New Ulm Public Schools

Science Curriculum 2015-16

Board approved:
June 9, 2016

Mission Statement

It is the mission of the New Ulm K-12 Science educators to support students in the active study of the natural and man-made world, including processes, structures, designs, and systems.

Vision

Science students will use their senses and tools to observe, record, and analyze data about the world and to make conclusions based on evidence.

Scientifically literate young people will understand basic science concepts, use skills for doing scientific investigations, solve technical problems, and design technologies for today's world.

Minnesota Academic Standards in Science

The 2009 *Minnesota Academic Standards in Science* set the expectations for achievement in science for K-12 students. The standards are grounded in the belief that all students can and should be scientifically literate.

Scientific literacy enables people to use scientific principles and processes to make personal decisions and to participate in discussions of scientific issues that affect society (NRC, 1996). The standards and benchmarks describe a connected body of science and engineering knowledge acquired through active participation in science experiences. These experiences include hands-on laboratory activities rooted in scientific inquiry and engineering design. The standards are placed at the grade level where mastery is expected with recognition that a progression of learning experiences in earlier grades builds the foundation for mastery later on.

The *Minnesota Academic Standards in Science* are organized by grade level into four content *strands*:

1) The Nature of Science and Engineering
2) Physical Science
3) Earth and Space Science
4) Life Science

It is important to note that the content and skills in The Nature of Science and Engineering are not intended to be taught as a stand-alone unit or an isolated course, but embedded and used in the teaching, learning and assessment of the content in the other strands. Each strand has three or four *sub strands*. Each sub strand contains two or more *standards* and one or more *benchmarks*. The benchmarks supplement the standards by

specifying the academic knowledge and skills students must achieve to satisfactorily complete a standard.

Minnesota Academic Standards (continued...)

STRAND 1: NATURE OF SCIENCE AND ENGINEERING

Sub strand 1: The Practice of Science

Standard 1. Understandings about science
2. Scientific inquiry and investigation

Sub strand 2: The Practice of Engineering

Standard 1. Understandings about engineering
2. Engineering design

Sub strand 3: Interactions Among Science, Technology, Engineering, Mathematics & Society

Standard 1. Systems
2. Careers and contributions in science and engineering
3. Mutual influence of science, engineering and society
4. The role of mathematics & technology in science & engineering

STRAND 2: PHYSICAL SCIENCE

Sub strand 1: Matter

Standard 1. Properties and structure of matter
2. Changes in matter

Sub strand 2: Motion

Standard 1. Describing motion
2. Forces

Sub strand 3. Energy

Standard 1. Kinds of energy
2. Energy transformations

Sub strand 4. Human Interactions with Physical Systems

Standard 1. Interaction with the environment

Minnesota Academic Standards (continued)...

STRAND 3: EARTH AND SPACE SCIENCE

Sub strand 1. Earth Structure and Processes

Standard 1. Plate tectonics
2. Earth's changing surface
3. Rock sequences and Earth history

Sub strand 2. Interdependence within the Earth System

Standard 1. Sources and transfer of energy
2. Weather and climate
3. Materials cycles

Sub strand 3. The Universe

Standard 1. Solar system motion
2. Formation of the solar system
3. Age, scale and origin of the universe

Sub strand 4. Human Interactions with Earth Systems

Standard 1. Interaction with the environment

STRAND 4: LIFE SCIENCE

Sub strand 1. Structure and Function in Living Systems

Standard 1. Levels of organization
2. Cells

Sub strand 2. Interdependence Among Living Systems

Standard 1. Ecosystems
2. Flow of energy and matter

Sub strand 3. Evolution in Living Systems

Standard 1. Reproduction
2. Variation
3. Biological evolution

Sub strand 4. Human Interactions with Living Systems

Standard 1. Interaction with the environment
2. Health and disease

Essential Learner Outcomes – ELOs for Grades K-4

Kindergarten

1. Raise questions about the natural world.
2. Observe weather changes.
3. Understand that there are living and nonliving things.
4. Understand that there is variation among individuals of one kind within a population.
5. Understand that people have five senses that can be used to learn about the environment.

Grade 1

1. Raise questions about the natural world, make careful observations and seek answers.
2. Investigate weather cycles.
3. Recognize the changes that occur in the sky in a 24-hour day.
4. Observe plant and animal life cycles.
5. Recognize the different habitats and animal groups.
6. Understand that organisms have basic needs.
7. Recognize basic Earth materials.

Grade 2

1. Understand that science is a human endeavor practiced throughout the world.
2. Understand that engineering design is the process of identifying problems and devising a product or solution.
3. Understand that objects can be sorted and classified based on their properties.
4. Understand that the motion of an object can be described by a change in its position over time.
5. Understand that living things are diverse with many different observable characteristics.
6. Understand that weather can be described in measurable quantities and changes from day to day and with the seasons.

Grade 3

1. Understand the nature of scientific investigations.
2. Understand the use of science as a tool to examine the natural world.
3. Explore the characteristics of sound and light.
4. Understand that an object's motion is affected by forces and can be described by the object's speed and the direction it is moving.
5. Investigate weather conditions.
6. Understand the characteristics and relationships of objects in the solar system.
7. Recognize that plants and animals have different structures that serve various functions.
8. Understand offspring are similar to their parents, but may have variations that can be advantageous

or disadvantageous in a particular environment.

9. Understand that natural systems have many components that interact to maintain the living system.

ELOs (continued)...

Grade 4

1. Understand how science is used to investigate interactions between people and the natural world.
2. Participate in a controlled scientific investigation.
3. Know that heating and cooling may cause changes to the properties of a substance.
4. Understand basic electricity and its application in everyday life.
5. Understand that a relationship exists between electricity and magnetism.
6. Explore the structures and functions of Earth systems.
7. Know that living things can be sorted into groups in many ways according to their varied characteristics, structures, and behaviors.
8. Know that matter and energy flow into, out of, and within a biological system.
9. Know the structures that serve various functions in the human body, including protection from disease.

Science Programming - Grades K-4

Kindergarten - Grade 2	Standards are met through the reading curriculum and the Scholastic News and support staff.
Grade 3	30 minutes - 2 or 3 times a week
Grade 4	2 to 3 hours a week

Essential Learner Outcomes (ELOs) for Grades 5-8

Grade 5

1. Replicating investigations and using differing explanations to explain results.
2. Collecting relevant evidence and critiquing an experiment.
3. Using simple machines to relate force to motion change.
4. Know the difference between renewable and nonrenewable materials and the impact on the environment.
5. Explains the structure and function of plant and animal parts and how they relate to survival.
6. Know how humans change the environment and if this change is beneficial or harmful to themselves or other organisms.
7. Use correct tools and measurements while collecting data.

Grade 6

1. Understand how science and engineering impact society.
2. Investigate how engineering design is the process of creating products, processes, and systems.
3. Recognize and differentiate natural and human designed systems.
4. Understand matter can be identified by properties.
5. Evaluate the motion of an object to determine the interaction of its speed, direction, change of position, and magnitude.
6. Know energy has identifiable forms that can be transformed within a system, transferred to other systems or the environment.

Grade 7

1. Create and conduct plans for investigations that include: asking questions, stating hypotheses, identifying variables, identifying constants, collecting data appropriately, and forming conclusions based on evidence.
2. Use appropriate metric tools and technology to gather, organize, interpret, analyze, and evaluate data collected from controlled experiments and recognize bias in order to formulate conclusions.
3. Distinguish between elements, compounds, and mixtures using simplified diagrams.
4. Describe the roles and relationships among producers, consumers, and decomposers in changing energy from one form to another in a food web within an ecosystem.
5. Use maps, satellite images and other data sets to compare wildlife populations in Minnesota.
6. Explain how matter cycles and energy flows through ecosystems and describes the significance of photosynthesis to these processes.
7. Relate structure and function in different types of cells and compare and contrast plant and animal cells.
8. Recognize that cells in multicellular organisms are organized into systems that perform specialized functions.
9. Explain how life functions, such as obtaining and using energy, are carried out in animals, plants, fungi, bacteria, and protists.

10. Describe the functions and interactions of human body systems (for example: circulatory, respiratory, muscular, skeletal, digestive) and the levels of organization within the human body.

ELOs (continued)...

11. Describe the role of genetic material in the transfer of biological characteristics during from one generation to another.
12. Distinguish between characteristics of organisms that are inherited and those acquired through environmental influences.
13. Infer relationships between living organisms and those in the fossil record using anatomical structures and use fossil evidence to prove that extinction is a common event.
14. Evaluate how variation can help or hinder an organism's ability to adapt and survive.
15. Analyze how viruses, bacteria, fungus and parasites interfere with normal body function causing disease.
16. Recognize that the human immune system, along with vaccines and antibiotics, protects against microscopic organisms and foreign substances that enter from outside the body and against some cancer cells that arise from within.

Grade 8

1. Describe the structure and composition of Earth's atmosphere and explain how the atmosphere affects heat transfer and climate.
2. Differentiate between the major water reservoirs on Earth and use a model to describe the cycling of water through Earth's systems.
3. Use satellite maps and collect data to provide evidence for how the motions and interactions of air masses and fronts results in changes in weather patterns.
4. Distinguish between elements, compounds, mixtures, metals, non-metals, acids and bases using physical and chemical properties.
5. Distinguish between physical and chemical changes, identify evidence used to recognize chemical changes, and demonstrate an understanding of the conservation of mass to physical and chemical changes within a closed system.
6. Identify and classify minerals and rocks according to physical properties and explain the processes that are involved in the formation of minerals and rocks.
7. Develop and use models to explain the evidence scientist use to understand phenomena such as Earth's interior, seismic waves, plate movement, motions of the planets and moon, weather patterns and groundwater resources.
8. Use maps and data sets to explain how plate tectonics has changed and continues to change the surface of the Earth resulting in phenomena and formations such as volcanoes, earthquakes, mountain ranges, ocean trenches, mid-ocean ridges and rift valleys.
9. Explain the role of constructive and destructive processes (i.e. weathering, erosion, deposition, glacial activity) in the sculpting of the Earth, especially regions in Minnesota.
10. Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to infer past geologic events.
11. Compare and contrast the main components our solar system and galaxy and use models to describe the role of gravity and inertia in the motions within our solar system.
12. Use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.
13. Describe the dynamics of water resources and nonrenewable resources (mineral and fossil fuels) and understand the human impact on these resources.

14. Use appropriate metric tools and technology to gather, organize, interpret, analyze, and evaluate data collected from controlled experiments and recognize bias in order to formulate conclusions.

Science Programming - Grades 5-8

Grade 5	*Science/Health*	*58 minutes daily*
Grade 6	*Science/Health*	*58 minutes daily*
Grade 7	*Life Science*	*Year round - daily*
Grade 8	*Earth Science*	*Year round - daily*

Essential Learner Outcomes (ELOs) for Grades 9-12

Grade 9

1. The student will be able to use basic scientific, engineering, and mathematical models to demonstrate the ability to solve simple content and analysis problems that arise in a science course.
2. The student will classify matter as elements, compounds or mixtures.
3. The student will be able to determine the properties of the atom based on the particles that compose them.
4. The student will identify the organization on the periodic table based on trends and properties.
5. The student will describe the different types of bonding based on the way atoms combine.
6. The student will understand that substances undergo chemical reactions and the changes of properties.
7. The student will understand that substances undergo chemical reactions and the changes of properties.
8. The student will learn about measuring motion and about how forces affect motion. The student will learn how to calculate average speed and average acceleration and about balanced, unbalanced forces, friction and gravity.
9. The student will learn about gravity's role in the acceleration of falling objects, in orbiting, and in projectile motion. The student will study Newton's laws of motion and learn how to calculate momentum while studying the law of conservation momentum.
10. The student will describe the relationship between energy and work, the way machines do work, and the different types of simple and compound machines.
11. The student will be able to recognize energy in its different forms, learn how energy is measured, and learn how energy can be converted from one form to another.
12. The student will learn about radioactivity and three different kinds of radioactive decay and know the differences, disadvantages, and advantages between nuclear fission and nuclear fusion.
13. The student will learn how objects become charged and how charged objects interact. The student will learn about the relationship between electric current, voltage, and resistance and examine ways to generate electrical power.
14. The student will describe how energy is transferred through sound waves and how pitch and loudness are related to wave properties of frequency and amplitude.
15. The student will describe how electromagnetic waves are light and their interactions.

Biology/Honors Biology

1. Use scientific processes in both field and lab investigations.
2. Explain and give examples of how biotechnology is used in agriculture, industry, and medicine.
3. Understand the principles of ecology, including nutrient cycles, energy flow, and population dynamics.
4. Classify, compare, and contrast the diversity of organisms on Earth and their modes of acquiring their requirements of life.
5. Know the differences between the processes of photosynthesis and cellular respiration in terms of energy flow, reactants, and products.
6. Understand how cells divide by mitosis and meiosis.
7. Understand the role of organic compounds, including enzymes, in living organisms.
8. Discuss how the digestive, respiratory, circulatory, and immune systems work together to maintain

homeostasis in an organism.

9. Describe how plants respond to their environment to maintain homeostasis.

ELOs (continued)...

10. Apply probability to Mendelian and non-Mendelian genetics.
11. Know the chemical structure of DNA and how DNA codes for proteins.
12. Understand the process of natural selection and evolution for all organisms on Earth.
13. List the evidence used to show that evolution occurs and has occurred.
14. Explain how selective pressures acting on populations may lead to new Species.
15. Understand the importance and nature of viruses and bacteria.

Chemistry/Fundamental Chemistry

1. The student will develop inquiry skills based on investigations and prior knowledge.
2. The student will be able to use basic chemistry, engineering, and mathematical models to demonstrate the ability to solve simple content and analysis problems that arise in a chemistry course.
3. The student will be able to explain the changes in atomic theory and the history of the atom. The student will be able to explain the parts of an atom and the properties and changes that occur in matter. The student will be able to describe the mole, its use, and show they can use this unit properly to determine amounts of matter.
4. The student will be able to show relationships between light and the quantized atom and use electron configurations to describe the electron location.
5. The student will understand the development of the periodic table and classify elements by periodic trends.
6. The student will be able to explain the concepts of bonding and the properties due to bonding type.
7. The student will be able name compounds and write formulas.
8. The students will be able to use chemical formulas to calculate amounts of matter and determine formulas.
9. The student will be able to define characteristics of chemical reactions, and show the ability to write chemical equations.
10. The student will be able to apply concepts of chemical equation and moles to calculate amounts of products in a practical setting.
11. The student will apply the kinetic molecular theory to the states of matter (solids, liquids & gases).
12. The student will apply the common gas laws to explain the relationships among temperature, pressure, volume, and number of particles of gas.
13. The student will be able to describe solution chemistry and its role in natural systems.
14. The student will be able to describe solution chemistry and form net ionic equations.
15. The student will be able to identify acids and bases, and the relationships between them.
16. The student will be able to carry out acid-base calculations and laboratory procedures including titrations.
17. The student will be able to compare and contrast the structure, properties and uses of organic compounds.

ELOs (continued)...

Physics

1. Analyze data through the use of experimentation and models to determine uncertainties and how products and advances are engineered, processed, or studied in science.
2. Understand the relationship of force, motion, and energy through the use of vectors, free-body diagrams, scientific laws, and movement of objects both on Earth and in the universe in both one and two dimensions.
3. Explain work, power, momentum, and energy and apply the knowledge to scientific laws (conservation of momentum and conservation of energy) using calculations and experimentation.
4. Describe the parts of a longitudinal and transverse waves and wave properties to relate it to sound and light waves and how they move in different states of matter. Use the properties of waves to utilize lenses, the electromagnetic spectrum, and the Doppler effect.
5. Describe electric fields and use information to describe electric circuits and how they are related to magnetic fields by describing how motors, generators, and transformers operate. Relate magnetic and electric fields to electromagnetic waves (from ELO #4).
6. Use the concept of heat energy and the law of conservation of energy to explain the transfer of heat between substances using convection, conduction, and radiation.

AP (Advanced Placement) Chemistry

1. The chemical elements are fundamental building materials of matter, and all matter can be understood in terms of arrangements of atoms. These atoms retain their identity in chemical reactions.
2. Chemical and physical properties of materials can be explained by the structure and the arrangement of atoms, ions, or molecules and the forces between them.
3. Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer of electrons.
4. Rates of chemical reactions are determined by details of the molecular collisions.
5. The laws of thermodynamics describe the essential role of energy and explain and predict the direction of changes in matter.
6. Any bond or intermolecular attraction that can be formed can be broken. These two processes are in a dynamic competition, sensitive to initial conditions and external perturbations.

Comparative Animal Anatomy and Physiology

1. Differentiate between invertebrates and vertebrates in terms of body structures and functions.
2. List and discuss the essential functions that animals perform in order to survive.
3. Be familiar with animal taxonomy and explain differences in animal hypa.
4. Discuss trends in animal evolution and use fossil evidence and embryonic development to explain the sequence of animal diversity.
5. Describe the different ways animals get food and excrete waste and how digestion and digestive systems function in different animals.
6. Use knowledge of respiratory structures to describe how both aquatic and land animals breath.

7. Compare open and closed circulatory systems and patterns of circulation in vertebrates (single-loop vs double-loop).

ELOs (continued)...

8. Describe different sensory/nervous systems in animals and the effect this has on animals' responses to stimuli.
9. Use knowledge of various skeletal and muscular systems, or lack of, to describe structure and movement of animals.
10. Explain how different animals reproduce (asexual vs. sexual; internal fertilization vs. external fertilization).
11. Explain how environmental pressures affect animal behaviors (feeding, courtship, territorial, communication).

Ecology

1. Demonstrate knowledge of basic ecological principles and theories at the organismal, population, community, and ecosystem levels.
2. Describe how organisms' interactions with their environment and other organisms affect patterns in their abundance and distribution.
3. Appreciate how an understanding of evolutionary processes informs the study of ecology.
4. Use observations and data to formulate research questions, hypotheses, and predictions of ecological scenarios and problems.
5. Demonstrate knowledge and interpretation of basic analysis and graphical representation of ecological data.
6. Apply ecological principles to current environmental challenges and conservation concerns.

Human Anatomy and Physiology

1. Use anatomical terminology to identify and describe locations of the body and major organs of each system covered.
2. Explain interrelationships among molecular, cellular, tissue and organ functions in each system.
3. Describe the interdependency and interactions of the systems.
4. Explain contributions of organs and systems to the maintenance of homeostasis.
5. Identify causes and effects of homeostatic imbalances.
6. Describe modern technology and tools used to study anatomy and physiology.
7. Demonstrate laboratory procedures used to examine anatomical structures and evaluate physiological function of each organ system.

Microbiology

1. Understand the basic structures (morphology) and functions of bacteria, viruses, fungi, and molds. Use the knowledge of the structure to explain how common infectious disease is treated (antibiotics, antivirals, antifungals).
2. Recognize interactions between microbes (including viruses) and humans including host defense mechanisms and disease transmission.

3. Explain the interactions and impact of microbes in the environment, including adaptations, mutations,
symbiotic relationships, and microbial recycling of resources (nitrogen cycle).

ELOs (continued)...

4. Know the importance of microbes in the food industry, both as starter cultures for food production and as agents of food spoilage.
5. Know the importance and benefit of microbes in organisms in terms of normal flora and consequences when the normal flora is disrupted.
6. Use a compound light microscope to view slides and make microscopic observations.
7. Properly prepare slides for microbiological examination, including; preparing smears from solid and liquid cultures, performing wet mounts, and performing Gram stains.
8. Properly use aseptic techniques for the transfer and handling of microorganisms and instruments.
9. Use appropriate microbiological media and test systems, including; isolating colonies, maintaining pure cultures, using biochemical test media, and accurately recording macroscopic observations.
10. Estimate the number of microbes in a sample using serial dilution techniques, including plate counts and most probable number (MPN) techniques.
11. Use standard microbiology laboratory equipment correctly, including; using the standard metric system for weights, lengths, diameters, and volumes, lighting and adjusting a laboratory burner, and using a water bath and an incubator.

Science Programming - Grades 9-12

Science 9	*Grade 9*	*Required - Year Long*
Biology	*Grade 10*	*Required - Year Long*
Honors Biology	*Grade 10*	*Required - Year Long*
Fundamental Chemistry *Administrative placement required;* *A year of Chemistry or Physics is required for graduation*	*Grades 10 - 12*	*Elective - Year Long*
Chemistry *A year of Chemistry or Physics is required for graduation*	*Grades 10 - 12*	*Elective - Year Long*
AP Chemistry *Advanced 2nd Year*	*Grades 11 -12*	*Elective - Year Long*
Physics *A year of Chemistry or Physics is required for graduation*	*Grades 11 - 12*	*Elective - Year Long*
Comparative Animal Anatomy and Physiology *Alternate year*	*Grades 11 -12*	*Elective - Semester*
Ecology	*Grades 11 - 12*	*Elective - Semester*
Human Anatomy & Physiology	*Grades 11 - 12*	*Elective - Semester*
Microbiology	*Grades 11 - 12*	*Elective - Semester*

College in Our Schools Science Programming

Our Natural World *[Biology 100]*	*Grade 11 - 12*	*semester - elective*
General Biology *[Biology 105]*	*Grade 11 - 12*	*semester - elective*