Bemidji Area Schools

Grades 9-12 Biology Science Outcomes

Strand	Substrand	Standard "Understand that ...	Benchmark "The student will …	Activity
1. The Nature of Science and Engineering	1. The Practice of Science	1. Science is a way of knowing about the natural world and is characterized by emperical criteria, logical argument and skeptical review.	9.1.1.1.1 Explain the implications of the assumption that the rules of the universe are the same everywhere and these rules can be discovered by careful and systematic investigation.	Discussion in class. Addressed in Science Investigations.
			9.1.1.1.2 Understand that scientists conduct investigations for a variety of reasons, including: to discover new aspects of the natural world, to explain observed phenomena, to test the conclusions of prior investigations, or to test the predictions of current theories.	Discussion in class. Addressed in Science Investigations.
			9.1.1.1.3 Explain how the traditions and norms of science define the bounds of professional scientific practice and reveal instances of scientific error or misconduct. *For example:* The use of peer review, publications and presentations.	
			9.1.1.1.4 Explain how societal and scientific ethics impact research practices. *For example:* Research involving human subjects may be conducted only with the informed consent of the subjects.	Dissections.
			9.1.1.1.5 Identify sources of bias and explain how bias might influence the direction of research and the interpretation of data. *For example:* How funding of research can influence questions studied, procedures used, analysis of data, and communication of results.	Addressed in Science Investigations.
			9.1.1.1.6 Describe how changes in scientific knowledge generally occur in incremental steps that include and build on earlier knowledge.	Addressed in Science Investigations.
			9.1.1.1.7 Explain how scientific and technological innovations-as well as new evidence-can challenge portions of, or entire accepted theories and models including, but not limited to: cell theory, atomic theory, theory of evolution, plate tectonic theory, germ theory of disease, and the big bang theory.	Addressed in Science Investigations.

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1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world.	9.1.1.2.1 Formulate a testable hypothesis, design and conduct an experiment to test the hypothesis, analyze the data, consider alternative explanations, and draw conclusions supported by evidence from the investigation.	Addressed in Science Investigations.
			9.1.1.2.2 Evaluate the explanations proposed by others by examining and comparing evidence, identifying faulty reasoning, pointing out statements that go beyond the scientifically acceptable evidence, and suggesting alternative scientific explanations.	Addressed in Science Investigations.
			9.1.1.2.3 Identify the critical assumptions and logic used in a line of reasoning to judge the validity of a claim.	Addressed in Science Investigations.
			9.1.1.2.4 Use primary sources or scientific writings to identify and explain how different types of questions and their associated methodologies are used by scientists for investigations in different disciplines..	Addressed in Science Investigations.
	2. The Practice of Engineering	1. Engineering is a way of addressing human needs by applying science concepts and mathematical techniques to develop new products, tools, processes and systems.	9.1.2.1.1 Understand that engineering designs and products are often continually checked and critiqued for alternatives, risks, costs and benefits, so that subsequent designs are refined and improved. *For example:* If the price of an essential raw material changes, the product design may need to be changed.	Addressed in Science Investigations.
			9.1.2.1.2 Recognize that risk analysis is used to determine the potential positive and negative consequences of using a new technology or design, including the evaluation of causes and effects of failures. *For example:* Risks and benefits associated with using lithium batteries.	Addressed in Science Investigations.
			9.1.2.1.3 Explain and give examples of how, in the design of a device, engineers consider how it is to be manufactured, operated, maintained, replaced and disposed of.	Addressed in Science Investigations.

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1. The Nature of Science and Engineering	2. The Practice of Engineering	2. Engineering design is an analytical and creative process of devising a solution to meet a need or solve a specific problem.	9.1.2.2.1 Identify a problem and the associated constraints on possible design solutions. *For example:* Constraints can include time, money, scientific knowledge and available technology.	Addressed in Science Investigations.
			9.1.2.2.2 Develop possible solutions to an engineering problem and evaluate them using conceptual, physical and mathematical models to determine the extent to which the solutions meet the design specifications. *For example:* Develop a prototype to test the quality, efficiency and productivitiy of a product.	Addressed in Science Investigations.
	3. Interactions Among Science, Technology, Engineering, Mathematics, and Society	1. Natural and designed systems are made up of components that act within a system and interact with other systems.	9.1.3.1.1 Describe a system, including specifications of boundaries and subsystems, relationships to other systems, and identification of inputs and expected outputs. *For example:* A power plant or ecosystem.	Addressed in Science Investigations.
			9.1.3.1.2 Identify properties of a system that are different from those of its parts but appear because of the interaction of those parts.	Cellular structure. Organization of living things. Human biology. Ecosystems/invasive species.
			9.1.3.1.3 Describe how positive and/or negative feedback occur in systems. *For example:* The greenhouse effect	Discussions of homeostasis. Immune response. Osmosis Labs.
		2. Men and women throughout the history of all cultures, including Minnesota American Indian tribes and communities, have been involved in engineering design and scientific inquiry.	9.1.3.2.1 Provide examples of how diverse cultures, including natives from all of the Americas, have contributed scientific and mathematical ideas and technological inventions. *For example:* Native American understanding of ecology; Lisa Meitner's contribution to understanding radioactivity; Tesla's ideas and inventions relating to electricity; Watson, Crick and Franklin's discovery of the structure of DNA; or how George Washington Carver's ideas changed land use.	Popcorn in Genetics unit. Maize. Prairie grass and fires.

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Strand	Substrand	Standard "Understand that ...	Benchmark "The student will …	Activity
1. The Nature of Science and Engineering	3. Interactions Among Science, Technology, Engineering, Mathematics, and Society	2. Men and women throughout the history of all cultures, including Minnesota American Indian tribes and communities, have been involved in engineering design and scientific inquiry.	9.1.3.2.2 Analyze possible careers in science and engineering in terms of education requirements, working practices and rewards.	
		3. Science and engineering operate in the context of society and both influence and are influenced by this context.	9.1.3.3.1 Describe how values and constraints affect science and engineering. *For example:* Economic, environmental, social, political, ethical, health, safety, and sustainability issues.	
			9.1.3.3.2 Communicate, justify, and defend the procedures and results of a scientific inquiry or engineering design project using verbal, graphic, quantitative, virtual, or written means.	
			9.1.3.3.3 Describe how scientific investigations and engineering processes require multi-disciplinary contributions and efforts. *For example:* Nanotechnology, climate change, agriculture, or biotechnology.	
		4. Science, technology, engineering, and mathematics rely on each other to enhance knowledge and understanding.	9.1.3.4.1 Describe how technological problems and advances often create a demand for new scientific knowledge, improved mathematics, and new technologies.	
			9.1.3.4.2 Determine and use appropriate safety procedures, tools, computers and measurement instruments in science and engineering contexts. *For example:* Consideration of chemical and biological hazards in the lab.	
			9.1.3.4.3 Select and use appropriate numeric, symbolic, pictorial, or graphical representation to communicate scientific ideas, procedures and experimental results.	

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Strand	Substrand	Standard "Understand that ...	Benchmark "The student will …	Activity
1. The Nature of Science and Engineering	3. Interactions Among Science, Technology, Engineering, Mathematics, and Society	4. Science, technology, engineering, and mathematics rely on each other to enhance knowledge and understanding.	9.1.3.4.4 Relate the reliability of data to consistency of results, identify sources of error, and suggest ways to improve the data collection and analysis. *For example:* Use statistical analysis or error analysis to make judgments about the validity of results	
			9.1.3.4.5 Demonstrate how unit consistency and dimensional analysis can guide the calculation of quantitative solutions and verification of results.	
			9.1.3.4.6 Analyze the strengths and limitations of physical, conceptual, mathematical and computer models used by scientists and engineers.	
4. Life Science	1. Structure and Function of Living Systems	1. Organisms use the interaction of cellular processes as well as tissues and organ systems to maintain homeostasis.	9.4.1.1.1 Explain how cell processes are influenced by internal and external factors, such as pH and temperature, and how cells and organisms respond to changes in their environment to maintain homeostasis.	Terms: Cellular Respiration, Circulation, homeostatasis, diffusion, osmosis, and metabolism. Microscope Lab with cells-saltwater-sugar, Grape Lab, and notes.
			9.4.1.1.2 Describe how the functions of individual organ systems are integrated to maintain homeostasis in an organism.	Covered during animal units. Human Systems project.
		2. Cells and cell structures have specific functions that allow an organism to grow, survive and reproduce.	9.4.1.2.1 Recognize that cells are composed primarily of a few elements (carbon, hydrogen, oxygen, nitrogen, phosphorus, and sulfur), and describe the basic molecular structures and the primary functions of carbohydrates, lipids, proteins and nucleic acids.	Terms: protein synthesis, enzymes, carbohydrates, protien, amino acid, lipid, nucleic acid, mitochondria, chloropast, ribsome, nucleus, cell membrane, nuclear membrane, cell wall, diffusion, osmosis, facilitated fiffusion, prokaryotic, eukaryotic. Chemistry of biology chapter. Calorimetry Lab. Tastes and Tongue Lab (applied). Draw and label parts of the cell membrane with function.

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4. Life Science	1. Structure and Function of Living Systems	2. Cells and cell structures have specific functions that allow an organism to grow, survive and reproduce.	9.4.1.2.2 Recognize that the work of the cell is carried out primarily by proteins, most of which are enzymes, and that protein function depends on the amino acid sequence and the shape it takes as a consequence of the interactions between those amino acids.	Origami Lab and notes.
			9.4.1.2.3 Describe how viruses, prokaryotic cells, and eukaryotic cells differ in relative size, complexity and general structure.	Cells and Viruses notes; Cells Lab.
			9.4.1.2.4 Explain the function and importance of cell organelles for prokaryotic and/or eukaryotic cells as related to the basic cell processes of respiration, photosynthesis, protein synthesis and cell reproduction.	Cell Campaign/Activity and Nine Square Activity.
			9.4.1.2.5 Compare and contrast passive transport (including osmosis and facilitated transport) with active transport such as endocytosis and exocytosis.	Osmosis Lab/Grape Lab: Utube segments; DIIGO (BHS Science).
			9.4.1.2.6 Explain the process of mitosis in the formation of identical new cells and maintaining chromosome number during asexual reproduction.	Mitosis Labs.
	2. Interdependence Among Living Systems	1. The interrelationship and interdependence of organisms generate dynamic biological communities in ecosystems.	9.4.2.1.1 Describe factors that affect the carrying capacity of an ecosystem and relate these to population growth.	Annenberg simulation - interactive website and discussion.
			9.4.2.1.2 Explain how ecosystems can change as a result of the introduction of one of more new species. *For example:* The effect of migration, localized evolution or disease organism.	Annenberg simulation. Breeding Bunnies Lab. Lethal allele. Albino article from *Volunteer* magazine.

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4. Life Science	2. Interdependence Among Living Systems	2. Matter cycles and energy flows through different levels of organization of living systems and the physical environment, as chemical elements are combined in different ways.	9.4.2.2.1 Use words and equations to differentiate between the processes of photosynthesis and respiration in terms of energy flow, beginning reactants and end products.	Terms: photosynthesis, respiration, glucose, carbon dioxide, water, oxygen, ATP, equation for photosynthesis, producer, consumer, decomposer, food chain, food web, autotroph, heterotroph, energy pyramid, trophic level. Plant unit.
	2. Interdependence Among Living Systems		9.4.2.2.2 Explain how matter and energy is transformed and transferred among organisms in an ecosystem, and how energy is dissipated as heat into the environment.	Drawing water, carbon and Nitrogen cycle - biogeochemical cycles. *Great White Shark* video.
		1. Genetic information found in the cell provides information for assembling proteins which dictate expression of traits in an individual.	9.4.3.1.1 Explain the relationships among DNA, genes and chromosomes.	Terms: allele, dominant allele, gene, genotype, heterozygous, homozygous, monohybrid, nucleotide, phenotype, protein, Punnett square, recessive allele, replication, transcription, and translation. *The New Genetics* - U.S. Department of Health & Human Services. DNA model. DNA transcription/translation worksheet. *RNAi* video-DVD transcription/translation from Howard Hughes Institute.
			9.4.3.1.2 In the context of a monohybrid cross, apply the terms phenotype, genotype, allele, homozygous and heterozygous.	Marshan Genetics Lab. Textbook notes and study guides. Breeding Bunnies Lab. Penny Toss Lab/Activity.

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4. Life Science	3. Evolution in Living Systems	1. Genetic information found in the cell provides information for assembling proteins which dictate expression of traits in an individual.	9.4.3.1.3 Describe the process of DNA replication and the role of DNA and RNA in assembling protein molecules.	*The New Genetics* - U.S. Department of Health & Human Services. DNA model. DNA transcription/translation worksheet. *RNAi* video-DVD transcription/translation from Howard Hughes Institute.
		2. Variation within a species is the natural result of new inheritable characteristics occurring from new combinations of existing genes or from mutations of genes in reproductive cells.	9.4.3.2.1 Use concepts from Mendel's laws of segregation and independent assortment to explain how sorting and recombination (crossing over) of genes during sexual reproduction (meiosis) increases the occurrence of variation in a species.	Terms: chromosome, egg, fertilization, gamete, independent assortment, meiosis, mitosis, mutation, recombination, crossing over, segregation, sperm. Marshan Genetics Lab. Textbook notes and study guides. Breeding Bunnies Lab. Penny Toss Lab/Activity. PTC paper. Tenetic Survey. *The New Genetics* - U.S. Department of Health & Human Services.
			9.4.3.2.2 Use the processes of mitosis and meiosis to explain the advantages and disadvantages of asexual and sexual reproduction.	Mitosis and meiosis activities/notes.
			9.4.3.2.3 Explain how mutations like deletions, insertions, rearrangements or substitutions of DNA segments in gametes may have no effect, may harm, or rarely may be beneficial, and can result in genetic variation within a species.	*The New Genetics* - U.S. Department of Health & Human Services. Transcription/translation activities.

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4. Life Science	3. Evolution in Living Systems	3. Evolution by natural selection is a scientific explanation for the history and diversity of life on Earth.	9.4.3.3.1 Describe how evidence led Darwin to develop the theory of natural selection and common descent to explain evolution.	*Terms: evolution, artificial selection, competition, selective pressure, Charles Darwin, adaptation, natural selection, environment changes, genetic variability.* *Darwin - NOVA clip.* *Howard Hughes EvolutionDVD.* *Natuarl Selection Glider Activity.* *Beaks and Feet Lab.*
			9.4.3.3.2 Use scientific evidence, including the fossil record, homologous structures, and genetic and/or biochemical similarities, to show evolutionary relationships among species.	*Howard Hughes Evolution* DVD. Natural Selection Glider Activity. Hominid Lab. Fossil Hunting Lab. Panda Bear example. Animals of the Future Activity.
			9.4.3.3.3 Recognize that artificial selection has led to offspring through successive generations that can be very different in appearance and behavior from their distant ancestors.	*Howard Hughes Evolution* DVD. Examples with any domesticated plant or animal. Animals of the Future Activity. Beaks and Feet Lab.
			9.4.3.3.4 Explain why genetic variation within a population is essential for evolution to occur.	*Howard Hughes Evolution* DVD. Natural Selection Glider Activity.
			9.4.3.3.5 Explain how competition for finite resources and the changing environment promotes natural selection on offspring survival, depending on whether the offspring have characteristics that are advantageous or disadvantageous in the new environment.	Breeding Bunnies Lab. *Howard Hughes Evolution* DVD. Natural Selection Glider Activity.
			9.4.3.3.6 Explain how genetic variation between two populations of a given species is due, in part, to different selective pressures acting independently on each population and how, over time, these differences can lead to the development of new species.	Beaks and Feet Lab. Grand Canyon Squirrels. *Howard Hughes Evolution* DVD. Breeding Bunnies Lab.

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4. Life Science	4. Human Interactions with Living Systems	1. Human activity has consequences on living organisms and ecosystems.	9.4.4.1.1 Describe the social, economic, and ecological risks and benefits of biotechnology in agriculture and medicine. *For example:* Selective breeding, genetic engineering, and antibiotic development and use.	Terms: biotechnology, selective breeding, sustainable development, risk and benefit assessment, genetic engineering, and antibiotic development. *Howard Hughes Evolution* DVD. *RNAi* video. Vaccines. *Evolutionary Arms Race* video. *1918 Influenza* from NOVA.
			9.4.4.1.2 Describe the social, economic and ecological risks and benefits of changing a natural ecosystem as a result of human activity. *For example:* Changing the temperature or composition of water, air or soil; altering the populations and communities, developing artificial ecosystems; or changing the use of land or water.	Annenberg simulation - interactive website and discussion. Minnow and Respiration Lab.
			9.4.4.1.3 Describe contributions from diverse cultures, including Minnesota American Indian tribes and communities, to the understanding of interactions among humans and living systems. *For example:* American Indian understanding of sustainable land use practices.	*Shape of Life* video series. History of aspirin.
		2. Personal and community health can be affected by the environment, body functions and human behavior.	9.4.4.2.1 Describe how some diseases can sometimes be predicted by genetic testing and how this affects parental and community decisions.	Terms: vaccine, antibody, antigen, immune system, disease, pathogen, and allergy. Genetic unit activities (look into local guest speaker on genetic counseling).
			9.4.4.2.2 Explain how the body produces antibodies to fight disease and how vaccines assist this process.	Virus and Bacteria unit. Vaccination Activity/PowerPoint. *Discovery* school video.
			9.4.4.2.3 Describe how the immune system sometimes attacks some of the body's own cells and how some allergic reactions are caused by the body's immune responses to usually harmless environmental substances.	Human Systems Project *Evolutionary Arms Race* video. Parasitic worm v. immune system.

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4. Life Science	4. Human Interactions with Living Systems	2. Personal and community health can be affected by the environment, body functions and human behavior.	9.4.4.2.4 Explain how environmental factors and personal decisions, such as water quality, air quality and smoking affect personal and community health.	Food Safety Activity. Smoking and personal health.
			9.4.4.2.5 Recognize that a gene mutation in a cell can result in uncontrolled cell division called cancer, and how exposure of cells to certain chemicals and radiation increases mutations and thus increases the chance of cancer.	Various Genetic unit activities.