7-12 Science Essential Learnings		
Grade level	**Enduring Understandings (4)**	**Essential learning (8-16)**
7-12 Sue Fischer, Jake Nelson, Dave Abel, Josh Abraham, Martin Healey, Larry Jacobson	**Systems:** Students will be able to describe, recognize, and compare systems within the natural world. **Patterns:** Students will be able to describe, recognize, compare, interpolate, and extrapolate patterns within the natural world. **Data:** Students will be able to collect, display, process, and analyze data Use logical reasoning and imagination to develop explanations and predictions. **Connections:** Students will be able to make connections between causes and effects; these would include natural events or human events. **Historical Significance:** Students will be able to place major scientific discoveries into a historical framework.	**7th Grade Life Science:** 1. Understand that when conducting scientific investigations, prior expectations can create bias and similar investigations may produce different results. 2. Plan and conduct a controlled experiment to test a hypothesis, generate a scientific conclusion, and examine explanations proposed by others. 3. Determine and use appropriate safety procedures, tools, measurement, graphs and mathematical analyses to describe and investigate natural and designed systems. 4. Recognize that all substances are composed of one or more elements, describe the differences between elements and compounds, and recognize that a chemical equation describes a reaction. 5. Recognize that all cells do not look alike and that specialized cells in multicellular organisms are organized into tissues and organs that perform specialized functions. 6. Describe how organs in the respiratory, circulatory, digestive, nervous, skeletal, muscular, skin and excretory systems interact to serve the needs of vertebrate organisms. 7. Explain how viruses, bacteria, fungi and parasites may infect the human body and interfere with normal body functions; recognize that vaccines induce the body to build immunity to disease without actually causing disease. 8. Recognize that cells carry out life functions, and that these functions are carried out in a similar way in all organisms, including animals, plants, fungi, bacteria, and protists. 9. Use the presence of the cell wall and chloroplasts to distinguish between plant and animal cells. 10. Identify a variety of populations and communities in an ecosystem and describe the relationships among them.

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		11. Compare and contrast the roles of organisms within the following relationships: predator/prey, parasite/host, and producer/consumer/decomposer. 12. 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. 13. Explain how the number of populations an ecosystem can support depends on the biotic resources available as well as abiotic factors. 14. Recognize that producers use the energy from sunlight to make sugars from carbon dioxide and water through a process called photosynthesis. 15. Recognize that cells contain genes and that each gene carries a single unit of information; recognize that organisms get about half of the genes inherited come from each parent. 16. Describe ways that human activities can change the populations and communities in an ecosystem. **8th Grade Earth and Space Science:** 1. Recognize that the Earth is composed of layers and describe the properties of these layers. 2. Correlate the distribution of Ocean trenches, mid ocean ridges and mountain ranges to tectonic activity. 3. Recognize that major geologic events are the result to slow moving tectonic plates. 4. Landforms result from processes such as eruptions, weathering, erosion, and deposits. 5. Explain how weathering erosion and general glacial activity has shaped Minnesota's landscape. 6. Interpret layers of sedimentary rocks and their fossils to infer ages of rocks and past geological events including extinctions. 7. Identify basic rock and mineral characteristics. 8.Recognize that Rock composition and formation of the three basic rock groups. 9.Recognize that Earth's axis and revolution causes the progression of the seasons.

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		10. Recognize that oceans have a major effect on climate. 11. Relate uneven heating of the Earth to global weather patterns. Local regional and global weather patterns will be interpreted. 12. Describe how the composition and structure of the Earth's atmosphere affects energy absorption, climate and distribution of gasses. 13. Analyse changes in wind direction, temperature, humidity and air pressure. Relate these concepts to weather fronts. 14. Relate global weather patterns to patterns in regional and local weather. 15. Describe the location composition and use of major water sources. 16. Describe how the water cycle distributes materials and purifies water sources. 17. Recognize that the sun is an average star. Also one of billions and billions of stars and the closest to the Earth. 18. Describe how gravity and inertia work together to keep objects in space in predictable motions. 19. Compare sizes composition and location of the solar system's planets and moons. 20. Describe how mineral and fossil fuel resources have formed over millions of years and explains how these resources are finite and non-renewable over human time lines. **<u>Physical Science:</u>** 1. Describe the role of valence electrons in the formation of chemical bonds. 2. Explain how the rearrangement of atoms in a chemical reaction illustrates the law of conservation of mass. 3. Describe a chemical reaction using words and symbolic equations. For example: The reaction of hydrogen gas with oxygen gas can be written: $2H_2 + O_2 \rightarrow 2H_2O$. 4. Relate exothermic and endothermic chemical reactions to temperature and energy changes. 5. Recognize that inertia is the property of an object that causes it to resist changes in motion. 6. Explain and calculate the acceleration of an object subjected to a set of forces in one dimension (F=ma).

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		7. Demonstrate that whenever one object exerts force on another, a force equal in magnitude and opposite in direction is exerted by the second object back on the first object. 8. Use Newton's universal law of gravitation to describe and calculate the attraction between massive objects based on the distance between them. For example: Calculate the weight of a person on different planets using data of the mass and radius of the planets. 9. Identify the energy forms and explain the transfers of energy involved in the operation of common devices. For example: Light bulbs, electric motors, automobiles or bicycles. 10. Calculate and explain the energy, work and power involved in energy transfers in a mechanical system. For example: Compare walking and running up or down steps. 11. Describe how energy is transferred through sound waves and how pitch and loudness are related to wave properties of frequency and amplitude. 12. Compare fission and fusion in terms of the reactants, the products and the conversion from matter into energy. For example: The fusion of hydrogen produces energy in the sun. Another example: The use of chain reactions in nuclear reactors. 13. Describe the properties and uses of forms of electromagnetic radiation from radio frequencies through gamma radiation. For example: Compare the energy of microwaves and X-rays. 14. Compare local and global environmental and economic advantages and disadvantages of generating electricity using various sources or energy. For example: Fossil fuels, nuclear fission, wind, sun or tidal energy. 15. Describe the trade-offs involved when technological developments impact the way we use energy, natural resources, or synthetic materials. For example: Fluorescent light bulbs use less energy than incandescent lights, but contain toxic mercury.

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		Biology: 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. 2. Describe how the functions of individual organ systems are integrated to maintain homeostasis in an organism. 3. 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. 4. 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. 5. Describe how viruses, prokaryotic cells, and eukaryotic cells differ in relative size, complexity and general structure.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. 6. Compare and contrast passive transport (including osmosis and facilitated transport) with active transport such as endocytosis and exocytosis. 7. Explain the process of mitosis in the formation of identical new cells and maintaining chromosome number during asexual reproduction.Use the processes of mitosis and meiosis to explain the advantages and disadvantages of asexual and sexual reproduction. 8. Describe factors that affect the carrying capacity of an ecosystem and relate these to population growth. 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.

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		9. Use words and equations to differentiate between the processes of photosynthesis and respiration in terms of energy flow, beginning reactants and end products. 10. Explain how matter and energy is transformed and transferred among organisms in an ecosystem, and how energy is dissipated as heat into the environment. 11. Explain the relationships among DNA, genes and chromosomes. Describe the process of DNA replication and the role of DNA and RNA in assembling protein molecules. 12. In the context of a monohybrid cross, apply the terms phenotype, genotype, allele, homozygous and heterozygous.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. 13. 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. 14. Describe how evidence led Darwin to develop the theory of natural selection and common descent to explain evolution. 15. Explain why genetic variation within a population is essential for evolution to occur. 16. Use scientific evidence, including the fossil record, homologous structures, and genetic and/or biochemical similarities, to show evolutionary relationships among species. 17. Recognize that artificial selection has led to offspring through successive generations that can be very different in appearance and behavior from their distant ancestors.

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		18. 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. 19. 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. 20. 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. 21. 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. 22. 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. 23. Describe how some diseases can sometimes be predicted by genetic testing and how this affects parental and community decisions. 24. Explain how the body produces antibodies to fight disease and how vaccines assist this process.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.

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		25. Explain how environmental factors and personal decisions, such as water quality, air quality and smoking affect personal and community health. 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. 26. Recognize that cells repeatedly divide to make more cells for growth and repair. **<u>Chemistry:</u>** 1. Explain the political, societal, economic and environmental impact of chemical products and technologies. For example: Pollution effects, atmospheric changes, petroleum products, material use or waste disposal. 2. Use significant figures and an understanding of accuracy and precision in scientific measurements to determine and express the uncertainty of a result. 3. Explain the relationship of an element's position on the periodic table to its atomic number and electron configuration. 4. Identify and compare trends on the periodic table, including reactivity and relative sizes of atoms and ions; use the trends to explain the properties of subgroups, including metals, non-metals, alkali metals, alkaline earth metals, halogens and noble gases. 5. Explain how elements combine to form compounds through ionic and covalent bonding. 6. Compare and contrast the structure, properties and uses of organic compounds, such as hydrocarbons, alcohols, sugars, fats and proteins. 7. Use IUPAC (International Union of Pure and Applied Chemistry) nomenclature to write chemical formulas and name molecular and ionic compounds, including those that contain polyatomic ions. 8. Determine the molar mass of a compound from its chemical formula and a table of atomic masses; convert the mass of a molecular substance to moles, number of particles, or volume of

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		gas at standard temperature and pressure. 9. Determine percent composition, empirical formulas and molecular formulas of simple compounds. 10. Describe the dynamic process by which solutes dissolve in solvents, and calculate concentrations, including percent concentration, molarity and parts per million. 11. Explain the role of solubility of solids, liquids and gases in natural and designed systems. For example: The presence of heavy metals in water and the atmosphere. Another example: Development and use of alloys. 12. Classify chemical reactions as double replacement, single replacement, synthesis, decomposition or combustion. 13. Use solubility and activity of ions to determine whether a double replacement or single replacement reaction will occur. 14. Relate the properties of acids and bases to the ions they contain and predict the products of an acid-base reaction. 15. Balance chemical equations by applying the laws of conservation of mass and constant composition. 16. Use the law of conservation of mass to describe and calculate relationships in a chemical reaction, including molarity, mole/mass relationships, mass/volume relations, limiting reactants and percent yield. 17. Describe the factors that affect the rate of a chemical reaction, including temperature, pressure, mixing, concentration, particle size, surface area and catalyst. 18. Recognize that some chemical reactions are reversible and that not all chemical reactions go to completion. 19. Use kinetic molecular theory to explain how changes in energy content affect the state of matter (solid, liquid and gaseous phases). 20. Use the kinetic molecular theory to explain the behavior of gases and the relationship among temperature, pressure, volume and the number of particles.

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		Physics I: 1. Describe changes in society that have resulted from significant discoveries and advances in technology in physics. For example: Transistors, generators, radio/television, or microwave ovens. 2. Use significant figures and an understanding of accuracy and precision in scientific measurements to determine and express the uncertainty of a result. 3. Use vectors and free-body diagrams to describe force, position, velocity and acceleration of objects in two-dimensional space. 4. Apply Newton's three laws of motion to calculate and analyze the effect of forces and momentum on motion. 5. Use gravitational force to explain the motion of objects near Earth and in the universe. 6. Explain and calculate the work, power, potential energy and kinetic energy involved in objects moving under the influence of gravity and other mechanical forces. 7. Describe and calculate the change in velocity for objects when forces are applied perpendicular to the direction of motion. For example: Objects in orbit. 8. Use conservation of momentum and conservation of energy to analyze an elastic collision of two solid objects in one-dimensional motion. 9. Analyze the frequency, period and amplitude of an oscillatory system. For example: An ideal pendulum, a vibrating string, or a vibrating spring-and-mass system. 10. Describe how vibration of physical objects sets up transverse and/or longitudinal waves in gases, liquids and solid materials. 11. Explain how interference, resonance, refraction and reflection affect sound waves. 12. Describe the Doppler effect changes that occur in an observed sound as a result of the motion of a source of the sound relative to a receiver.

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		Physics II: 1. Explain why currents flow when free charges are placed in an electric field, and how that forms the basis for electric circuits. 2. Explain and calculate the relationship of current, voltage, resistance and power in series and parallel circuits. For example: Determine the voltage between two points in a series circuit with two resistors. 3. Describe how moving electric charges produce magnetic forces and moving magnets produce electric forces. 4. Use the interplay of electric and magnetic forces to explain how motors, generators, and transformers work. 5. Describe the nature of the magnetic and electric fields in a propagating electromagnetic wave. 6. Explain and calculate how the speed of light and its wavelength change when the medium changes. 7. Explain the refraction and/or total internal reflection of light in transparent media, such as lenses and optical fibers. 8. Use properties of light, including reflection, refraction, interference, Doppler effect and the photoelectric effect, to explain phenomena and describe applications. 9. Compare the wave model and particle model in explaining properties of light. 10. Compare the wavelength, frequency and energy of waves in different regions of the electromagnetic spectrum and describe their applications. 11. Describe and calculate the quantity of heat transferred between solids and/or liquids, using specific heat, mass and change in temperature. 12. Explain the role of gravity, pressure and density in the convection of heat by a fluid. 13. Compare the rate at which objects at different temperatures will transfer thermal energy by electromagnetic radiation.

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		<u>10-12 Earth and Space Science:</u> 1. Compare and contrast the interaction of tectonic plates at convergent and divergent boundaries. For example: Compare the kinds of magma that emerge at plate boundaries. 2. Use modern earthquake data to explain how seismic activity is evidence for the process of subduction. For example: Correlate data on distribution, depth and magnitude of earthquakes with subduction zones. 3. Describe how the pattern of magnetic reversals and rock ages on both sides of a mid-ocean ridge provides evidence of sea-floor spreading. 4. Explain how the rock record provides evidence for plate movement. For example: Similarities found in fossils, certain types of rocks, or patterns of rock layers in various locations. 5. Describe how experimental and observational evidence led to the theory of plate tectonics. 6. Use relative dating techniques to explain how the structures of the Earth and life on Earth have changed over short and long periods of time. 7. Cite evidence from the rock record for changes in the composition of the global atmosphere as life evolved on Earth. For example: Banded iron formations as found in Minnesota's Iron Range. 8. Compare and contrast the energy sources of the Earth, including the sun, the decay of radioactive isotopes and gravitational energy. 9. Explain how the outward transfer of Earth's internal heat drives the convection circulation in the mantle to move tectonic plates. 10. Explain how Earth's rotation, ocean currents, configuration of mountain ranges, and composition of the atmosphere influence the absorption and distribution of energy, which contributes to global climatic patterns. 11. Explain how evidence from the geologic record, including ice core samples, indicates that climate changes have

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		occurred at varying rates over geologic time and continue to occur today. 12. Trace the cyclical movement of carbon, oxygen and nitrogen through the lithosphere, hydrosphere, atmosphere and biosphere. For example: The burning of fossil fuels contributes to the greenhouse effect. 13. Describe how the solar system formed from a nebular cloud of dust and gas 4.6 billion years ago. 14. Explain how the Earth evolved into its present habitable form through interactions among the solid earth, the oceans, the atmosphere and organisms. 15. Compare and contrast the environmental conditions that make life possible on Earth with conditions found on the other planets and moons of our solar system. 16. Explain how evidence, including the Doppler shift of light from distant stars and cosmic background radiation, is used to understand the composition, early history and expansion of the universe. 17. Explain how gravitational clumping leads to nuclear fusion, producing energy and the chemical elements of a star. 18. Analyze the benefits, costs, risks and tradeoffs associated with natural hazards, including the selection of land use and engineering mitigation. For example: Determining land use in floodplains and areas prone to landslides. 19. Explain how human activity and natural processes are altering the hydrosphere, biosphere, lithosphere and atmosphere, including pollution, topography and climate. For example: Active volcanoes and the burning of fossil fuels contribute to the greenhouse effect.

Mission and Vision: Students graduating from Waseca Public Schools will be scientifically literate. If they so choose, they will be able to pursue any science career that captures their fancy.