

Grade Level 10

Science Content Focus:

Life Science and Human Body

Grade Level 10, Science Content: Life Science and Human Body

Science Domains: Inquiry; Life Science and Human Body

Science Content: Survival of Organisms; Life Cycles and Reproduction; Cell and Tissue Differentiation; Chemical Reactions within Cells; Interdependence within Ecosystems; Classification of Living Things; Natural Selection/Evolution; Heredity; Body Systems; Human Disease; Patterns of Human Development

Overarching Enduring Understandings:

- All living organisms and their component cells have identifiable characteristics that allow for survival.
- Energy enters an ecosystem in the form of sunlight and flows through the system to each cell. Matter interacts, changes, and recycles in an ecosystem. Populations of organisms survive by maintaining interdependent relationships with one another, and by utilizing biotic and abiotic resources from the environment.
- All living things exhibit patterns of similarity in their structures, behaviors and biochemistry.
- Natural selection is a process that accounts for the diversity of organisms we find on earth today.
- The human body is unique in its heredity, body systems, and development and can be affected by the environment.

Concepts to Emphasize:

abiotic components of ecosystems, biological adaptation, biological evolution, structure and functions of biological molecules, breakdown and synthesis of food molecules, carbon atom bonding principles, carbon cycle, catalyst, homeostasis at the chemical level (pH, buffering), structure and function at the cellular level, cellular energy conversion, cellular regulation, cellular transport of materials, cellular response, interdependence between cell organelles, interdependence between cell reactions, protein synthesis, chromosome pairing, DNA replication, transformation of matter and/or energy, energy requirements of living systems, factors affecting enzyme function, evidence for the unity among organisms, DNA as a code, cell division, homeostasis between body systems, environmental effects on homeostasis, immunity, gene expression, genetic diversity, genetic mutation, cellular differentiation, principles of human genetics, human development, natural selection, energy conversions, recombination of genetic material, reproductive capacity, reproductive value of traits, survival value of traits, human modification of ecosystems and natural resources

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CCSU Power Standards

Power Standard #1 – Scientific Inquiry: Students demonstrate the ability to apply inquiry skills to explore and understand the world around them. (Aligns with Vermont Standard 7.1)

Power Standard #4 – Life Science and Human Body: Students observe and describe structures, characteristics, systems, life cycles, patterns of development, and interdependent relationships that allow organisms to survive and species to evolve. (Aligns with Vermont Standards 7.13, 7.14)

Aligns with Vermont Standards	Vermont Grade Cluster Expectations Competency Focus	Essential Questions and Science Concepts	CCSU Power Indicators Proficiency Focus
	<p>S9-12:30: <i>Survival of Organisms</i> Students demonstrate their understanding of Cell Structure and Function—Survival Requirements by...</p> <ul style="list-style-type: none"> • <u>Predicting the direction of movement</u> of substances across a membrane. <p>AND</p> <ul style="list-style-type: none"> • <u>Developing a model</u> that illustrates the interdependence of cellular organelles (mitochondria, ribosomes, lysosomes, endoplasmic reticulum, cytoplasm) in biochemical pathways within the cell (e.g. mitochondria and chloroplasts: cellular respiration and photosynthesis; nucleus and ribosomes: DNA transcription and protein synthesis). <p>AND</p>	<ul style="list-style-type: none"> • What does it mean to survive? • How can the characteristics of cells help them to survive? • How does function reflect structure in cells? • How and why do cells grow and reproduce? <p>a) There are four basic types of organic compounds found in a cell (proteins, carbohydrates, lipids and nucleic acids).</p> <p>b) Enzymes, proteins that regulate biochemical reactions, are critical to the survival of cells.</p> <p>c) The molecular structure of a cell membrane allows for elective transfer of substances into and out of the cell. (i.e., diffusion, osmosis, facilitated diffusion, active transport).</p>	<p>Draw or model a cell (plant or animal) and identify each structure and its function (4a)</p> <p>Explain how the cell membrane uses diffusion and osmosis to maintain homeostasis (4b)</p> <p>Identify the characteristics and functions of each of the biological macromolecules: lipids, carbohydrates, nucleic acids, and proteins (4c)</p>

	<ul style="list-style-type: none"> Identifying how the basic (general) shape and structure of each of the four types of organic molecules determine its role in maintaining cell survival (i.e., simple carbohydrates [monosaccharides] can be an energy source as a single molecule and a storage/structural molecule when multiple units are chemically combined—[starch, cellulose, chitin].). <p>AND</p> <ul style="list-style-type: none"> Explaining that a specific sequence of amino acids determines the shape of a protein (i.e., sickle cell hemoglobin). 	<p>d) The shape of proteins in a cell determines the structure and function of that cells, hence survival of the organism (i.e., cytoskeleton, biochemical functions).</p>	
	<p>S9-12:31 – Life Cycles and Reproduction Students demonstrate their understanding of Reproduction by...</p> <ul style="list-style-type: none"> <u>Developing a model which illustrates how the DNA of all cells/tissues in an organism is produced from a single fertilized egg cell (mitosis).</u> <p>AND</p> <ul style="list-style-type: none"> <u>Explaining how the nucleotide sequence in DNA (gene) directs the synthesis of specific proteins needed by a cell (e.g., protein synthesis).</u> 	<ul style="list-style-type: none"> To what extent is the reproduction of cells and organisms related? <p>a) Every body cell in an organism contains the identical genome (DNA) which is maintained from one cell generation to the next by mitosis and DNA replication.</p> <p>b) The genetic information in a cell’s DNA is used to direct the synthesis of the thousands of proteins that each cell requires, however only portions of the genome are active in any one cell.</p> <p>c) Genetic variation in cells arises from gamete formation and sexual reproduction.</p>	<p>Describe the molecular structure of the gene, with emphasis on DNA (4f)</p> <p>Describe the process of DNA replication as it relates to mutations (4g)</p> <p>Solve genetics problems to understand patterns of inheritance (4h)</p> <p>Identify the key components of protein synthesis (4i)</p> <p>Explain how the differences between mitosis and meiosis produce different outcomes for organisms (4j)</p>

	<p>S9-12:32 – Cell and Tissue Differentiation Students demonstrate their understanding of Differentiation by...</p> <ul style="list-style-type: none"> • <u>Predicting the change in an embryo, caused by disruption of the ectoderm or mesoderm or endoderm during embryonic development</u> (e.g., Fetal Alcohol Syndrome, drugs, injury). <p>AND</p> <ul style="list-style-type: none"> • Comparing the role of various sub-cellular units in unicellular organisms to comparable structures in multi-cellular organisms (i.e., oral groove, gullet, food vacuole in <i>Paramecium</i> compared to digestive systems in multi-cellular organisms). 	<ul style="list-style-type: none"> • How do cells and groups of cells work together to carry out specialized functions? <p>a) Cell differentiation is regulated through the expression of different genes within the embryo cells. During embryonic development of complex multicellular organisms, chemicals within the cells deactivate portions of the genetic code as influenced by the cell's environment and past history.</p> <p>b) Unicellular organisms lack differentiation, but sub-cellular units carry out all life functions.</p>	
	<p>S9-12:33 – Chemical Reactions Within Cells Students demonstrate their understanding of how Energy Flow Within Cells Supports an Organism's Survival by...</p> <ul style="list-style-type: none"> • <u>Comparing and contrasting the structure of mitochondria and chloroplasts as cell organelles, the interrelatedness of their functions, and their importance to the survival of all cells.</u> <p>AND</p> <ul style="list-style-type: none"> • Describing a possible flow of energy from the environment through an organism to the cellular level, and through the cell from assimilation through storage in ATP. <p>AND</p> <ul style="list-style-type: none"> • Investigating and describing enzyme action under a variety of chemical and physical conditions. 	<ul style="list-style-type: none"> • How do cells process energy for survival? <p>a) In living systems energy flows through matter and is stored and released through chemical reactions. Basic survival energy transformations between cells and their environment include aerobic and anaerobic respiration and photosynthesis reactions.</p> <p>b) Energy is necessary for work to be accomplished and life to be sustained (e.g., At the cellular level this work can be growth, repair, reproduction, and synthesis.).</p> <p>c) Energy is stored in living systems in ATP molecules. Energy is transformed through living systems from the environment through specific cell organelles and specific chemical processes.</p> <p>d) Energy transformations in living systems are enzyme dependent.</p>	

	<p>S9-12:34 – <i>Interdependence within Ecosystems</i> Students demonstrate their understanding of Energy Flow in an Ecosystem by...</p> <ul style="list-style-type: none"> • <u>Developing a model that compares the energy at different trophic levels in a given ecosystem.</u> 	<ul style="list-style-type: none"> • To what extent are producers and consumers dependent on each other? • To what extent could we live without plants? • To what extent are producers and consumers dependent on each other? • To what extent do decomposers play a role in recycling? • In what ways can changes in an ecosystem affect its balance? <p>a) Energy from the sun enters all ecosystems through photosynthesis, is passed through trophic levels (producers, consumers, decomposers) with energy released as heat at every level until all the original energy is eventually released as heat (Energy Pyramid and 10% Rule).</p>	<p>Explain how the movement of energy and the movement of chemicals are different in ecosystems (4l)</p>
	<p>S9-12:35 – <i>Interdependence within Ecosystems</i> Students demonstrate their understanding of Food Webs in an Ecosystem by...</p> <ul style="list-style-type: none"> • <u>Designing (and implementing) an investigation that demonstrates the chemical relationship between carbon compounds of the organisms in a food web (e.g., dyed yeast—<i>Paramecium</i>—roundworm).</u> 	<p>b) Within ecosystems, the processes of photosynthesis and cell respiration recycle matter (i.e., carbon compounds) found within organisms and the abiotic environment.</p>	<p>Describe how photosynthesis and cellular respiration are interdependent reactions (4k)</p>
	<p>S9-12:36 – <i>Interdependence within Ecosystems</i> Students demonstrate their understanding of Equilibrium in an Ecosystem by...</p> <ul style="list-style-type: none"> • <u>Designing an investigation to compare a natural system with one altered by human activities</u> (e.g., acid rain, eutrophication through agricultural runoff, fertilizer, pollution, solid waste, clear cutting, toxic emissions or conservation and habitat reclamation). 	<p>c) Human beings are part of the earth’s ecosystems; human activities can deliberately or inadvertently, alter the equilibrium in an ecosystem.</p>	

	<p>S9-12:37 – Interdependence within Ecosystems Students demonstrate their understanding of Recycling in an Ecosystem by...</p> <ul style="list-style-type: none"> • <u>Developing and explaining a model that shows the recycling of inorganic compounds within a natural ecosystem</u> (e.g., Compare worm compost with commercial fertilizer.). 	<p>d) Matter (inorganic compounds) used by living things on the molecular level is cycled from old life to new life through major chemical cycles of the earth (e.g., N, H₂O, C-O, P).</p>	
	<p>S9-12:38 – Classification of Living Things Students demonstrate their understanding of Classification of Organisms by ...</p> <ul style="list-style-type: none"> • <u>Developing a graphic representation that illustrates and compares the degree of molecular similarity among several species</u> (e.g., DNA or amino acid sequences). 	<ul style="list-style-type: none"> • How can you tell an animal from a plant? • How do scientists use characteristics to sort living things? • How do scientists decide whether or not organisms are of the same species? • How has knowledge of molecular biology changed the way scientists classify organisms? <p>a) Formal classification systems of organisms (Domain, Kingdom, Phylum...) are based upon molecular similarities and differences among organisms.</p> <p>b) A species is the most fundamental unit of classification. Similarity of species (degree of kinship) can be substantiated by the molecular composition (e.g., DNA /amino acid sequences).</p>	
	<p>S9-12:39 – Natural Selection/Evolution Students demonstrate their understanding of Evolution/Natural Selection by...</p> <ul style="list-style-type: none"> • <u>Applying the theory of Natural Selection to a scenario depicting change within a given population over time</u> (through many generations) (e.g., bacterial resistance to antibiotics, neck of the giraffe, animal camouflage). 	<ul style="list-style-type: none"> • How do traits change in a population? • Why do some traits remain in the population? • In what ways is evolution supported by scientific evidence? <p>a) The diversity of present-day organisms resulted from changes over time in many ancestral organisms.</p> <p>b) Evolution (change over time) is based on variety</p>	<p>Explain how variation, adaptation, and natural selection contribute to evolution (4d)</p> <p>Use evidence from the fossil record, molecular biology, similarities in development, and</p>

		<p>within species. A greater variation within a species increases the possibility of species survival under changing conditions. Life on earth is thought to have begun four billion years ago, as simple, one-celled organisms about some of which still exist today.</p> <p>c) Natural Selection provides a mechanism for evolution and leads to organisms well-suited for survival in a particular, existing environment.</p> <p>d) Species result from evolution due to:</p> <ul style="list-style-type: none"> • overpopulation • genetic variability of offspring • a finite supply of resources, producing stress and competition • the selection (survival and subsequent reproduction) of offspring best suited to a particular environment <p>e) Molecular evidence supports other types of evidence for evolution.</p>	<p>homologous structures to explain how groups of organisms change over time (4e)</p>
	<p>S9-12:40 - Heredity Students demonstrate their understanding of Human Heredity by...</p> <ul style="list-style-type: none"> • <u>Modeling and explaining how the structure of DNA is maintained and relates to genes and chromosomes, which code for specific protein molecules within a cell.</u> <p>AND</p> <ul style="list-style-type: none"> • <u>Modeling or diagramming new gene combinations that result from sexual reproduction</u> (e.g., dominant/recessive traits). <p>AND</p>	<ul style="list-style-type: none"> • In what ways are people alike and different from each other? • In what ways are people alike and different from other animals? • In what ways are children’s traits similar to their parents’ traits? • How do children get traits from their parents? <p>a) Instructions for specified characteristics of an organism are carried in DNA. (NSES) The information passed from parents to offspring is coded in DNA molecules. DNA molecules are long chains linking</p>	<p>Describe the molecular structure of the gene, with emphasis on DNA (4f)</p> <p>Describe the process of DNA replication as it relates to mutations (4g)</p> <p>Solve genetics problems to</p>

	<ul style="list-style-type: none"> • <u>Explaining how alteration of a DNA sequence may affect physical/chemical characteristics of the human body</u> (e.g., sickle-cell anemia, cancer). <p>AND</p> <ul style="list-style-type: none"> • Comparing and contrasting the chromosome content of somatic cells and that of sex cells (gametes). 	<p>just four kinds of smaller molecules, whose sequence encodes genetic information.</p> <ul style="list-style-type: none"> b) The human body is formed from cells that contain homologous pairs, two copies of each chromosome. c) New heritable characteristics can result from new combinations of existing genes or from mutations of genes in reproductive cells. d) All body cells have identical genetic information, but its expression may be very different from one cell to another due to the instructions given to different types of cells. <ul style="list-style-type: none"> • The sorting and recombination of genes in sexual reproduction results in a great variety of possible gene combinations (Include value of meiosis, but not phases). • Some new gene combinations make little difference, some can produce organisms with new and perhaps enhanced capabilities and some can be deleterious. • Gene mutations can be caused by radiation and chemicals (legal and illegal) and are passed on to offspring when they occur in sex cells. • Inserting, deleting or substituting DNA segments can alter genes. • Changes in DNA (mutations) occur spontaneously at low rates, but can affect the organism in many ways or may go unnoticed. e) Gene mutations in a cell can result in uncontrolled division called cancer. Exposure of cells to certain chemicals and radiation increases mutations and thus chances of cancer. 	<p>understand patterns of inheritance (4h)</p> <p>Identify the key components of protein synthesis (4i)</p> <p>Explain how the differences between mitosis and meiosis produce different outcomes for organisms (4j)</p>
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S9-12:41 – Body Systems

Students demonstrate their understanding of Human Body (biochemical) Systems by...

- Diagramming a feedback loop that illustrates how several human body systems work together to restore homeostasis in response to an external stimulus (environmental/behavioral) (e.g., exercise, fight/flight, stress, drugs, normal cellular metabolism, any nervous system response).

AND

- Explaining examples of how the human body may be affected by the state of the internal environment and by heredity and by life experience (e.g., effects of malnutrition).

AND

- Predicting and explaining how the effect of various physiological factors influences the continuation of the human species (reproductive success) (e.g., anorexia and/or steroid use, radiation/toxic wastes/drug use, mutagenic agents and/or improper diet/obesity).

- **To what extent is human behavior determined by our internal biochemical environment, our heredity and our life experiences?**
- **To what extent is the reproductive success of humans affected by physiological factors?**
- **To what extent can the effect of physiological factors on the reproductive success of humans be predicted?**

- a) All systems of the body are continually working together (communicating) to maintain balance (homeostasis) by responding to internal and external stimuli, (e.g., cell (B and T lymphocyte interaction, neurotransmitter secretion by nerve cells); organ-organ (hormones trigger target cells; motor impulses trigger muscles); system (respiratory / circulatory / excretory system interactions, endocrine / digestive / motor and biochemical responses to stress); external stimuli-organism (hypo/hyperthermia, chemical stimuli affect organs/systems/whole organism; sense reception, nerve response)
- b) Human behavior is determined by the state of our internal biochemical environment, our heredity and our life experiences (e.g., innate/learned behaviors).
- c) Reproduction is necessary for survival of a species. (e.g., in vitro fertilization, fetal alcohol syndrome, hormone imbalances, stress).

	<p>S9-12:42 – Human Disease Students demonstrate their understanding of the Patterns of Human Health/Disease by...</p> <ul style="list-style-type: none"> • <u>Identifying a variety of nonspecific means of protection for the human body and explaining how these maintain human health (i.e., prevent disease).</u> <p>AND</p> <ul style="list-style-type: none"> • <u>Describing the general process of the human immune response to foreign substances and organisms (e.g., phagocyte action and antibody production and maintenance).</u> <p>AND</p> <ul style="list-style-type: none"> • Showing through models/diagrams/graphic organizers how specific biological abnormalities alter the normal functioning of human systems (e.g., feedback diagram). <p>AND (EXTENSION)</p> <ul style="list-style-type: none"> • Explaining the effect of unique viral diseases on the cells of the human immune system (e.g., retroviruses). 	<ul style="list-style-type: none"> • How is the immune system uniquely suited to protect the human body? <ol style="list-style-type: none"> a) The Human Body protects itself against infectious diseases (caused by microorganisms, viruses, animal parasites) through physical protection and physiological (immune) responses. b) The Immune System is designed to protect against microscopic organisms (bacteria, fungi) and foreign substances that enter from outside the body and against some cancer cells that arise within. c) Some allergic responses are caused by the body’s immune responses to usually harmless environmental substances. d) Humans have a variety of mechanisms—sensory, motor, emotional, social and technological—that can reduce and modify health hazards (e.g. blinking, fight or flight, coping mechanisms, medicine). e) The severity of human disease depends upon many factors, such as resistance to disease the virulence of the infecting organism. f) Biological abnormalities, such as injuries or chemical imbalance, cause or increase susceptibility to disease (e.g. hormonal imbalance, epilepsy, depression). (Atlas 91) g) (EXTENSION) Some viral diseases, such as AIDS, destroy critical cells of the immune system. 	
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	<p>S9-12:43 – <i>Patterns of Human Development</i> Students demonstrate their understanding of the Patterns of Human Development by...</p> <ul style="list-style-type: none"> • <u>Tracing the development of the human embryo from fertilization to gastrula stage, comparing its progress to that of other vertebrate organisms</u> (e.g., amphibians and reptiles and birds and mammals). <p>AND</p> <ul style="list-style-type: none"> • <u>Comparing the gestation of humans and the period of dependency after birth to that of other vertebrates.</u> <p>AND</p> <ul style="list-style-type: none"> • <u>Identifying the important events that occur in each stage (trimester) of human development (e.g., First trimester—embryonic organ systems established, Second trimester—fetal development/organ maturation, Third trimester—overall growth).</u> <p>AND</p> <ul style="list-style-type: none"> • Justifying a position on the use of technology to influence human embryonic or fetal life. 	<ul style="list-style-type: none"> • What is the process of differentiation and development from fertilized egg to adult? • In what ways is human growth & development similar and different to other organizations? • How does the use of technology to maintain, prolong sustain or terminate life raise social, moral, ethical and legal issues. <p>a) Human development begins with a single cell formed by fusion of egg cell and sperm cell and continues through nine months of further development and growth, similar to the development of other animals with backbones; and differences in an embryo’s environment can influence the path of development.</p> <p>b) During human gestation and development a balance is necessary between brain size and birth size, therefore humans need more time after birth for full development of the brain and nervous system than other vertebrates.</p> <p>c) The long period of human development is associated with the prominent role of the brain.</p> <p>d) The use of technologies to maintain, prolong, sustain, or terminate life raise social, moral, ethical and legal issues.</p>	
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