

Content Description and Suggested Activities

Goal 1

Goal 1: Learner will develop abilities necessary to do and understand scientific inquiry. Goal 1 addresses scientific investigation. These objectives are an <i>integral</i> part of <i>each of the other goals</i> . Students must be given the opportunity to design and conduct their own investigations in a safe laboratory. The students should use questions and models to formulate the relationship identified in their investigations and then report and share those findings with others.		
Objective	Content Description	
1.01 Identify biological problems and questions that can be answered through scientific investigations.	<ul style="list-style-type: none"> Develop questions for investigation from a given topic or problem. 	
1.02 Design and conduct scientific investigations to answer biological questions. <ul style="list-style-type: none"> Create testable hypotheses. Identify variables. Use a control or comparison group when appropriate. Select and use appropriate measurement tools. Collect and record data. Organize data into charts and graphs. Analyze and interpret data. Communicate findings. 	<ul style="list-style-type: none"> Distinguish and appropriately graph dependent and independent variables. Discuss the best method of graphing/presenting particular data. Report and share investigation results with others. 	
1.03 Formulate and revise scientific explanations and models of biological phenomena using logic and evidence to: <ul style="list-style-type: none"> Explain observations. Make inferences and predictions. Explain the relationship between evidence and explanation. 	<ul style="list-style-type: none"> Use questions and models to determine the relationships between variables in investigations. 	
1.04 Apply safety procedures in the laboratory and in field studies: <ul style="list-style-type: none"> Recognize and avoid potential hazards. Safely manipulate materials and equipment 	<ul style="list-style-type: none"> Predict safety concerns for particular experiments Relate biological concepts to safety applications such as: <ul style="list-style-type: none"> Disease transmission Nutrition Animal care 	

July 2007

needed for scientific investigations.		
<p>1.05 Analyze reports of scientific investigations from an informed scientifically literate viewpoint including considerations of:</p> <ul style="list-style-type: none"> • Appropriate sample. • Adequacy of experimental controls. • Replication of findings. • Alternative interpretations of the data. 	<ul style="list-style-type: none"> • Read a variety of reports of scientific research. 	

Goal 2

Goal 2: Learner will develop an understanding of the physical, chemical and cellular basis of life.

Objective	Content Description	
<p>2.01 Compare and contrast the structure and functions of the following organic molecules:</p> <ul style="list-style-type: none"> • Carbohydrates. • Proteins. • Lipids. • Nucleic Acids. 	<ul style="list-style-type: none"> • Examine the role and importance of organic molecules to organisms. • Examples to investigate include starch, cellulose, insulin, glycogen, glucose, enzymes, hemoglobin, fats, DNA and RNA. (<i>Distinguish among mono, and polysaccharides - concept not terminology</i>) • Interpret results of tests for starch (iodine), lipids (brown paper), monosaccharides (Benedict's Solution), and protein (Biuret's). • Emphasis should be on functions and subunits of each organic molecule. For example, enzymes are proteins composed of long chains of amino acids that are folded into particular shapes and that shape determines the specific reaction that the enzyme will catalyze. (<i>The terms condensation reaction, dehydration synthesis and hydrolysis have been deliberately excluded.</i>) 	
<p>2.02 Investigate and describe the structure and function of cells including:</p> <ul style="list-style-type: none"> • Cell organelles. • Cell specialization. • Communication among cells within an organism. 	<ul style="list-style-type: none"> • Structure and function of: nucleus, plasma membrane, cell wall, mitochondria, vacuoles, chloroplasts, and ribosomes. Students should be able to identify these cell organelles. • Proficient use and understanding of light microscopic techniques. Students should determine total power magnification as well as steps in proper microscope usage. • Hierarchy of cell organization: Cells → tissues → organs → organ systems. • Structure of cells as it relates to their specific functions. • Students should view a variety of cells with particular emphasis on the differences between plant and animal cells. • Chemical signals may be released by one cell to influence the activity of another cell. For example, a nerve cell can send a message to a muscle cell or to another a nerve cell. • role of receptor proteins • hormones • 	

<p>2.03 Investigate and analyze the cell as a living system including:</p> <ul style="list-style-type: none"> • Maintenance of homeostasis. • Movement of materials into and out of cells. • Energy use and release in biochemical reactions. 	<ul style="list-style-type: none"> • Examples for exploration should include regulation of temperature, pH, blood glucose levels and water balance. • Discussion should include active vs. passive transport, diffusion, osmosis, and the porous nature of the semi-permeable plasma membrane. (<i>Pinocytosis, phagocytosis, endocytosis, and exocytosis have been deliberately excluded</i>) • Given different types of cells, students should be able to predict any changes in osmotic pressure that may occur as the cell is placed in solutions of differing concentrations. (<i>Emphasis is on the processes, not terminology such as hypertonic, isotonic, hypotonic, turgor pressure</i>) • Examine ATP as the source of energy for cell activities. • Students will describe how cells store and use energy with ATP and ADP molecules. 	
<p>2.04 Investigate and describe the structure and function of enzymes and explain their importance in biological systems.</p>	<p>Instruction should include investigation of:</p> <ul style="list-style-type: none"> • Enzymes as proteins that speed up chemical reactions (catalyst). • Enzymes as re-usable and specific. • Enzymes as affected by such factors as pH, and temperature. <p>Students should understand that enzymes are necessary for all biochemical reactions and have a general understanding of how enzymes work.</p>	
<p>2.05 Investigate and analyze the bioenergetic reactions:</p> <ul style="list-style-type: none"> • Aerobic respiration • Anaerobic respiration • Photosynthesis 	<p>The emphasis should be placed on investigation of:</p> <ul style="list-style-type: none"> • Overall equations including reactants and products and not on memorizing intermediate steps of these processes. • Factors which affect rate of photosynthesis and or cellular respiration. • Comparison and contrast of these processes with regard to efficiency of ATP formation, the types of organisms using these processes, and the organelles involved. <ul style="list-style-type: none"> ○ Anaerobic respiration should include lactic acid and alcoholic fermentation. <p>Instruction should include the comparison of anaerobic and aerobic organisms. (<i>Glycolysis, Kreb's Cycle, and Electron Transport Chain have been deliberately excluded</i>) (<i>Students are not required to distinguish between light dependent and light independent parts of photosynthesis</i>)</p>	

Goal 3

Goal 3: Learner will develop an understanding of the continuity of life and the changes of organisms over time.

Objective	Content Description	
<p>3.01 Analyze the molecular basis of heredity including:</p> <ul style="list-style-type: none"> • DNA Replication • Protein Synthesis (transcription and translation) • Gene Regulation 	<p>Instruction should include:</p> <ul style="list-style-type: none"> • Structure of DNA as compared to RNA • Complementary base pairing • Understanding that the sequence of nucleotides in DNA codes for proteins – the central key to cell function and life. • How the process allows daughter cells to have an exact copy of parental DNA. • Understanding of the semi-conservative nature of the replication process. (nature of the process, not the term semi-conservative) • Mutations as a change in the DNA code. • The position of replication within the cell cycle. • The importance of relatively weak hydrogen bonds. <p>The recognition of protein synthesis as a process of:</p> <ul style="list-style-type: none"> • Transcription that produces an RNA copy of DNA, which is further modified into the three types of RNA • mRNA traveling to the ribosome (rRNA) • Translation - tRNA supplies appropriate amino acids • Amino acids linked by peptide bonds to form polypeptides which are folded into proteins. • Use of a codon chart to determine the amino acid sequence produced by a particular sequence of bases. <ul style="list-style-type: none"> • All (with a few exceptions) of an organism's cells have the same DNA but differ based on the expression of genes. <ul style="list-style-type: none"> • differentiation of cells in multicellular organisms • cells responding to their environment by producing different types and amounts of protein. • advantages (injury repair) and disadvantages (cancer) of the overproduction, underproduction or production of proteins at the incorrect times. 	

<p>3.02 Compare and contrast the characteristics of asexual and sexual reproduction.</p>	<p>Instruction should include:</p> <ul style="list-style-type: none"> • Recognizing mitosis as a part of asexual reproduction and meiosis as a part of sexual reproduction. • Similarities and differences between mitosis and meiosis including replication and separation of DNA and cellular material, changes in chromosome number, number of cell divisions, and number of cells produced in complete cycle. • Putting mitosis diagrams in order and describing what is occurring throughout the process. <p><i>Students are not expected to memorize the names of the steps or the order of the step names.</i></p> <ul style="list-style-type: none"> • The sources of variation including: <ul style="list-style-type: none"> ○ Crossing over. ○ Random assortment of chromosomes. ○ Gene mutation ○ Nondisjunction ○ Fertilization 	
<p>3.03 Interpret and predict patterns of inheritance.</p> <ul style="list-style-type: none"> • Dominant, recessive and intermediate traits. 	<p>Instruction should include:</p> <ul style="list-style-type: none"> • Identifying and determining genotypes and phenotypes. • Recognition that phenotype is the result of both genotype and the environment. • A discussion of Mendel's experiments and laws. • Interpreting karyotypes (gender, chromosomal abnormalities) • Understanding that dominant traits mask recessive alleles. • There are a variety of intermediate patterns of inheritance, including codominance and incomplete dominance. While teachers should not necessarily expect students at this level to distinguish between these forms of intermediate inheritance on a biochemical level they should be able to solve problems involving apparently intermediate phenotypes. The following discussion is included to help teachers with understanding these frequently confused terms. <ul style="list-style-type: none"> ○ Incomplete dominance (also called partial dominance) results in the blending of traits. (Usually results from an inactive or less active gene so the heterozygous phenotype appears intermediate. E.g. Pink flowers) ○ Co-dominant alleles result in the expression of both traits. (two 	

<ul style="list-style-type: none"> • Multiple alleles. • Polygenic traits. • Sex linked traits. • Independent assortment. • Test cross. • Pedigrees. • Punnett squares. 	<p style="text-align: center;">different proteins are produced and both are detected e.g. roan cows and AB blood type.)</p> <ul style="list-style-type: none"> • Autosomal inheritance patterns and characteristics of sickle cell anemia, cystic fibrosis, and Huntington's disease • Solving and interpreting co-dominant crosses involving multiple alleles. • A, B, AB and O blood types (alleles: I^A, I^B, and i). • Determining if parentage is possible based on blood types. • Recognizing that some traits are controlled by more than one pair of genes. • This pattern of inheritance is identified by the presence of a wide range of phenotypes (consider examples of skin and hair color). • An understanding of human sex chromosomes. • Solving crosses involving sex linked traits (examples: color-blindness and hemophilia.) • Understand why males are more likely to express a sex-linked trait. • The importance of the genes being on separate chromosomes as it relates to meiosis. • How the process of meiosis leads to independent assortment and ultimately to greater genetic diversity. • Given certain phenotypes suggest an appropriate test cross to determine the genotype of an organism. • Identify the genotypes of individuals from a given pedigree. (students should be able to interpret pedigrees which show phenotype not genotype) • Solving and interpreting problems featuring monohybrid crosses. (Parental, F1, F2 generations) • Determining parental genotypes based on offspring ratios. 	
--	--	--

<p>3.04 Assess the impacts of genomics on individuals and society.</p> <ul style="list-style-type: none"> • Human genome project. • Applications of biotechnology. 	<p>Instruction should include:</p> <ul style="list-style-type: none"> • The reasons for establishing the human genome project. • Recognition that the project is useful in determining whether individuals may carry genes for genetic conditions and in developing gene therapy. • Gel electrophoresis as a technique to separate molecules based on size. <i>(Students are not expected to know the steps of gel electrophoresis in order or great detail. They should be able to interpret the results and have a general understanding of what takes place during the process.)</i> • Uses of DNA fingerprinting • Applications of transgenic organisms (plants, animals, & bacteria) in agriculture and industry including pharmaceutical applications such as the production of human insulin. • Ethical issues and implications of genomics and biotechnology. (stem cell research and genetically modified organisms) 	
<p>3.05 Examine the development of the theory of evolution by natural selection including:</p> <ul style="list-style-type: none"> • Development of the theory. • The origin and history of life. • Fossil and biochemical evidence. • Mechanisms of evolution. 	<p>Instruction should include:</p> <ul style="list-style-type: none"> • Historical development of the theory of evolution by natural selection. • Biogenesis in contrast to abiogenesis with emphasis on the experiments used to support both ideas. • Early atmosphere hypotheses and experiments. • How the early conditions affected the type of organism that developed (anaerobic and prokaryotic). • Evolution of eukaryotic and aerobic organisms. • Fossils– relative and absolute dating methods • A discussion of what can be inferred from patterns in the fossil record. • Biochemical similarities. • Shared anatomical structures. <p><i>(Patterns in embryology and homologous and analogous vocabulary are intentionally excluded)</i></p> <ul style="list-style-type: none"> • How variations provide material for natural selection. • The role of geographic isolation in speciation. • The importance of the environment in 	

<ul style="list-style-type: none">• Applications (pesticide & antibiotic resistance).	selecting adaptations. <ul style="list-style-type: none">• Discuss the evolutionary selection of resistance to antibiotics and pesticides in various species.	
---	---	--

Goal 4

Goal 4: Learner will develop an understanding of the unity and diversity of life.

Objective	Content Description	
<p>4.01 Analyze the classification of organisms according to their evolutionary relationships.</p> <ul style="list-style-type: none"> • The historical development and changing nature of classification systems. • Similarities and differences between eukaryotic and prokaryotic organisms. • Similarities and differences among the eukaryotic kingdoms: Protists, Fungi, Plants, and Animals. • Classify organisms using keys. 	<p>Students should learn about the changing nature of classification based new knowledge generated by research on evolutionary relationships.</p> <p>History of classification system</p> <ul style="list-style-type: none"> • Originally two kingdoms (plants and animals). More kingdoms added as knowledge of the diversity of organisms increased. • Development of the seven level classification system (KPCOFGS) and binomial nomenclature <p><i>(The intention is that students understand that classification systems are changed as new knowledge is gathered. Currently, the thinking is 3 Domains with 6-7 kingdoms)</i></p> <p>Basis of classification system</p> <ul style="list-style-type: none"> • Evolutionary phylogeny, DNA and biochemical analysis, embryology, morphology • Interpret phylogenetic trees. <p>Only basic differences and similarities should be detailed.</p> <ul style="list-style-type: none"> • Membrane bound organelles – none in prokaryotes. • Ribosomes in both. • Contrasts in chromosome structure. • Contrasts in size. <p>Compare:</p> <ul style="list-style-type: none"> • Cellular structures. • Unicellular vs. Multicellular. • Methods of making/getting food and breaking down food to get energy. • Reproduction. <p>Use dichotomous keys to identify organisms.</p>	
<p>4.02 Analyze the processes by which organisms representative of the following groups accomplish essential life functions including:</p> <ul style="list-style-type: none"> • Unicellular protists, annelid worms, insects, amphibians, mammals, non- 	<p>Teachers should help students compare and contrast how the organisms listed accomplish the essential life functions specified below. The focus is on physiology rather than on the names of parts.</p> <ul style="list-style-type: none"> • Transport – how organisms get what they need to cells; how they move waste from cells to organs of excretion. • Excretion – how organisms get rid of their waste and balance their fluids (pH, salt 	

<p>vascular plants, gymnosperms and angiosperms.</p> <ul style="list-style-type: none"> • Transport, excretion, respiration, regulation, nutrition, synthesis, reproduction, and growth and development. 	<p>concentration, water).</p> <ul style="list-style-type: none"> • Regulation – how organisms control body processes – hormones, nervous system. • Respiration – how organisms get oxygen from the environment and release carbon dioxide back to the environment and how plants exchange gases. • Nutrition – how organisms break down and absorb foods. • Synthesis – how organisms build necessary molecules. • Reproduction – sexual versus asexual, eggs, seeds, spores, placental, types of fertilization. • Growth and development – metamorphosis, development in egg or in uterus, growth from seed or spore. 	
<p>4.03 Assess, describe and explain adaptations affecting survival and reproductive success.</p> <ul style="list-style-type: none"> • Structural adaptations in plants and animals (form to function). • Disease-causing viruses and microorganisms. • Co-evolution. 	<p>Focus should be on structural adaptations from organisms that are listed in 4.02, particularly:</p> <ul style="list-style-type: none"> • Feeding adaptations. • Adaptations to ensure successful reproduction. • Adaptations to life on land. <p>Instruction should include:</p> <ul style="list-style-type: none"> • Structure of viruses. • Mutation of viruses and other microorganisms. • Variety of disease causing (pathogenic) agents (viruses, bacteria) including: <ul style="list-style-type: none"> • HIV • Influenza • Smallpox • Streptococcus (strep throat) <p>Emphasis should be on the relationship between angiosperms and their pollinators.</p>	
<p>4.04 Analyze and explain the interactive role of internal and external factors in health and disease:</p> <ul style="list-style-type: none"> • Genetics. 	<p>Focus should be on the interactive role of genetics and the environment in determining a specific response including:</p> <ul style="list-style-type: none"> • Sickle cell anemia and malaria • Lung/mouth cancer and tobacco use • Skin cancer, vitamin D, folic acid and sun exposure • Diabetes (diet/exercise and genetic interaction). • PKU and diet 	<div data-bbox="1263 1291 1588 1367" style="border: 1px solid red; padding: 2px;">Deleted: ¶ ¶ ¶</div> <div data-bbox="1263 1367 1588 1430" style="border: 1px solid red; padding: 2px;">Deleted: ¶ PKU and diet</div>

<ul style="list-style-type: none"> • Immune response. • Nutrition. • Parasites. • Toxins. 	<p>Instruction should include basic understanding of:</p> <ul style="list-style-type: none"> • Function and relationship of T-cells, B-cells, antibodies/antigens. (Overview only of different types and roles of T and B cells: role of memory cells, B cells make antibodies, some T cells help B cells make antibodies, other T cells kill infected cells.) • Passive and active immunity. • Vaccines. <p>Teachers should emphasize aspects of nutrition that contribute to:</p> <ul style="list-style-type: none"> • Optimal health. • Poor nutrition (obesity, malnutrition and specific deficiencies.) <p>Teachers should focus on the general life cycle (not specific details), vector, symptoms, and treatments for: Malarial parasite (Plasmodium)</p> <p>Understand effects of environmental toxins</p> <ul style="list-style-type: none"> • Lead • Mercury 	
<p>4.05 Analyze the broad patterns of animal behavior as adaptations to the environment.</p> <ul style="list-style-type: none"> • Innate behavior. • Learned behavior. • Social behavior. 	<p>Taxes and instincts, including:</p> <ul style="list-style-type: none"> • suckling (instinct) • insects moving away from or toward light (taxis) • migration, estivation, hibernation <p>Focus should be on various types of learned behavior including:</p> <ul style="list-style-type: none"> • Habituation • Imprinting • Classical conditioning (e.g. Pavlov's dog – stimulus association) • Trial and error (focus on concept of trial and error learning not term operant conditioning). <p>Focus should be on communication, territorial defense, and courtship, including:</p> <ul style="list-style-type: none"> • Communication within social structure using pheromones (ex: bees and ants). • Courtship dances. • Territorial defense (ex: Fighting Fish). 	

Goal 5

Goal 5: Learner will develop an understanding of the ecological relationships among organisms.		
Objective	Content Description	
<p>5.01 Investigate and analyze the interrelationships among organisms, populations, communities and ecosystems</p> <ul style="list-style-type: none"> • Techniques of field ecology • Abiotic and biotic factors • Carrying capacity 	<p>Students should be able to identify and describe symbiotic relationships</p> <ul style="list-style-type: none"> • Mutualism • Commensalism • Parasitism <p>Students should be able to identify and predict patterns in Predator /prey relationships.</p> <p>Use field ecology techniques such as sampling and quadrant studies to determine species diversity and changes over time.</p> <p>Explain how abiotic and biotic factors are related to one another and their importance in ecosystems.</p> <p>Analyze how limiting factors influence carrying capacity (e.g. food availability, competition, harsh winter).</p> <p>Interpret population growth graphs.</p>	
<p>5.02 Analyze the flow of energy and the cycling of matter in the ecosystem.</p> <ul style="list-style-type: none"> • Relationship of the carbon cycle to photosynthesis and respiration • Trophic levels- direction and efficiency of energy transfer 	<p>Investigate the carbon cycle as it relates to photosynthesis and respiration.</p> <p>Analyze food chains, food webs, and energy pyramids for direction and efficiency of energy transfer.</p>	

<p>5.03 Assess human population and its impact on local ecosystems and global environments:</p> <ul style="list-style-type: none"> • Historic and potential changes in population • Factors associated with those changes. • Climate Change. • Resource use • Sustainable practices/ stewardship. 	<p>Instruction should include:</p> <ul style="list-style-type: none"> • Analyze human population growth graphs (historical and potential changes) .(See 5.01) • Factors influencing birth rates and death rates. • Effects of population size, density and resource use on the environment. • Discussion of human impact on local ecosystems: <ul style="list-style-type: none"> • Acid rain • Habitat destruction • Introduced non-native species. • How changes in human population affects populations of other organisms. <p>Discussion of factors that influence climate:</p> <ul style="list-style-type: none"> •greenhouse effect (relate to carbon cycle and human impact on atmospheric CO₂) •natural environmental processes (e.g. volcanoes) <p>Investigation of the direct and indirect impact of humans on natural resources (e.g. deforestation, pesticide use and bioaccumulation research)</p> <p>Examples of sustainable practices and stewardship.</p>	<p>Inquiry Support Activity: Environmental Factors that Affect the Hatching of Brine Shrimp</p>
---	---	---