VALWOOD

GO BEYOND

Pre-AP Biology Curriculum

Pre-AP Biology (9th Grade) Overview

Course Description

Pre-Advanced Placement (Pre-AP) Biology is a first-year honors biology course that introduces the concepts necessary for proficiency in the identification of patterns, processes, and relationships in living systems. This course is designed to support critical understanding of the content learned in K-8 life science and further encourage exploration of more abstract topics in biology through the most necessary of scientific skills: inquiry. Students will also learn how to properly utilize the scientific method and become comfortable with standard laboratory practices, equipment, and field work.

Topics at a Glance

- Chemistry of Life
- Cell Structure and Function
- Cellular Reproduction
- Introductory Genetics
- Foundations of Gene Expression
- Cellular Energetics
- Cell Communication
- Ecology and Evolution
- Plant Form and Function
- Animal Diversity

Assessments

- Instructor-created unit assessments, including quizzes and tests
- Instructor-created semester assessments
- Lab reports
- Group and/or individual research presentations

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

Content Area: PRE-AP 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: a. Distinguish between prokaryotic and eukaryotic cells and their respective cellular structures b. Identify key evidence, including the structural components of both mitochondria and chloroplasts, that supports the endosymbiotic theory c. Calculate and examine the effect of changing surface area-to-volume ratios on the metabolic efficiency of cell structures d. Construct an explanation of how cell structures and organelles interact as a system in eukaryotes e. Evaluate the molecular composition of the cell membrane as a phospholipid bilayer and a fluid mosaic f. Understand and determine the role of both passive and active cellular transport in maintaining homeostasis g. Make predictions about the direction and effect of osmoregulation in living cells	**Inquiry Questions:** 1. What variables affect the rate of transport across a membrane? 2. What is the effect of a nonfunctional organelle on cell survival? 3. How does the ratio of surface area to cellular volume limit cell size? **Relevance and Application:** 1. Osmotically balanced solutions such as intravenous and ophthalmic solutions are critical in medical settings. 2. Technology, such as dialysis, can replace transport processes normally associated with the kidneys. 3. Membrane potentials are maintained via sodium potassium pumps allowing for action potentials in activities such as: muscle contraction, nerve impulse transmission, and cotransport. **Nature of Discipline:** 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: PRE-AP 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: a. Identify the unique genetic characteristics of various forms of cellular reproduction, including binary fission, mitosis, and meiosis b. Determine the hallmarks and sequence of both the dividing and non-dividing stages of the cell cycle c. Construct an argument to support a claim about the relative advantages and disadvantages of sexual versus asexual reproduction d. Make predictions regarding the ploidy and genetic diversity of daughter cells following cell division e. Make predictions regarding the effect of nondisjunction during the stages of meiosis f. Identify the unique cellular forms that result from cell division and make claims about their contribution to successive generations g. Explain the process of cellular differentiation following fertilization of multicellular eukaryotes	**Inquiry Questions:** 1. What advantages does asexual or sexual reproduction confer on a species? 2. What environmental factors can contribute to regulation or undirected changes to the cell cycle? 3. Why is it possible to clone a whole organism from an undifferentiated cell? 4. Why do researchers seek stem cells for the development of potential treatments for medical conditions? **Relevance and Application:** 1. Students develop a better understanding of the causes, dangers, and treatments of cancer 2. Stem cells may be used to treat medical conditions such as diabetes, Parkinson's disease, torn cartilage, and damaged hearts. **Nature of Discipline:** 1. Debate the advantages and disadvantages of bioengineering (cloning and genetically modifying organisms) in the food supply. 2. Debate the ethical and political issues associated with stem cell research and how these affect research.

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

Content Area: PRE-AP 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: 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 b. Explain how the structure of the DNA double helix dictates the semiconservative nature of its replication and transcription c. Develop and use models to examine the role of all major enzymes involved in the replication of DNA or conversion of nucleic acids from one form to another d. Explain the role of both mRNA and the ribosome in the production of proteins from genetic sequences e. Understand and communicate the normal flow of gene expression in living organisms and make an educated claim about the nature of retroviruses f. Make predictions regarding environmental impact on genetic information and the transmission of mutations g. Distinguish the various forms of mutations and explain their likely effect on the structure and function of gene products	**Inquiry Questions:** 1. Why is it possible for a cell from one species to express genes from another species as in genetically modified organisms? 2. How is it possible to distinguish nature and nurture? 3. What environmental variables may influence the rate of translation? 4. How does cell signaling regulate gene expression? **Relevance and Application:** 1. Students can communicate information regarding the ethics of biotechnology and genetic engineering 2. Recombinant DNA technology has many uses in society such as the development of new medical therapies and increased production of drugs. 3. DNA replication errors may affect phenotype. **Nature of Discipline:** 1. Recognize that private and public laboratories perform research on genetically modified organisms. Discuss the ethical implications and the funding of such research. 2. Understand that scientists work from the assumption that basic principles for genetics apply to all organisms.

Content Area: PRE-AP 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: Cellular Energetics
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: a. Create models that describe the anatomy of an enzyme b. Establish a connection between levels of protein or enzyme structure and relative metabolic activity, including the role of inhibitors and environmental impact on enzyme function c. Provide visual models that distinguish between catabolic and anabolic pathways in terms of energy consumption, product formation, reaction rate, and entropy d. Discuss the effect of enzymes on metabolic efficiency in relation to changes in the energy of activation e. Explain the sequential order of the light-dependent and light-independent processes of photosynthesis in terms of their reactants and products f. Explain the sequential order of the steps in both aerobic and anaerobic respiration in terms of their reactants and products g. Evaluate the influence of the environment in determining the efficiency or form of metabolism used to provide energy for an organism	**Inquiry Questions:** 1. How are rates of enzyme activity impacted by changing environmental conditions? 2. How do enzymes catalyze reactions? 3. What role does water play within living organisms? 4. What is the role of water, oxygen, and protons in the formation of a proton gradient? **Relevance and Application:** 1. Explain how high temperatures such as a fever may alter cellular enzyme activity. 2. Form a strong understanding of the laws of thermodynamics 3. The process of photosynthesis and cellular respiration demonstrates evolution of life from prokaryotes 4. Demonstrate the cyclical flow of energy between plant and animals to debate and justify concerns about environmental preservation **Nature of Discipline:** 1. Recognize that the current understanding of photosynthesis and cellular respiration has developed over time. 2. Critically evaluate models for photosynthesis and cellular respiration.

Content Area: PRE-AP BIOLOGY

Standard: LIFE SCIENCE 1 – Structure and Function of Living Cells
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: Cell Communication
Concepts and skills students master:
Multicellular organisms coordinate responses and behavior through directed cell signaling

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Explain how multicellular organisms use chemical structures to facilitate adaptive signaling networks between various cellular systems to achieve homeostasis b. Scientifically justify claims about the effects of internal and external stimuli on cellular processes c. Identify various modes of intrinsic and extrinsic signaling in prokaryotic and eukaryotic organisms d. Determine the role of transmembrane and intracellular receptors in facilitating signal reception, transduction, and response e. Discuss the role of second messengers, such as cAMP, and phosphorylation cascades in signal amplification f. Explain the need for molecular regulation of cellular responses through feedback mechanisms and predict the impact of loss-of-function mutations on response to cellular signals	**Inquiry Questions:** 1. Where and when are negative versus positive feedback loops necessary for maintaining homeostasis? 2. What is the effect of using different combinations of receptors and signaling molecules across different organ systems? 3. How are phosphorylation cascades used and regulated? 4. Why are cAMP and calcium effective second messengers? **Relevance and Application:** 1. Drugs target receptor proteins such as hormones and neurotransmitters in membranes and mimic the action of natural signals there. 2. The disruption of homeostatic mechanisms may lead to disease, and if severe enough, death. 3. The regulatory responses of autoimmune diseases such as Type I diabetes, multiple sclerosis and rheumatoid arthritis are different than those of healthy immune systems. **Nature of Discipline:** 1. Research and present findings about how medical problems that impact life span have changed throughout history due to altered lifestyles and advances in medicine.

Content Area: PRE-AP 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: Ecology and Evolution
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: a. Critically evaluate the role of environmental pressures on population gene pools and the subsequent emergence of favorable adaptations b. Explore speciation through derived characters, common ancestry, and evaluation of homologous versus analogous features c. Distinguish between similar and dissimilar species through application of major species concepts and molecular-based evidence d. Provide and articulate evidence for the occurrence of evolution through natural selection e. Compare and contrast evolution through natural and artificial selective pressures f. Examine the strength and influence of selective pressures and genetic drift events through visual and mathematical models, including application of Hardy-Weinberg equilibrium g. Describe the modes of speciation and explain the environmental factors that drive them	**Inquiry Questions:** 1. How does studying extinct species contribute to our current understanding of evolution? 2. How can patterns of characteristics shared among organisms be used to categorize life's diversity according to relatedness? 3. How can you use a Hardy-Weinberg equation to determine direction and speed of evolution in a population? **Relevance and Application:** 1. Resistance can occur when antibiotics and pesticides are overused or abused. 2. Human activities can generate selective pressures on organisms, such as breeding new kinds of dogs and improving livestock. 3. Species undergo natural selection due to environmental pressures. **Nature of Discipline:** 1. Understand that all scientific knowledge is subject to new findings and that reproducible, corroborated, and converging lines of data yield a scientific theory. 2. 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: PRE-AP 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 and Evolution
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: a. Explain the relationship between environmental pressures and the expected changes in both population size and community diversity b. Make predictions about community diversity and sustainability through application and analysis of mathematical models 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 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 e. Distinguish between endothermic and ectothermic metabolic regulation and establish a connection between metabolic approach and environmental conditions	**Inquiry Questions:** 1. How do keystone species maintain balance in ecosystems? 2. How does the introduction of a non-native species influence the balance of an ecosystem? 3. What are the interspecific relationships within a community? 4. How does the growth rate within a population change over time? **Relevance and Application:** 1. Earth's carrying capacity is limited. 2. Exponential human population growth has directly impacted the biosphere. 3. The extraction of resources by humans impacts ecosystems. **Nature of Discipline:** 1. Critically evaluate scientific explanations to determine if the research methodology and evidence presented are appropriate and sufficient to support the claims.

Content Area: PRE-AP 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

GRADE LEVEL EXPECTATION: Plant Form and Function
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: a. Describe the basic requirements for plant life b. Offer an explanation for the role of plant needs in the chronological evolution of major plant clades and identify the adaptations characteristic of each clade c. Identify, differentiate, and describe the features and functions of all major plant organs and their constitutive tissues d. Explain the relationship between tissue structure and the resulting emergent properties of organs e. Discuss the growth and development of plant tissues from meristem during germination, maturation, and reproduction f. Provide descriptions and create models of transpiration, capillary action, and water absorption through the roots g. Describe the relationship between internal and external environmental stimuli and adaptive plant responses that maintain homeostasis h. Make a claim regarding the role and susceptibility of RuBisCO during the light-independent reactions and offer an explanation for diversity in carbon fixation pathways	**Inquiry Questions:** 1. Why is the success and diversity of plant life critical for the success of animal life? 2. What advantage does the alternation of generations confer on plant species? 3. In what ways do plants mimic animal life on Earth? 4. How does the environment direct the adaptations of specific plant clades and influence changes to carbon fixation? **Relevance and Application:** 1. Producers are capable of both glucose production and consumption and therefore serve as the foundation for life within the biosphere 2. Complex plant life has co-evolved with animal life, strengthening the ecological interdependence of organisms 3. Understanding basic plant biology and anatomy facilitates a better grasp of sustainable and practical botanical or agricultural practices **Nature of Discipline:** 1. Evaluation and comparison of life forms from different taxonomic kingdoms 2. Effective investigation and discussion of human pressures on environmental sustainability

Content Area: PRE-AP BIOLOGY

Standard: **LIFE SCIENCE 1 –** Structure and Function of Living Cells
LIFE SCIENCE 4 – Ecological Interdependence
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: Animal Diversity
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: a. Describe the basic requirements for classification and survival of animal life b. Distinguish between invertebrates and chordates and understand the general traits characteristic of members in either group c. Effectively communicate broad anatomical features including cephalization, formation of a coelom or pseudocoelom, body symmetry, segmentation, and basic body regions d. Offer an explanation for the role of animal needs in the chronological evolution of major animal phyla and identify the adaptations characteristic of each phylum e. Describe the relationship between internal and external environmental stimuli and adaptive animal responses that maintain homeostasis f. Distinguish between innate and learned animal behaviors and evaluate the advantage of behaviors over baseline functions	**Inquiry Questions:** 1. What distinguishes animal life from plant life? 2. What common features are shared among all animals? 3. What evidence do we have that suggests the evolution of all animals from aquatic prokaryotes? 4. In what ways do animals maintain homeostasis? 5. In what ways do animals demonstrate behaviors beyond involuntary response to a stimulus? **Relevance and Application:** 1. Establish a better understanding of human construction, evolution, and evolutionary relationship to other animals 2. Provide a foundation for both human anatomy and psychology 3. Examine the biological structures that allow for functional diversity that can be mimicked through biomechanical engineering **Nature of Discipline:** 1. Deeply examine the relationship between structure and function 2. Apply the knowledge of biological structures to design more effective machines, equipment, and artificial intelligence

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