Question

- How do scientists classify organisms using "relatedness"?

Core Topics

- Linnaeus
- Binomial nomenclature
- Domains and kingdom systems

Unit Objectives

Students will be able to:

- interpret taxonomic hierarchies
- examine developments in higher classification systems

Sample Assessment

Interpretation of dichotomous key

Pacing

1 week

12. Microbiology

Science Standards

Cell Chemistry and Biotechnology – Science and Technology in Society

Microorganisms have an essential role in life processes and cycles on Earth.

Students will describe the similarities and differences between bacteria and viruses.

Students will describe how bacterial and viral infectious diseases are transmitted, and explain the roles of sanitation, vaccination and antibiotic medications in the prevention and treatment of infectious diseases.

Students will explain how bacteria and yeasts are used to produce foods for human consumption.

Describe the difference between genetic disorders and infectious diseases.

Essential Questions

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

Focus Questions

- How does the structure and function of microbes influence their role in nature?
- What impacts, both positive and negative, do microorganisms have on human society?
- Why are microbes important?
- How has the study of Biology impacted human society?

Core Topics

- Environmental roles of bacteria (helpful vs. harmful)
- Transmission, treatment and prevention of diseases caused by bacteria and viruses

Unit Objectives

Students will be able to:

- investigate the structure and function of subcellular parasites to include viruses, prions, and viroids
- define lysogenic and lytic cycles in viruses
- recognize variations in bacterial morphology, modes of respiration and modes of nutrition
- identify the role of microorganisms in our environment
- compare and contrast the structure of viruses, bacteria, protista, and yeast
- describe the use of microorganisms in medicine, pharmacology and agriculture

Sample Assessment

Streak Plate analysis

Pacing

3 weeks

13. Animal and Plant Evolution

Science Standards

Genetics, Evolution and Biodiversity – Heredity and Evolution

Evolution and biodiversity are the result of genetic changes that occur over time in constantly changing environments.

Students will describe how structural and behavioral adaptations increase the chances for organisms to survive in their environments.

Essential Question

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

Focus Questions

- How does evolution shape the unity and diversity of life?
- What are the effects of water on the evolution of plants and animals?

Core Topics

- Animal adaptations to a changing environment
- Plant adaptations to a changing environment

Unit Objectives

Students will be able to:

- explain the adaptations that made it possible for animals to move from water to land.
- explain the adaptations that made it possible for plants to move from water to land.

Sample Assessment

Evolutionary adaptations/comparative anatomy

Pacing

3 weeks