VALWOOD

GO BEYOND

# Biology Curriculum

# CP Biology (9th Grade) Overview

## Course Description

College Preparatory (CP) Biology is a first-year on-level biology course that familiarizes students with the fundamentals of biology and reinforces content learned in K-8 life science. Students evaluate the large-scale systems and interactions in the natural world and follow a reductionist approach to slowly investigate the processes necessary to support life on Earth. The course focuses on broad understanding supported by real-life connections to the material.

## Topics at a Glance

- Origin and Evolution of Life
- Phylogeny and Taxonomy
- Ecology
- Biodiversity of Eukaryotes
- Metabolism and Enzymes
- Chemistry of Life
- Cell Structure and Function
- Cellular Reproduction
- Foundations of Gene Expression
- Introductory Genetics

## Assessments

- Instructor-created unit assessments, including quizzes and tests
- Instructor-created semester assessments
- Lab reports
- Summative group and/or individual projects

## Big Ideas in CP BIOLOGY (Grade Level Expectations)

| Standards | 9th Grade | |
|---|---|---|
| 1. Structure and Function of Living Cells | 1. | The structure of molecules, organelles, and cells determine their function in living systems |
| | 2. | The efficiency of metabolic processes is influenced by surface area-to-volume ratios of biological structures |
| | 3. | Environmental conditions affect the structure and function of proteins and the cells that contain them |
| | 4. | Photosynthesis and cellular respiration cycle energy and matter within cells, populations, and biological communities |
| | 5. | Various forms of cellular reproduction sustain the genetic continuity of life |
| 2. Expression and Transmission of Genetic Information | 1. | Nucleic acids allow for the transmission, storage, and expression of genetic information |
| | 2. | The structure of DNA and RNA demands the sequential flow of the central dogma |
| | 3. | The structure of DNA and RNA preserves consensus sequences while allowing for genetic diversity |
| | 4. | Mutations and variation may arise through meiotic error, faulty replication, or environmental factors |
| 3. Organization of Living Systems | 1. | Life is organized on a scale that ranges from molecules to organisms |
| | 2. | Taxonomic systems are employed to group organisms based on shared characteristics |
| | 3. | Phylogenetic trees are supported by empirical evidence and demonstrate both common ancestry and descent with modification |
| 4. Ecological Interdependence | 1. | Environmental factors influence the flow of energy and biodiversity of ecosystems |
| | 2. | Ecosystem sustainability is supported by increasing biodiversity |
| | 3. | Organisms survive differentially within changing environmental limits |
| | 4. | Organisms fulfill various roles within their ecosystem |
| 5. Theory of Evolution | 1. | Organisms have changed over time in a manner consistent with evolution from a common ancestor |
| | 2. | Mathematical models can demonstrate and predict the change in population genetics over time |
| | 3. | Environmental pressures catalyze and direct speciation and natural selection |
| | 4. | Natural selection is responsible for the increasing rate of biological resistance to manufactured pharmaceuticals |
| | 5. | Undirected changes in natural selection and genetic drift events decrease the diversity of affected populations |

**LIFE SCIENCE**

**Description of Standard:** Students know and understand the characteristics and structure of living things, the processes of life, and how living things interact with each other and their environment.

## Valwood Graduate Competencies

The Valwood graduate competencies are the preschool through twelfth-grade concepts and skills that all graduates will be able to demonstrate.

**Valwood Graduate Competencies in the LIFE SCIENCE STANDARD:**

- Analyze the relationship between structure and function across all major levels of organization in living systems
- Evaluate and express the role of natural selection in the development and interdependence of living systems
- Analyze the impact of environmental pressures on the evolution, genetic makeup, sustainability, and functionality of living systems
- Explain how organisms fulfill all requirements of a living system including the expression, transmission, and regulation of genes

**Content Area: CP BIOLOGY**

**Standard: LIFE SCIENCE 3 –** Organization of Living Systems
**LIFE SCIENCE 5** – Theory of Evolution

**Valwood Graduates:**
Evaluate and express the role of natural selection in the development and interdependence of living systems

**GRADE LEVEL EXPECTATION: Origin and Evolution of Life**
**Concepts and skills students master:**
Organisms have changed over time in a manner consistent with evolution from a common ancestor

| Evidence Outcomes | 21st Century Skills and Readiness Competencies |
|---|---|
| **Students can:**<br>a. Communicate new evidence about the history of Earth and the timeline of emerging life<br><br>b. Critically evaluate the role of environmental pressures on population gene pools and the subsequent emergence of favorable adaptations<br><br>c. Provide and articulate evidence for the occurrence of evolution through natural selection<br><br>d. Compare and contrast evolution through natural and artificial selective pressures<br><br>e. Describe the modes of speciation and explain the environmental factors that drive them | **Inquiry Questions:**<br>1. How does studying extinct species contribute to our current understanding of evolution?<br>2. How can patterns of characteristics shared among organisms be used to categorize life's diversity according to relatedness?<br>3. How can you use a Hardy-Weinberg equation to determine direction and speed of evolution in a population?<br><br>**Relevance and Application:**<br>1. Resistance can occur when antibiotics and pesticides are overused or abused.<br>2. Human activities can generate selective pressures on organisms, such as breeding new kinds of dogs and improving livestock.<br>3. Species undergo natural selection due to environmental pressures.<br><br>**Nature of Discipline:**<br>1. Understand that all scientific knowledge is subject to new findings and that reproducible, corroborated, and converging lines of data yield a scientific theory.<br>1. Differentiate among the use of the terms "hypothesis," "theory," and "law" as they are defined and used in science compared to the usage of these terms in other disciplines or everyday use. |

**Content Area: CP BIOLOGY**

**Standard: LIFE SCIENCE 4 –** Ecological Interdependence
**LIFE SCIENCE 5** – Theory of Evolution

**Valwood Graduates:**
Analyze the impact of environmental pressures on the evolution, genetic makeup, sustainability, and functionality of living systems

**GRADE LEVEL EXPECTATION: Ecology**
**Concepts and skills students master:**
Environmental factors influence the flow of energy and biodiversity of ecosystems

| Evidence Outcomes | 21st Century Skills and Readiness Competencies |
|---|---|
| **Students can:**<br>a. Explain the relationship between environmental pressures and the expected changes in both population size and community diversity<br><br>b. Make predictions about community diversity and sustainability through analysis of models<br><br>c. Demonstrate the cyclic flow of matter and energy through organisms and their respective trophic levels and make scientifically justified claims relating biomass, resource availability, and carrying capacity<br><br>d. Evaluate the various niches within a community, including keystone species, indicator species, pioneer species, invasive species, and foundation species, and the role of each in facilitating ecological succession | **Inquiry Questions:**<br>1. How do keystone species maintain balance in ecosystems?<br>2. How does the introduction of a non-native species influence the balance of an ecosystem?<br>3. What are the interspecific relationships within a community?<br>4. How does the growth rate within a population change over time?<br><br>**Relevance and Application:**<br>1. Earth's carrying capacity is limited.<br>2. Exponential human population growth has directly impacted the biosphere.<br>3. The extraction of resources by humans impacts ecosystems.<br><br>**Nature of Discipline:**<br>1. Critically evaluate scientific explanations to determine if the research methodology and evidence presented are appropriate and sufficient to support the claims. |

**Content Area: CP BIOLOGY**

**Standard: LIFE SCIENCE 3 –** Organization of Living Systems

**Valwood Graduates:**

- Evaluate and express the role of natural selection in the development and interdependence of living systems
- Analyze the relationship between structure and function across all major levels of organization in living systems

**GRADE LEVEL EXPECTATION: Phylogeny and Taxonomy**

**Concepts and skills students master:**

Phylogenetic trees are supported by empirical evidence and demonstrate both common ancestry and descent with modification

| Evidence Outcomes | 21st Century Skills and Readiness Competencies |
|---|---|
| **Students can:**<br>a. Explore speciation through derived characters, common ancestry, and evaluation of homologous versus analogous features<br><br>b. Identify similar and dissimilar species through taxonomic classification and dichotomous keys and distinguish the morphological differences between organisms<br><br>c. Create models that streamline the identification of species and relate their evolutionary origins on cladograms and phylogenetic trees<br><br>d. Interpret and evaluate character tables and phylogenetic trees and use them to form evidence-based predictions about evolutionary relationships | **Inquiry Questions:**<br>1. How do subtle differences in morphological features allow inferences on ancient environments and speciation events?<br>2. How do changes in morphology and genetic sequences arise?<br>3. What features are most reliable when establishing an evolutionary lineage?<br>4. How are phylogenetic trees constructed from character tables?<br><br>**Relevance and Application:**<br>1. Demonstration of the relatedness of all life on Earth<br>2. Students are better able to organize broad informational components and synthesize accurate conclusions<br>3. The definition of a species is not "fixed" at one level of accuracy, encouraging an ongoing discourse about ancestry, relatedness, evolution, and scientific observation<br><br>**Nature of Discipline:**<br>1. Inductive and deductive reasoning<br>2. Visual representation of physical information<br>3. Debate about the necessary and inevitable falsifiability of science |

**Content Area: CP BIOLOGY**

**Standard:** **LIFE SCIENCE 1 –** Structure and Function of Living Cells
**LIFE SCIENCE 3 –** Organization of Living Systems
**LIFE SCIENCE 5** – Theory of Evolution

**Valwood Graduates:**
- Evaluate and express the role of natural selection in the development and interdependence of living systems
- Analyze the relationship between structure and function across all major levels of organization in living systems

**GRADE LEVEL EXPECTATION: Biodiversity of Eukaryotes**
**Concepts and skills students master:**
Taxonomic systems are employed to group organisms based on shared characteristics

| Evidence Outcomes | 21st Century Skills and Readiness Competencies |
|---|---|
| **Students can:**<br>a. Distinguish between organisms that are classified as prokaryotes or eukaryotes with particular emphasis on plant and animal systems<br><br>b. Describe the basic requirements for classification and survival of plant and animal life<br><br>c. Identify, differentiate, and describe the features and functions of major plant organs and their constitutive tissues<br><br>d. Explain the relationship between tissue structure and the resulting emergent properties of organs<br><br>e. Distinguish between invertebrates and chordates and understand the general traits characteristic of members in either group<br><br>f. Communicate the expected evolutionary order of plant and animal groups<br><br>g. Describe the relationship between internal and external environmental stimuli and adaptive animal responses and behaviors | **Inquiry Questions:**<br>1. Why is the success and diversity of plant life critical for the success of animal life?<br>2. What evidence do we have that suggests the evolution of all animals from aquatic prokaryotes?<br>3. In what ways do plants mimic animal life on Earth?<br>4. In what ways do animals maintain homeostasis?<br><br>**Relevance and Application:**<br>1. Producers are capable of both glucose production and consumption and therefore serve as the foundation for life within the biosphere<br>2. Complex plant life has co-evolved with animal life, strengthening the ecological interdependence of organisms<br>3. Understanding basic plant biology and anatomy facilitates a better grasp of sustainable and practical botanical or agricultural practices<br><br>**Nature of Discipline:**<br>1. Evaluation and comparison of life forms from different taxonomic kingdoms<br>2. Effective investigation and discussion of human pressures on environmental sustainability |

**Content Area: CP BIOLOGY**

**Standard: LIFE SCIENCE 1 –** Structure and Function of Living Cells
**LIFE SCIENCE 4** – Ecological Interdependence

**Valwood Graduates:**
- Analyze the impact of environmental pressures on the evolution, genetic makeup, sustainability, and functionality of living systems
- Analyze the relationship between structure and function across all major levels of organization in living systems

**GRADE LEVEL EXPECTATION: Metabolism and Enzymes**
**Concepts and skills students master:**
- Photosynthesis and cellular respiration cycle energy and matter within cells, populations, and biological communities
- Environmental conditions affect the structure and function of proteins and the cells that contain them

| Evidence Outcomes | 21st Century Skills and Readiness Competencies |
|---|---|
| **Students can:**<br>a. Establish a connection between environmental conditions and enzyme function as a result of its flexible structure<br><br>b. Distinguish between catabolic and anabolic pathways in terms of product formation and energy consumption<br><br>c. Discuss the effect of enzymes on metabolic efficiency in relation to changes in the energy of activation<br><br>d. Differentiate the effects of competitive and non-competitive inhibitors on enzyme function and metabolic rate<br><br>e. Explain the sequential order of the light-dependent and light-independent processes of photosynthesis in terms of their basic reactants and products<br><br>f. Explain the sequential order of the steps in both aerobic and anaerobic respiration in terms of their reactants and products<br><br>g. Evaluate the influence of the environment in determining the efficiency or form of metabolism used to provide energy for an organism | **Inquiry Questions:**<br>1. How are rates of enzyme activity impacted by changing environmental conditions?<br>2. How do enzymes catalyze reactions?<br>3. What role does water play within living organisms?<br>4. What is the role of water and oxygen in the formation of ATP?<br><br>**Relevance and Application:**<br>1. Explain how high temperatures such as a fever may alter cellular enzyme activity.<br>2. The process of photosynthesis and cellular respiration demonstrates evolution of life from prokaryotes<br>3. Demonstrate the cyclical flow of energy between plant and animals to debate and justify concerns about environmental preservation<br><br>**Nature of Discipline:**<br>1. Recognize that the current understanding of photosynthesis and cellular respiration has developed over time.<br>2. Critically evaluate models for photosynthesis and cellular respiration. |

**Content Area: CP BIOLOGY**

**Standard: LIFE SCIENCE 1 –** Structure and Function of Living Cells

**Valwood Graduates:**
Analyze the relationship between structure and function across all major levels of organization in living systems

**GRADE LEVEL EXPECTATION: The Chemistry of Life**
**Concepts and skills students master:**
The structure of molecules, organelles, and cells determine their function in living systems

| Evidence Outcomes | 21st Century Skills and Readiness Competencies |
|---|---|
| **Students can:**<br>a. Make predictions about the strength and formation of chemical bonds between nearby atoms<br><br>b. Plan and carry out investigations related to the polar covalence of water and the emergent properties of water<br><br>c. Determine the utility of covalent bonds, including their formation and breakdown, in the construction of organic macromolecules<br><br>d. Construct arguments supported by evidence to relate the structure of macromolecules to their role in cellular processes<br><br>e. Assess the general structure and function of carbohydrates, lipids, proteins, and nucleic acids | **Inquiry Questions:**<br>1. What is the effect on atomic function because of subatomic changes?<br>2. What is the role of chemical bonding in the structure of life on Earth?<br>3. How does the structure of water contribute to its emergent properties?<br>4. What is the role of the macromolecules in living organisms?<br><br>**Relevance and Application:**<br>1. Water is necessary for the regulation of both the biotic and abiotic world.<br>2. Subatomic changes in structure can result in macroscopic changes to organismal function.<br>3. Dietary decisions are fully elucidated through understanding of the molecular components of food.<br>4. The functionality of proteins determines the success of life on Earth.<br><br>**Nature of Discipline:**<br>1. Form testable hypotheses from well-defined observations that are further analyzed during appropriate experimentation and data collection.<br>2. Establish the importance of structure and function that will support the ideas in all following biological subject areas. |

**Content Area: CP BIOLOGY**

**Standard: LIFE SCIENCE 1 –** Structure and Function of Living Cells

**Valwood Graduates:**
Analyze the relationship between structure and function across all major levels of organization in living systems

**GRADE LEVEL EXPECTATION: Cell Structure and Function**
**Concepts and skills students master:**
The structure of molecules, organelles, and cells determine their function in living systems

| Evidence Outcomes | 21st Century Skills and Readiness Competencies |
|---|---|
| **Students can:**<br>a. Distinguish between prokaryotic and eukaryotic cells and their respective cellular structures<br><br>b. Identify key evidence, including the structural components of both mitochondria and chloroplasts, that supports the endosymbiotic theory<br><br>c. Construct an explanation of how cell structures and organelles interact as a system in eukaryotes<br><br>d. Evaluate the molecular composition of the cell membrane as a phospholipid bilayer and a fluid mosaic<br><br>e. Understand and determine the role of both passive and active cellular transport in maintaining homeostasis<br><br>f. Make predictions about the direction and effect of osmoregulation in living cells | **Inquiry Questions:**<br>1. What variables affect the rate of transport across a membrane?<br>2. What is the effect of a nonfunctional organelle on cell survival?<br>3. How does the ratio of surface area to cellular volume limit cell size?<br><br>**Relevance and Application:**<br>1. Osmotically balanced solutions such as intravenous and ophthalmic solutions are critical in medical settings.<br>2. Technology, such as dialysis, can replace transport processes normally associated with the kidneys.<br>3. Membrane potentials are maintained via sodium potassium pumps allowing for action potentials in activities such as: muscle contraction, nerve impulse transmission, and cotransport.<br><br>**Nature of Discipline:**<br>1. Ask testable questions and make a falsifiable hypothesis about how cells transport materials into and out of the cell and use an inquiry approach to find the answer |

**Content Area: CP BIOLOGY**

**Standard: LIFE SCIENCE 1 –** Structure and Function of Living Cells

**Valwood Graduates:**
Explain how organisms fulfill all requirements of a living system including the expression, transmission, and regulation of genes

**GRADE LEVEL EXPECTATION: Cellular Reproduction**
**Concepts and skills students master:**
Various forms of cellular reproduction sustain the genetic continuity of life

| Evidence Outcomes | 21st Century Skills and Readiness Competencies |
|---|---|
| **Students can:**<br>a. Identify the unique genetic characteristics of various forms of cellular reproduction, including mitosis and meiosis<br><br>b. Determine the hallmarks and sequence of both the dividing and non-dividing stages of the cell cycle<br><br>c. Construct an argument to support a claim about the relative advantages and disadvantages of sexual versus asexual reproduction<br><br>d. Make predictions regarding the ploidy and genetic diversity of daughter cells following cell division<br><br>e. Make predictions regarding the effect of nondisjunction during the stages of meiosis<br><br>f. Identify the unique cellular forms that result from cell division and make claims about their contribution to successive generations<br><br>g. Explain the process of cellular differentiation following fertilization of multicellular eukaryotes | **Inquiry Questions:**<br>1. What advantages does asexual or sexual reproduction confer on a species?<br>2. What environmental factors can contribute to regulation or undirected changes to the cell cycle?<br>3. Why is it possible to clone a whole organism from an undifferentiated cell?<br>4. Why do researchers seek stem cells for the development of potential treatments for medical conditions?<br><br>**Relevance and Application:**<br>1. Students develop a better understanding of the causes, dangers, and treatments of cancer<br>2. Stem cells may be used to treat medical conditions such as diabetes, Parkinson's disease, torn cartilage, and damaged hearts.<br><br>**Nature of Discipline:**<br>1. Debate the advantages and disadvantages of bioengineering (cloning and genetically modifying organisms) in the food supply.<br>2. Debate the ethical and political issues associated with stem cell research and how these affect research. |

**Content Area: CP BIOLOGY**

**Standard: LIFE SCIENCE 2 –** Expression and Transmission of Genetic Information

**Valwood Graduates:**
Explain how organisms fulfill all requirements of a living system including the expression, transmission, and regulation of genes

**GRADE LEVEL EXPECTATION: Foundations of Gene Expression**
**Concepts and skills students master:**
- Nucleic acids allow for the transmission, storage, and expression of genetic information
- The structure of DNA and RNA demands the sequential flow of the central dogma

| Evidence Outcomes | 21st Century Skills and Readiness Competencies |
|---|---|
| **Students can:**<br>a. Visualize and describe all the structural differences between DNA and RNA and make supported claims relating these differences in structure to deviations in function<br><br>b. Explain how the structure of the DNA double helix dictates the semiconservative nature of its replication and transcription<br><br>c. Identify the role of all major enzymes involved in the replication and transcription of DNA<br><br>d. Explain the role of both mRNA and the ribosome in the production of proteins from genetic sequences<br><br>e. Understand and communicate the normal flow of gene expression in living organisms<br><br>f. Distinguish the various forms of mutations and explain their likely effect on the structure and function of gene products | **Inquiry Questions:**<br>1. Why is it possible for a cell from one species to express genes from another species as in genetically modified organisms?<br>2. How is it possible to distinguish nature and nurture?<br>3. What environmental variables may influence the rate of translation?<br>4. How does cell signaling regulate gene expression?<br><br>**Relevance and Application:**<br>1. Students can communicate information regarding the ethics of biotechnology and genetic engineering<br>2. Recombinant DNA technology has many uses in society such as the development of new medical therapies and increased production of drugs.<br>3. DNA replication errors may affect phenotype.<br><br>**Nature of Discipline:**<br>1. Recognize that private and public laboratories perform research on genetically modified organisms. Discuss the ethical implications and the funding of such research.<br>2. Understand that scientists work from the assumption that basic principles for genetics apply to all organisms. |

**Content Area: CP BIOLOGY**

**Standard: LIFE SCIENCE 2 –** Expression and Transmission of Genetic Information

**Valwood Graduates:**
Explain how organisms fulfill all requirements of a living system including the expression, transmission, and regulation of genes

**GRADE LEVEL EXPECTATION: Introductory Genetics**
**Concepts and skills students master:**
Nucleic acids allow for the transmission, storage, and expression of genetic information

| Evidence Outcomes | 21st Century Skills and Readiness Competencies |
|---|---|
| **Students can:**<br>a. Distinguish between genes and alleles and understand the role of both in the chromosomal theory of inheritance<br><br>b. Use Mendel's laws of segregation and independent assortment to make empirical claims regarding genetic outcomes<br><br>c. Determine the relative strength and expression of alleles for a given gene<br><br>d. Use mathematical models, including the laws of probability, to predict genetic outcomes<br><br>e. Use visual models, including pedigrees, to examine gene quality and modes of inheritance for traits that demonstrate complete dominance<br><br>f. Distinguish inheritance patterns that demonstrate complete dominance, codominance, or incomplete dominance | **Inquiry Questions:**<br>1. How does genetic variation arise and what advantages does genetic diversity offer?<br>2. What is the likelihood that genetic conditions will be inherited and maintained within populations?<br>3. Under what circumstances could inherited genes not be expressed?<br>4. Under what circumstances can non-lethal mutations be useful<br><br>**Relevance and Application:**<br>1. Students can make informed considerations of personalized medicine and better understand the role of genetic counselors<br>2. Knowledge of inheritance patterns allow for educated predictions regarding the appearance of traits in a family line<br><br>**Nature of Discipline:**<br>1. Forming predictions and conducting relevant calculations to reinforce the physicality of genetic inheritance<br>2. Interpretation of visual and numerical data<br>3. Debate the role of nature and nurture in the development of living systems |

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