BIOLOGY 21

Description

This course will provide students with a comprehensive knowledge of biology and will prepare students for entry into the Advanced Placement program. The course uses a molecular biology approach. Topics will be illustrated through the following themes that will recur throughout the course: evolution; structure and function; energy relationships; reproduction and inheritance; unity and diversity; and stability and patterns of change. Students in this course are capable of handling primary source material for reference and are highly motivated, self-directed learners. This course requires excellent study skills including note taking, time management and organization.

Course Overview

Course Goals

Students will understand that:

- due to its unique chemical structure, carbon forms many organic and inorganic compounds.
- fundamental life processes depend on the physical structure and the chemical activities of the cell.
- similarities in the chemical and structural properties of DNA in all living organisms allow the transfer of genes from one organism to another.
- in sexually reproducing organisms, each offspring contains a mix of characteristics inherited from both parents.
- evolution and biodiversity are the result of genetic changes that occur over time in constantly changing environments.
- microorganisms have an essential role in life processes and cycles on Earth.
- 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.
- the use of resources by human populations may affect the quality of the environment.

Essential Questions

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

Assessments

Common Assessments

- Apple Juice/Enzymes Performance Task
- Bioengineered Food STS
- Eggmosis Lab Investigation
- Yeast population Dynamic Performance Task
- Human population Dynamics STS
- Antibiotic Resistance lab investigation

Content Outline	Standards	Grade Level Skills

I. Unit 1 - Introduction II. Unit 2 - Biochemistry III. Unit 3 - Cell Structure and Function IV. Unit 4 - Cell Energetics V. Unit 5 - Nucleic Acids and Molecular Genetics VI. Unit 6 -Cell Cycle and Meiosis VII. Unit 7 - Classical and Applied Genetics VIII. Unit 8 - Classification IX. Unit 9 - Evolution and Population Genetics X. Unit 10 - Microbiology XI. Unit 11 - Animal Evolution XII. Unit 12 - Plant Evolution XIII. Unit 13 - Ecology	State of Connecticut Science Curriculum Frameworks Connecticut State Standards in Core Science are met in the following areas: • ***Scientific Inquiry*** • ***Scientific Literacy*** • ***Scientific Numeracy*** • ***Chemical Structures and Properties – Properties of Matter*** • ***Cell Chemistry and Biotechnology – Structure and Function*** • ***Cell Chemistry and Biotechnology – Science and Technology in Society*** • ***Genetics, Evolution and Biodiversity – Heredity and Evolution*** • ***Genetics, Evolution and Biodiversity - Science and Technology in Society***	Students will: • make predictions based on observations. • present relationships between variables in appropriate formats (table, graph, chart). • evaluate the credibility and validity of various sources of scientific information. • formulate a testable hypothesis. • demonstrate logical connections between scientific concepts guiding a hypothesis and experimental design. • assess the validity of experimental results based on the design of an experiment. • use scientific information responsibly.

Pacing Guide						
1st Marking Period			2nd Marking Period			
September	October		November	December		January
Unit 1 **Introduction** 1 week	Unit 2 **Biochemistry** 3 weeks	Unit 3 **Cell Structure and Function** 2.5 weeks	Unit 4 **Cell Energetics** 2 weeks	Unit 5 **Nucleic Acids & Molecular Genetics** 3 weeks	Unit 6 **Cell Cycle and Meiosis** 2 weeks	Unit 7 **Classical and Applied Genetics** 3 weeks
3rd Marking Period			4th Marking Period			
February	March		April	May		June
Unit 8 **Classification** 2 weeks	Unit 9 **Evolution and Population Genetics** 3 weeks	Unit 10 **Microbiology** 3 weeks	Unit 11 **Animal Evolution** 2.5 weeks	Unit 12 **Plant Evolution** 2.5 weeks	Unit 13 **Ecology** 3 weeks	

Unit 1 - Introduction, 1 week top

Standards

Scientific Inquiry

Scientific inquiry:

- is a thoughtful and coordinated attempt to search out, describe, explain and predict natural phenomena.
- progresses through a continuous process of questioning, data collection, analysis and interpretation.
- 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.
- 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:

- identify questions that can be answered through scientific investigation.
- read, interpret and examine the credibility and validity of scientific claims in different sources of information.
- formulate a testable hypothesis and demonstrate logical connections between the scientific concepts guiding the hypothesis and the design of the experiment.
- design and conduct appropriate types of scientific investigations to answer different questions.
- identify independent and dependent variables, including those that are kept constant and those used as controls.
- assess the reliability of the data that was generated in the investigation.

Unit Objectives

Students will be able to:

- identify characteristics of life.
- identify the themes of biology.
  - evolution
  - interdependence in nature
  - homeostasis
  - reproduction and inheritance
  - structure and function
  - energy transformation

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?
- What are the major themes of Biology?
- How do biologists use scientific inquiry in a search for biological knowledge?

Assessments

- Termite Navigation
- Bean germination lab

Skill Objectives

Students will:

- apply scientific methods to perform inquiry based laboratories.
  - design a controlled experiment (Independent variable, Dependent variable, Control, Variables held Constant).

		○ create and use graphs to analyze data. ○ draw conclusions from analyzed data. ○ assess the validity of the experimental design and data collected. • demonstrate safe lab techniques.

Unit 2 – Biochemistry, 3 weeks top

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.
- 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.

Unit Objectives

Students will be able to:

- describe the central nature of the element carbon in organic compounds.
- examine the structure and function of organic compounds, including monomers and polymers:
  - Carbohydrates: mono-, di-, and polysaccharides
  - Lipids: triglycerides, saturated and unsaturated fats, phospholipids
  - Proteins: amino acids, polypeptide, and multiple functions of
  - Nucleic acids: nucleotides, DNA and RNA
- compare and contrast dehydration synthesis and hydrolysis (catabolic and anabolic processes.)
- catabolic and anabolic processes.
- explain the relationship between the structure and function of enzymes.
- identify the factors affecting enzyme function (temperature, pH).

Essential Question

- 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 difference between catabolic and anabolic processes?
- How is the structure of a biomolecule related to its function?

Assessment

- Apple Juice CAPT lab*

Skill Objectives

Students will:

- formulate a testable hypothesis.
- present relationships between variables in appropriate formats (table, graph, chart).
- assess the validity of experimental results based on the design of an experiment.

Unit 3 – Cell Structure and Function, 2.5 weeks top

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.

Unit Objectives
Students will be able to:

- compare and contrast structural components and their functions in prokaryotes, eukaryotes (plant and animal) and viruses.
- explain the structure and function of the cell membrane, nucleus and cytoplasmic structures.
- summarize the flow of materials through the endo-membrane system.
- differentiate between passive and active transport with regards to concentration gradient and particle size and charge.

Essential Question

- How are organisms structured to ensure efficiency and survival?

Focus Questions

- 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 is the difference between prokaryotic and eukaryotic cells?
- How do materials go in and out of cells?

Assessments

- Digital Microscopy
- Diffusion/Osmosis Lab

Skill Objectives
Students will:

- use digital microscopes to observe and record information about various plant and animal cells.

Unit 4 – Cell Energetics, 2 weeks top

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.

Unit Objectives

Students will be able to:

- discuss the carbon cycle in terms of the complementary roles of photosynthesis in producers and cellular respiration in all living things (producers and consumers) Also, highlight the role of combustion in the carbon cycle.
- describe the process of cellular respiration
- describe the process of glycolysis resulting in a 3-carbon molecule and ATP.
- explain the role of oxygen, ATP and carbon dioxide in aerobic respiration.
- explain the role of mitochondria in aerobic respiration and how the structure is related to its function.
  - Krebs Cycle: 3-carbon molecule in, CO_2 and ATP out
  - ETC: O_2 in, H_2O & ATP out
  - "Carrier molecules" move electrons from glycolysis to Kreb's Cycle and ETC
- explain the production of alcohol or lactic acid in fermentation.
- compare the production of ATP through aerobic and anaerobic respiration.
- explain the role of the chloroplast in photosynthesis and how the structure is related to its function.
  - identify starting material and end products of light reaction and Calvin cycle.
- compare and contrast the overall processes of photosynthesis and cellular respiration at the cellular level.
- identify the evolutionary sequence of anaerobic → photosynthesis → aerobic respiration.

Essential Questions

- What is the role of energy in our world?
- How are organisms structured to ensure efficiency and survival?

Focus Questions

- What are the similarities and differences between autotrophs and heterotrophs?
- How do organisms obtain, use and transfer energy to maintain homeostasis?
- What are the similarities and differences between photosynthesis and cell respiration?
- How are aerobic and anaerobic respiration different?
- What is the evolutionary sequence of events in the development of autotrophs, anaerobic and aerobic heterotrophs?

Assessment

- Yeast CAPT lab*

Skill Objectives

Students will:

- demonstrate logical connections between scientific concepts guiding a hypothesis and experimental design.
- make predictions based on observations.

Unit 5 –Nucleic Acids and Molecular Genetics, 3 weeks top

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 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:

- describe, in general terms, how the genetic information of organisms can be altered to make them produce new materials.
- explain the risks and benefits of altering the genetic composition and cell products of existing organisms.

Unit Objectives

Students will be able to:

- compare and contrast the structure and function of DNA, rRNA, mRNA, and tRNA.
- describe the mechanism of DNA replication:
  - role of helicase and polymerase.
- describe the universal nature of the genetic code.
- describe the processes of transcription and translation in protein synthesis.
  - use of codon chart to determine the amino acid sequence from DNA.
- categorize mutations at the molecular level in DNA.
  - frameshift mutations – addition and deletion
  - point mutations - substitution
- discuss, in general terms, how genetic information can be altered to produce new materials.
  - organisms: for example, oil digesting bacteria, pest-resistant corn*
  - medicines: for example, insulin, vaccinations*
  - gene therapy: for example, cystic fibrosis, Parkinson's disease, diabetes*
- analyze the risks and benefits of altering the genetic composition of organisms to create genetically modified foods.

*Suggested examples, use per teacher discretion

Essential Question

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

Focus Questions

- What is DNA's function?
- How is DNA replicated?
- What is the "genetic code" and how is it used to create proteins?
- How do we use biotechnology to enhance our lives?
- How do genes explain both the diversity and similarity of organisms?

Assessments

- Protein synthesis game
- STS Genetically Modified Foods*

Skill Objectives

Students will:

- use a codon chart to determine the amino acid sequence from DNA.
- research and present information (brochure, PowerPoint, oral presentation, etc.) about the risks and benefits of genetically modified foods.
- use scientific information responsibly.

Unit 6 – Cell Cycle and Meiosis, 2 weeks top

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.

Unit Objectives

Students will be able to:

- describe the events that occur in each phase of the cell cycle – interphase-G1-S-G2, mitosis, cytokinesis
- identify the structures of a eukaryotic organism's chromosome.
- describe the movement of chromosomes during mitosis.
- differentiate between mitosis in plant and animal cells.
- describe the separation of homologous chromosomes during meiosis to produce unique haploid cells:
  - crossing over
  - independent assortment
  - segregation

Essential Question

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

Focus Questions

- What processes occur during the life of a cell?
- How is life perpetuated from generation to generation?
- What types of cells are produced by mitosis and meiosis?
- What events (crossing over, independent assortment, mutations) occur during meiosis that cause variation in the gametes?

Assessments

- Cell cycles
- Microviewers/Microscopes

Skill Objectives

Students will:

- use microscopes and microviewers to identify the stages of mitosis in both plant and animal cells.

Unit 7 – Classical and Applied Genetics, 3 weeks top

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

Unit Objectives

Students will be able to:

- utilize terms genotype, phenotype, homozygous, heterozygous, and allele:
  - predict the outcome of various modes of inheritance using punnett squares
  - complete dominant/recessive
  - incomplete dominance
  - codominance
  - sex-linked
- analyze inheritance patterns using pedigrees.
  - autosomal dominant/autosomal recessive
  - sex-linked
- apply rules of probability to predict the results of genetic crosses.
- explain the role of sex chromosomes in sex determination.
- identify human chromosomal disorders using karyotypes.

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 does genetic inheritance explain both the diversity and similarity of organisms?
- How do Punnett squares predict probability?
- What is a pedigree and how is it used?
- How is sex determined?

Assessments

- Simulated blood typing
- Karyotype lab

Skill Objectives

Students will:

- create and interpret Punnett squares for mono- and di-hybrid crosses.
- interpret human karyotypes and identify human chromosomal disorders.

MID_YEAR EXAM

Unit 8 – Classification, 2 weeks top

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.

Unit Objectives

Students will be able to:

- identify relatedness between species using Linnaean taxonomic hierarchies.
- writing using binomial nomenclature.
- create evolutionary relationships using phylogenetic trees and cladograms.
- identify an organism using dichotomous key.

Essential Question

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

Focus Question

- How do scientists classify organisms using "relatedness"?

Assessment

- You hold the key

Skill Objectives

Students will:

- interpret evolutionary relationships using phylogenetic trees and cladograms.

Unit 9 – Evolution and Population Genetics, 3 weeks top

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.
- explain how the current theory of evolution provides a scientific explanation for fossil records of ancient life forms.
- describe how structural and behavioral adaptations increase the chances for organisms to survive in their environments.

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.
- compare and contrast gradualism and punctuated equilibrium.

Essential Question

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

Focus Questions

- What causes organisms to change over time?
- What is evolution and what is the scientific evidence to support it?
- Are there different types of evolution?
- How long does evolution take to change organisms?
- What impacts the survival of organisms?

Assessment

- Amino Acid Sequences

Skill Objectives

Students will:

- use amino acid sequences to determine evolutionary relationships among organisms.

Unit 10 – Microbiology, 3 weeks top

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

Genetics, Evolution and Biodiversity – Heredity and Evolution

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

Students will describe the difference between genetic disorders and infectious diseases.

Unit Objectives

Students will be able to:

- explain the structure and function of viruses, prions, and viroids.
- relate lysogenic and lytic cycles in viruses.
- recognize variations in bacterial morphology, modes of respiration and modes of nutrition.
- discuss reproduction in bacteria – binary fission.
- explain conjugation as a method of genetic recombination in bacteria.
- identify the role of microorganisms in our environment.
- compare and contrast the structure of viruses, bacteria.
- illustrate the human body's general immune response to pathogens.
  - first Line of Defense
  - second Line of Defense
- describe the use of microorganisms in medicine, pharmacology and agriculture.

Essential Questions

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

Focus Questions

- Why are microbes important?
- 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?
- How are viruses and bacteria different?

Assessment

- Bacterial Sensitivity

Skill Objectives

Students will:

- formulate a testable hypothesis.
- demonstrate logical connections between scientific concepts guiding a hypothesis and experimental design.
- assess the validity of experimental results based on the design of an experiment.
- make predictions based on observations.

Unit 11 – Animal Evolution, 2.5 weeks top

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.

Unit Objectives

Students will be able to:

- describe the key structural characteristics that distinguish the major animal phyla:
  - 9 major phyla – porifera, cnidaria, platyhelminthes, nematoda, annelida, mollusca, arthropoda, echinodermata, chordata (classes- fishes, amphibians, reptiles, aves, mammals)
  - structural characteristics – symmetry, cephalization, # of tissue layers presence of body cavity and # of openings, segmented body
- explain the adaptations that made it possible for animals to move from water to land:
  - trends -Methods of reproduction, method of gas exchange, methods of transporting materials throughout the organism, overcoming gravity, movement, prevention of desiccation, overwintering (migration, hibernation, endothermy)

Essential Question

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

Focus Questions

- What are the effects of water on the evolution of plants and animals?
- How does natural selection contribute to the success or demise of a new species?
- How did organisms meet the challenges of moving to land?

Assessment

- Adaptations of animals

Skill Objectives

Students will:

- read and interpret animal phylogenetic trees.

Unit 12 – Plant Evolution, 2.5 weeks top

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.

Unit Objectives

Students will be able to:

- describe the key structural characteristics that distinguish the major plant phyla:
  - 4 major phyla- bryophytes, tracheophytes, gymnosperms, angiosperms (monocot and dicot)
- explain structural characteristics that made it possible for plants to move from water to land -vascular tissues, seeds, development and modification of roots stems and leaves, methods of reproduction, prevention of desiccation.

Essential Question

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

Focus Questions

- What are the effects of water on the evolution of plants and animals?
- How does natural selection contribute to the success or demise of a new species?
- How did organisms meet the challenges of moving to land?

Assessment

- Adaptations of plants

Skill Objectives

Students will:

- read and interpret plant phylogenetic trees.
- identify an organism using dichotomous key.

Unit 13 – Ecology, 3 weeks top

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

Global Interdependence - Science and Technology in Society

The use of resources by human populations may affect the quality of the environment.

Students will explain how the accumulation of mercury, phosphates and nitrates affects the quality of water and the organisms that live in rivers, lakes and oceans.

Unit Objectives

Students will be able to:

- distinguish between the abiotic and biotic components in an ecosystem.
- trace the interactions among populations of different species within a community in terms of energy flow, (food webs, trophic levels), and symbiosis (parasitism, mutualism, commensalism, predation).
- describe the factors that affect carrying capacity of the environment.
- 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.
- explain how technological advances have affected the size and growth rate of human populations throughout history.
- recognize the biosphere is a closed system, nutrients must be recycled.
- overview of carbon, water, and nitrogen cycles
- algal blooms due to fertilizer runoff
- explain how community interactions can powerfully affect an ecosystem.

Essential Questions

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

Focus Questions

- Why are all of parts of an ecosystem dependent on each other?
- How do organisms interact with the biotic and abiotic components in the biosphere?
- What is a food web?
- What is a trophic level?
- What are the effects of humans on the environment?

Assessment

- "Who" swallowed the mouse?

Skill Objectives

Students will:

- compare age structure diagrams for a developed, developing and underdeveloped country and identify the factors that affect a population's age structure.