VALWOOD

GO BEYOND

Biology Curriculum

Biology Course Overview

Course Description	Topics at a Glance
Biology is a course emphasizing the understanding and application of the concepts of life. Students are encouraged to see the relevance of biology to their everyday lives and to develop a deep respect for living things and their environment. This course introduces general biology with concentration on molecules and cells, genetics and evolution, diversity of life, and ecological principles. Laboratory exercises and projects are coordinated to reinforce lecture presentations to promote a true understanding of, and proficiency in, the scientific method.	• Matter and energy in ecosystems • Basic biochemistry • Cell membranes and transport process • Genetics • Evolution • Population and community ecology • Photosynthesis and respiration • Homeostasis and physiology

Assessments

- Teacher Created Assessments
- Assessments adopted from course materials

Standard	Big Ideas In Biology (Grade Level Expectations)
Life Science	1. Matter tends to be cycled within an ecosystem, while energy is transformed and eventually exits an ecosystem. 2. The size and persistence of populations depend on the interactions with each other and on the abiotic factors in an ecosystem. 3. Cellular metabolic activities are carried out by biomolecules produced by organisms. 4. The energy for life primarily derives from the interrelated processes of photosynthesis and cellular respiration. Photosynthesis transforms the Sun's light energy into the chemical energy of molecular bonds. Cellular respiration allows cells to utilize chemical energy when these bonds are broken. 5. Cells use the passive and active transport of substances across membranes to maintain relatively stable intracellular environments. 6. Cells, tissues, organs, and organ systems maintain relatively stable internal environments, even in the face of changing external environments. 7. Physical and behavioral characteristics of an organism are influenced to varying degrees by heritable genes, many of which encode instructions for the production of proteins. 8. Multicellularity makes possible a division of labor at the cellular level through the expression of select genes, but not the entire genome. 9. Evolution occurs as the heritable characteristics of populations change across generations and can lead populations to become better adapted to their environment.

2. Life Science

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 in living systems at a variety of organizational levels, and recognize living systems' dependence on natural selection
- Explain and illustrate with examples how living systems interact with the biotic and abiotic environment
- Analyze how various organisms grow, develop, and differentiate during their lifetimes based on an interplay between genetics and their environment
- Explain how biological evolution accounts for the unity and diversity of living organisms

Content Area: Science - High School Biology

Standard: 2. Life Science

Valwood Graduates:

Explain and illustrate with examples how living systems interact with the biotic and abiotic environment

GRADE LEVEL EXPECTATION

Concepts and skills students master:

1. Matter tends to be cycled within an ecosystem, while energy is transformed and eventually exits an ecosystem

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Analyze how energy flows through trophic levels b. Analyze and interpret data from experiments on ecosystems c. Develop, communicate, and justify an evidence-based scientific explanation showing how ecosystems follow the laws of conservation of matter and energy d. Define and distinguish between matter and energy, and how they are cycled or converted through life processes e. Describe how carbon, nitrogen, phosphorus, and water cycles work f. Analyze how energy flows through trophic levels h. Describe how human activity has affected the biogeochemical cycles and propose possible solutions to those changes which have had negative impacts	**Inquiry Questions:** 1. How does a change in abiotic factors influence the stability or progression of an ecosystem? 2. What happens when the cycling of matter in ecosystems is disrupted? 3. What energy transformations occur in ecosystems? 4. How does the process of burning carbon-rich fossil fuels compare to the oxidation of carbon biomolecules in cells? 5. How does a specific change within an ecosystem impact the ecosystem as a whole?
	Relevance and Application: 1. When the matter or energy flow in an ecosystem is disturbed, there are measurable effects such as the eutrophication of water. 2. Matter and energy are cycled in natural systems such as wetlands in both similar and different ways than in human-managed systems such as waste water treatment plants.
	Nature of Discipline: 1. Address differences between experiments where variables can be controlled and those where extensive observations on a highly variable natural system are necessary to determine what is happening. 2. Share experimental data, and respectfully discuss conflicting results emulating the practice of scientists. 3. Design ecological experiments in a closed system.

Content Area: Science - High School Biology

Standard: 2. Life Science

Valwood Graduates:

Explain and illustrate with examples how living systems interact with the biotic and abiotic environment

GRADE LEVEL EXPECTATION

Concepts and skills students master:

2. The size and persistence of populations depend on their interactions with each other and on the abiotic factors in an ecosystem

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Analyze and interpret data about the impact of removing keystone species from an ecosystem or introducing non-native species into an ecosystem b. Describe or evaluate communities in terms of primary and secondary succession as they progress over time c. Evaluate data and assumptions regarding different scenarios for future human population growth and their projected consequences d. Examine, evaluate, question, and ethically use information from a variety of sources and media to investigate ecosystem interactions e. Discuss the environmental impacts of human population growth f. Understand exponential and logistic growth rates and be able to mathematically determine rate of growth in a population	**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. How is the succession of local organisms altered in an area that is disturbed or destroyed? 4. What are the interspecific relationships within a community? 5. How does modern agriculture affect biodiversity? 6. To what degree is disturbance a "natural" component of ecosystem level processes? *7.* 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. Exploration of possible alternative resources is vital. 4. Using resources in a sustainable manner allows for continued use of the resource. 5. The extraction of resources by humans impacts ecosystems. *6.* Factors such as climate change, La Niña, and El Niño impact 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: Science - High School Biology

Standard: 2. Life Science

Valwood Graduates:

Analyze the relationship between structure and function in living systems at a variety of organizational levels, and recognize living systems' dependence on natural selection

GRADE LEVEL EXPECTATION

Concepts and skills students master:

3. Cellular metabolic activities are carried out by biomolecules produced by organisms

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Understand life is dependent upon water and its unique chemical and physical properties b. Identify biomolecules and their precursors/building blocks c. Develop, communicate, and justify an evidence-based explanation for optimum enzyme activity d. Infer the consequences of suboptimal enzyme function to organisms – such as altered blood pH or fever - using direct or indirect evidence e. Analyze and interpret data on the body's utilization of carbohydrates, lipids, nucleic acids, and proteins *f.* Describe the structure and function of hydrogen bonds and the importance of these bonds to life	**Inquiry Questions:** 1. How are rates of enzyme activity in cells affected by various factors such as pH or temperature? 2. How does one know that enzymes speed up chemical reactions? 3. What role does water play within living organisms? 4. Why is a diet diverse in macromolecules, minerals, and vitamins essential to life? 5. How do enzymatic failures result in disease? 6. How are hydrolysis and dehydration synthesis interrelated? **Relevance and Application:** 1. Apply knowledge of biomolecular structure and activity to make consumer decisions, especially about diet with respect to saturated and unsaturated fatty acids, essential and nonessential amino acids, and simple and complex carbohydrates. 2. Explain how high temperatures such as a fever may alter cellular enzyme activity. **Nature of Discipline:** 1. Critically evaluate scientific explanations in popular media to determine if the research methodology and evidence presented are appropriate and sufficient to support the claims.

Content Area: Science - High School Biology

Standard: 2. Life Science

Valwood Graduates:

Analyze the relationship between structure and function in living systems at a variety of organizational levels, and recognize living systems' dependence on natural selection

GRADE LEVEL EXPECTATION

Concepts and skills students master:

4. The energy for life primarily derives from the interrelated processes of photosynthesis and cellular respiration. Photosynthesis transforms the sun's light energy into the chemical energy of molecular bonds. Cellular respiration allows cells to utilize chemical energy when these bonds are broken

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Understand the structure and function of chloroplasts and mitochondria b. Develop, communicate, and justify an evidence-based scientific explanation about the optimal environment for photosynthetic activity c. Discuss the interdependence of autotrophic and heterotrophic life forms such as depicting the flow of a carbon atom from the atmosphere, to a leaf, through the food chain, and back to the atmosphere d. Explain how the bonds of carbon compounds are gradually oxidized to provide energy in the form of adenosine triphosphate (ATP), which drives many chemical reactions in the cell e. Explain the movement of electrons and the role of electron carriers and enzymes in photosynthesis and cellular respiration f. Describe the primary processes of photosynthesis and cellular respiration g. Evaluate key pieces of evidence such as subcellular location of photosynthesis and cellular respiration and relate it to Endosymbiosis theory.	**Inquiry Questions:** 1. What variables can be manipulated to change the rate of photosynthesis? 2. What variables affect the rate of cellular respiration? 3. How does body heat relate to cellular respiration? 4. How do various chemicals prevent ATP formation in the Electron Transport Chain? **Relevance and Application:** 1. Agriculture is important to humans. Most food comes from agriculture. 2. Various foods such as cheeses, yogurts, alcohol, and breads are produced by fermentation – anaerobic respiration – that is carried out by various organisms. 3. The experience of muscle fatigue after intense exercise is related to anaerobic respiration in muscle cells. 4. Primary producers such as marine phytoplankton and rainforest flora play an integral role in sustaining all life on Earth. 5. The process of photosynthesis and cellular respiration reflects evolution of life from early prokaryotic ancestors. **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: Science - High School Biology

Standard: 2. Life Science

Valwood Graduates:

Analyze the relationship between structure and function in living systems at a variety of organizational levels, and recognize living systems' dependence on natural selection

GRADE LEVEL EXPECTATION

Concepts and skills students master:

5. Cells use passive and active transport of substances across membranes to maintain relatively stable intracellular environments

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Diagram the cell membrane schematically, demonstrating understanding of all structures and their functions b. Analyze various methods for substance transport across cell membranes with regard to rate of transport and energy requirements c. Compare organisms that live in freshwater and marine environments, and identify the challenges of osmotic regulation for these organisms d. Use tools to gather, view, analyze, and interpret data produced during scientific investigations that involve passive and active transport e. Use computer simulations and models to analyze cell transport mechanisms f. Describe the role of cell transport in maintaining turgor pressure in plants	**Inquiry Questions:** 1. What variables affect the rate of transport across a membrane? 2. Why is it important that cell membranes are selectively permeable? 3. How does cell transport maintain turgor pressure? 4. 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. Drugs target receptor proteins such as hormones and neurotransmitters in membranes and mimic the action of natural signals there. 3. Technology, such as dialysis, can replace transport processes normally associated with the kidneys. 4. 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. 2. Emphasize the use of ethical practices in science such as: peer review; factual reporting of methods and outcomes; publicizing work; and sharing a lens of professional skepticism.

Content Area: Science - High School Biology

Standard: 2. Life Science

Valwood Graduates:

Analyze the relationship between structure and function in living systems at a variety of organizational levels, and recognize living systems' dependence on natural selection

GRADE LEVEL EXPECTATION

Concepts and skills students master:

6. Cells, tissues, organs, and organ systems maintain relatively stable internal environments, even in the face of changing external environments

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Discuss the hierarchal organization of life b. Discuss how two or more body systems interact to promote health for the whole organism c. Analyze and interpret data related to the effectiveness of feedback loops in maintaining homeostasis d. Distinguish between causation and correlation regarding disrupted homeostasis in particular diseases (such as diabetes and cancer) e. Use computer simulations and models of homeostatic mechanisms f. Describe the use of mitotic cell cycle in growth, development, and repair within organisms g. Give examples of negative and positive feedback loops h. Compare and contrast how viruses and bacteria result in disease	**Inquiry Questions:** 1. How can an experiment be designed and conducted to test for homeostasis during exercise and other body activities? 2. Where and when are negative versus positive feedback loops necessary for maintaining homeostasis? **Relevance and Application:** 1. The disruption of homeostatic mechanisms may lead to disease, and if severe enough, death. 2. Body systems are impacted by health and disease. For example, atherosclerotic plaque inside a blood vessel can result in a heart attack. 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 the results of dietary deficiencies or excesses. 2. Research and present findings about how medical problems that impact life span have changed throughout history due to altered lifestyles and advances in medicine. 3. Differentiate between scientific evidence evaluated by the Food and Drug Administration (FDA) for drug approval and anecdotal evidence shared among individuals or in magazines/newspapers that a food or supplement is effective for a given problem.

Content Area: Science - High School Biology

Standard: 2. Life Science

Valwood Graduates:

Analyze how various organisms grow, develop, and differentiate during their lifetimes based on an interplay between genetics and their environment

GRADE LEVEL EXPECTATION

Concepts and skills students master:

7. Physical and behavioral characteristics of an organism are influenced to varying degrees by heritable genes, many of which encode instructions for the production of proteins

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Analyze and interpret evidence that genes are functional portions of DNA b. Analyze and interpret data on the processes of DNA replication, transcription, translation, and gene regulation, and show how these processes are common to all organisms c. Recognize that proteins carry out most cell activities and mediate the effect of genes on physical and behavioral traits in an organism d. Recognize that variation is a result of sexual reproduction due to the meiotic processes of independent assortment of chromosomes, crossing over, and mutations e. Use examples to explain how genetic mutations can benefit, harm, or have neutral effects on an organism f. Describe and predict patterns of inheritance	**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. Why are human offspring not genetic clones of their parents or siblings? 3. How is it possible to distinguish nature and nurture? 4. Why do some genetic conditions skip generations? **Relevance and Application:** 1. Recombinant DNA technology has many uses in society such as the development of new medical therapies and increased production of drugs. 2. Selective breeding differs from genetic modification, yet shares a common goal. 3. There are benefits and risks to having genetically modified organisms in the food supply. 4. 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: Science - High School Biology

Standard: 2. Life Science

Valwood Graduates:

Analyze how various organisms grow, develop, and differentiate during their lifetimes based on an interplay between genetics and their environment

GRADE LEVEL EXPECTATION

Concepts and skills students master:

8. Multicellularity makes possible a division of labor at the cellular level through the expression of select genes, but not the entire genome

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Develop, communicate, and justify a scientific explanation of how cells differentiate to form specialized tissues due to the expression of some genes and not others b. Understand that the role of the majority of eukaryotic DNA is under investigation, but be able to analyze and interpret data showing that most eukaryotic DNA does not actively code for proteins within cells c. Be able to explain, using evidence, that the principles of cloning are based upon the majority of an organism's cells maintaining a full complement of the genome d. Analyze and utilize data on medical conditions supporting claims that genetic mutations and cancer are brought about by exposure to environmental agents (such as toxins, radiation, or smoking) e. Understand that an organism's environment can determine when a gene is expressed, and this occurs through multiple mechanisms	**Inquiry Questions:** 1. Why is it possible to clone a whole organism from an undifferentiated cell? 2. Why do researchers seek stem cells for the development of potential treatments for medical conditions? **Relevance and Application:** 1. Stem cells may be used to treat medical conditions such as diabetes, Parkinson's disease, torn cartilage, and damaged hearts. 2. Recent research and insights into DNA and genes have changed aspects of society such as: the criminal justice system, food supply, and medical treatments. **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: Science - High School Biology

Standard: 2. Life Science

Valwood Graduates:

Explain how biological evolution accounts for the unity and diversity of living organisms

GRADE LEVEL EXPECTATION

Concepts and skills students master:

9. Evolution occurs as the heritable characteristics of populations change across generations and can lead populations to become better adapted to their environment

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Develop, communicate, and justify an evidence-based scientific explanation for how Earth's diverse life forms evolved from a common ancestor b. Analyze and interpret multiple lines of evidence such as molecular studies, comparative anatomy, biogeography, the fossil record and embryology supporting the idea that all species are related by common ancestry c. Analyze and interpret data suggesting speciation can occur as a result of gradual or discrete bursts of rapid changes over geologic time d. Analyze and interpret data on how evolution can be driven by three key components of natural selection: heritability, genetic variation, and differential survival and reproduction e. Generate a model, such as an evolutionary tree, showing how a group of organisms most likely diverged from a common ancestor f. Describe the events resulting in the structure of modern cells through the endosymbiotic process	**Inquiry Questions:** 1. How do subtle differences among closely related fossil species provide evidence of environmental change and speciation? 2. How does studying extinct species contribute to our current understanding of evolution? 3. How can patterns of characteristics shared among organisms be used to categorize life's diversity according to relatedness? 4. 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.