The following document provides the expected science performance standards for grades K-2, 3-5 and 6-8. Nation-wide implementation of these standards was recommended by NGS and being incorporated by several states to improve science readiness of American students. Thought leaders, scientists, clinicians and university faculties have come together to design a curriculum for SED Laboratory that allows students master core and overlapping concepts in a fully equipped engineering, molecular biology laboratory environment.

K-2: National Science standard and Curriculum

Introduction

K-2 Performance Standards: Students are able to comprehend that pushes and pulls can have different strengths and direction, motion and stability and that external force is required to change stationary or moving objects. Students are able to design solutions, and predict the impact of external forces. It is expected that students comprehend the relationship between vibration and sound; students comprehend that sound needs a medium to travel, while light does not; that light is necessary for vision. Experimenting with light, K-2 students are able to identify and understand transparent, translucent and opaque properties, and how light interact with different materials. They begin to develop understanding of common habitats, contents of natural and designed world. Students understand the interaction, relationships and interdependence of plants, animals and humans, and predict outcomes of external alterations/interventions. They recognize the fundamental similarities and differences between plants, animals, insects, and humans. Students begin to develop understanding of space, planets, stars, asteroids, and meteorites. K-2 students are expected to understand climate, whether, and variations and significance of forecast. Students start acquiring crosscutting scientific principles, cause and effect relationships, common systems and their modifications, interdependence and overlap of different branches of science. Students develop solid grade level foundation for proficiency excellence by engaging in evidence-based argument synthesis. This includes asking questions, developing models, experiments and design solutions to test, predict, observe, analyze and evaluate quantitative and qualitative outcomes to support or refute statements, arguments and phenomena. ***The overarching goal is to understand that every health, engineering and technological design/innovation/solution is inspired by knowledge application from the principles of natural world and built by using materials gathered from the Nature***.

K-2 Segment Core Ideas

- Fundamental forces and interactions
- Energy, kinds of energy, light, sound, vibrations
- Matter: Structure, properties and classification of materials and matter, testing suitability of materials for design solutions, disassembly and reassembly of objects and matter for creating new objects.

- Reversible and irreversible changes, heat and cold, relevance to engineering, technology and biological systems; events and causes generating observable changes
- Space, patterns, cycles and their influence on natural and designed world
- Ecosystems: Diversity, differences and similarities; insects, animals, plants, environment, behavior, growth, water, sunlight, energy
- Making of a living system, basic units, similarities and differences
- Structure and function, adaptation, traits, variation, survival; seed dispersal and pollination
- Inspiration and influence of Natural world in engineering and technology design
- Impact of designed world on the natural world.
- Weather, climate, land and water system, role of water and air in earth's processes and in shaping erosion and preventive designs, fast and rapid changes shaping the earth
- Engineering and Design: the structure and shape of the design is dictated by the intended function.

Grades 3-5: National Science standard (NGS) and curriculum

3-5 grade standards our individually outlined for clarity and expectations. At SED, students are divided based on their performance levels and to develop solid foundation through hands on hypothesis driven inquiry. Students performing at highest levels are tested with progressively challenging concept application followed by testing.

The performance expectations in third grade help students formulate answers to questions such as: "What is typical weather in different parts of the world and during different times of the year? How can the impact of weather-related hazards be reduced? How do organisms vary in their traits? How are plants, animals, and environments of the past similar or different from current plants, animals, and environments? What happens to organisms when their environment changes? How do equal and unequal forces on an object affect the object? How can magnets be used?" Using disciplinary core Ideas from the NRC Framework. Students are able to organize and use data to describe typical weather conditions expected during a particular season. By applying their understanding of weather-related hazards, students are able to make a claim about the merit of a design solution that reduces the impacts of such hazards. Students are expected to develop an understanding of the similarities and differences of organisms' life cycles. An understanding that organisms have different inherited traits, and that the environment can also affect the traits that an organism develops, is acquired by students at this level. In addition, students are able to construct an explanation using evidence for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing. Students are expected to develop an understanding of types of organisms that lived long ago and also about the nature of their environments. Third graders are expected to develop an understanding of the idea that when the environment changes some organisms survive and reproduce, some move to new locations, some move into the transformed environment, and some die. Students are able to determine the effects of balanced and unbalanced forces on the motion of an object and the cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other. They are then able to apply their understanding of magnetic interactions to define a simple design problem that can be solved with magnets. The crosscutting concepts of patterns; cause and effect; scale, proportion, and quantity; systems and system models;

interdependence of science, engineering, and technology; and influence of engineering, technology, and science on society and the natural world are called out as organizing concepts for these disciplinary core ideas. In the third grade performance expectations, students are expected to demonstrate grade-appropriate proficiency in asking questions and defining problems; developing and using models, planning and carrying out investigations, analyzing and interpreting data, constructing explanations and designing solutions, engaging in argument from evidence, and obtaining, evaluating, and communicating information. Students are expected to use these practices to demonstrate understanding of the core ideas.

The performance expectations in fourth grade help students formulate answers to questions such as: "What are waves and what are some things they can do? How can water, ice, wind and vegetation change the land? What patterns of Earth's features can be determined with the use of maps? How do internal and external structures support the survival, growth, behavior, and reproduction of plants and animals? What is energy and how is it related to motion? How is energy transferred? How can energy be used to solve a problem?" In line with Fourth grade performance expectations, students are able to use a model of waves to describe patterns of waves in terms of amplitude and wavelength, and that waves can cause objects to move. Students are expected to develop understanding of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. They apply their knowledge of natural Earth processes to generate and compare multiple solutions to reduce the impacts of such processes on humans. In order to describe patterns of Earth's features, students analyze and interpret data from maps. Fourth graders are expected to develop an understanding that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. By developing a model, they describe that an object can be seen when light reflected from its surface enters the eye. Students are able to use evidence to construct an explanation of the relationship between the speed of an object and the energy of that object. Students are expected to develop an understanding that energy can be transferred from place to place by sound, light, heat, and electric currents or from object to object through collisions. They apply their understanding of energy to design, test, and refine a device that converts energy from one form to another. The crosscutting concepts of patterns; cause and effect; energy and matter; systems and system models; interdependence of science, engineering, and technology; and influence of engineering, technology, and science on society and the natural world are called out as organizing concepts for these disciplinary core ideas. In the fourth grade performance expectations, students are expected to demonstrate grade-appropriate proficiency in asking questions, developing and using models, planning and carrying out investigations, analyzing and interpreting data, constructing explanations and designing solutions, engaging in argument from evidence, and obtaining, evaluating, and communicating information. Students are expected to use these practices to demonstrate understanding of the core ideas.

The performance expectations in fifth grade help students formulate answers to questions such as: "When matter changes, does its weight change? How much water can be found in different places on Earth? Can combining other substances create new substances? How does matter cycle through ecosystems? Where does the energy in food come from and what is it used for? How do lengths and directions of shadows or relative lengths of day and night change from day to day, and how does the appearance of some stars change in different seasons?"
Fifth grade performance expectations include disciplinary core Ideas from the NRC Framework. Students are able to describe that matter is made of particles too small to be seen through the development of a model. Students develop an understanding of the idea that regardless of the type of change that matter undergoes, the total weight of matter is conserved. Students determine whether the mixing of two or more substances results in new substances. Through the development of a model using an example, students are able to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. They describe and graph data to provide evidence about the distribution of water

on Earth. Students develop an understanding of the idea that plants get the materials they need for growth chiefly from air and water. Using models, students can describe the movement of matter among plants, animals, decomposers, and the environment and that energy in animals' food was once energy from the sun. Students are expected to develop an understanding of patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky. The crosscutting concepts of patterns; cause and effect; scale, proportion, and quantity; energy and matter; and systems and systems models are called out as organizing concepts for these disciplinary core ideas. In the fifth grade performance expectations, students are expected to demonstrate grade-appropriate proficiency in developing and using models, planning and carrying out investigations, analyzing and interpreting data, using mathematics and computational thinking, engaging in argument from evidence, and obtaining, evaluating, and communicating information; and to use these practices to demonstrate understanding of the core ideas.

3-5 Segment Core Ideas

- Fundamental forces, interactions and impact: Balanced and unbalanced forces, objects in motion, speed and energy relationship, collision, and measurement, computation, strength of force, magnets and design solutions with magnets, impact of distance on forces, electricity and electric field, electromagnets, cause and effect testing, observations and argument, forces in technology, engineering and design
- Matter, particles, atoms, nucleus, electrons, conservation of matter weight during heating, cooling and mixing, properties of matter and classification, weight, mass, time, temperature, volume.
- Chemical reactions, cause and effect, conservation of mass, matter (weight) is conserved when it changes form; mixing two materials can produce a new substance with different properties.
- Matter and energy: Energy is generated by chemical processes, sun, food, biological systems, energy flow, decomposers, web of life, energy and matter cycles in ecosystem.
- Light, sound and electrical energy transfer, devices converting one energy to another, natural resources for harnessing energy, engineering design challenges
- Wave and motion relationship, energy transfer devices and technology, coded information transfers using light and sound, line segment, rays, angles, perpendicular and parallel lines, photons, amplitude, audio readings and visual signals
- Ecosystem dependence and relationship, dynamics and resilience, survival in groups; selection and adaptation of living system in the face of environmental change, social interactions and group behavior, how structures, shapes and functions evolve or become vestigial for coping changes, biodiversity and interdependence
- Fossils, analysis and prediction of the environment
- Genetics, traits, inheritance, cycles of birth, growth, reproduction and death, plants and flowering, similarities of trait inheritance in plants and animals, effect of environment on traits, variation in traits in individuals of the same species and advantages conferred in survival and propagation, natural selection, cause and effect evidence and arguments
- Weather and Climate in different regions, natural hazards, engineering and technical design solutions for diminishing impact
- Structure function and relationship, light reflecting from objects and entering eye make objects visible, light sensing structures in living systems, differences and similarities, electromagnetic radiations-use and impact, sensory systems and its components, memory and actions
- Earth, history, geosphere, hydrosphere, biosphere, atmosphere, fossils, rock formation and forces, rainfall, water, ice, wind and living system, plate tectonics, mountain ranges, volcanoes, topology and map, impact of living system on properties of region; poles, natural

hazards-reason, impact and engineering solutions, protection of earth's resources, human impact on earth's system and its protection.
- Space: Gravitation force, origin, significance and impact, universe and its components, solar system, seasonal appearance of stars, positions, night, day and seasons.
- Engineering design and solutions with limited and restricted resources, problem solving approach, prototypes, testing and optimization

Middle School 6-8 Grade Segment: Next Generation Science Standards

Physical Science

Middle school standards are set at a level of performance required by the end of 8-th grade. Students understand four core ideas in the physical sciences. The segment builds on the K–5 ideas and skills allowing learners to explain critical phenomena central to physical sciences, life sciences, geology and space. Students in middle school is expected to develop strengths in physical science weaving core ideas with scientific/engineering practices and crosscutting concepts to explain real world phenomena. Students need to develop understanding of several scientific practices including model development, planning and conducting investigations, analyzing and interpreting data, while applying mathematical and computational analysis to synthesize arguments and conclusion. Students are also expected to demonstrate understanding and evaluation of the designed world.

The performance expectations in the topic **Structure and Properties of Matter** help students to understand: a) How limited set of elements (118 to be precise) can combine to give rise to millions of types of molecules and materials? "How can different molecules combine to produce a substance with different properties? Why does sugar water (distilled) does NOT conduct electricity? How does heat and cold affect particles? Students develop clear understanding of what occurs at the atomic and molecular scale. By the end of 8^{th} grade, students are expected to understand that a) matter is made up atoms that are indivisible and indestructible, b) All atoms of an element are identical, c) Atoms of different element combine in whole numbers to form compounds, d) When compounds decompose, atoms are recovered unchanged, meaning that atoms are indestructible. Students understand that pure substances have characteristic properties and are made from a single type of atom or molecule. They will be able to formulate molecular level description to explain different states of matters and changes between phases. Students apply crosscutting concepts to understand cause and effect; scale, proportion and quantity; structure and function; interdependence of science, engineering, technology and their influence on the natural and designed world. Students are expected to demonstrate proficiency in model development, observation, evaluation, and effective evidence based communication.

Topics in **Chemical Reactions** help students understand: "How are new materials formed from existing fundamental elements? How do we represent chemical reaction? What stays unchanged and what changes in a chemical reaction? Students are expected to understand the atomic and molecular scale during chemical reactions. By the end of middle school, students provide molecular accounts to explain how chemical reactions involve combining different atoms to form new substances, and how atoms rearrange during chemical reactions. Students apply design and process optimization concepts in engineering and chemical reaction systems. The crosscutting concepts of patterns and energy and matter are called out as organizing concepts for these disciplinary core ideas. In these performance expectations, students are expected to demonstrate proficiency in developing and using models, analyzing and interpreting data, and designing solutions. Students use these scientific and engineering practices to demonstrate understanding of core chemistry ideas. They are able to design processes that will minimize rusting parts in cars and bridges.

Forces and Interactions help students understand forces in physical systems- gravitational, electromagnetic and nuclear forces. They understand that forces can act through a contact or from action at a distance. They develop the idea that Force is a vector of magnitude and direction. Disciplinary core Idea is divided into Forces and Motion and Types of interactions. By the end of middle school, students apply Newton's Third Law of Motion to explain the motion of objects. Students apply core concepts in gravitational, electrical, and magnetic forces to explain a variety of phenomena why some materials attract each other while other repel. Students understand that gravitational interactions are always attractive while electrical and magnetic forces can attractive and negative. Students understand that objects can exert forces in the absence of contact, through fields. They develop the understanding that magnetism and electricity is always connected. Students apply an engineering practice and concept to solve a problem caused when objects collide. The crosscutting concepts of cause and effect; system and system models; stability and change; and the influence of science, engineering, and technology on society and the natural world serve as organizing concepts for these disciplinary core ideas. In these performance expectations, students must be able to demonstrate proficiency in asking questions, planning and carrying out investigations, and designing solutions, and engaging in argument; and to use these practices to demonstrate understanding of the core ideas.

Standards in the **Energy** section help students answer to the question, "How can energy be transferred from one source/system to another?" Why some forces need medium to travel while others don't. At the middle school level, the disciplinary core idea is broken down into four core ideas: Definitions of Energy, Energy Conservation and Transfer, the relationship between Energy and Forces, and Energy in Chemical Process and Everyday Life. Students are required to demonstrate qualitative understanding of ideas about energy including that the interactions between objects can be explained and predicted using the concept the energy can be transferred between objects and systems, but the total change of energy in any system is always conserved meaning that energy change always equals to the total energy transferred to or from the system'. Students understand that moving objects have kinetic energy and that objects can contain stored (potential) energy, which is dictated by relative positions. Students appreciate difference between energy and temperature, and understand the relationship between force and energy. Students are able to apply the learned concepts to design energy transfer challenges. Middle school students organize concepts of scale, proportion, and quantity; systems and models. These performance standards help students demonstrate proficiency in model development, planning investigations, analyzing and interpreting data, designing solutions, and engaging in evidence-based argument to demonstrate understanding of the core ideas.

The performance standards in **Waves and Electromagnetic Radiation** help students formulate an answer to the question, "What are the characteristic properties of waves and how can they be used?" At the middle school level, the disciplinary core Idea from the NRC Framework is broken down into Wave Properties, Electromagnetic Radiation, and Information Technologies and Instrumentation. Students are able to describe and predict characteristic properties and behaviors of waves when the waves interact with matter. Students can apply an understanding of waves as a means to send digital information. The crosscutting concepts of patterns and structure and function are used as organizing concepts for these disciplinary core ideas. These performance expectations focus on students demonstrating proficiency in developing and using models, using mathematical thinking, and obtaining, evaluating and communicating information; and to use these practices to demonstrate application of big ideas and unifying concepts.

Middle School Life Science

Middle school students understand key concepts to help understand principles of living system. There are four life science disciplinary core ideas: 1) **From Molecules to Organisms**: **Structures and Processes**, 2) **Ecosystems: Interactions**, **Energy, and Dynamics**, 3) **Heredity: Inheritance and Variation of Traits**, 4) **Biological Evolution: Unity and Diversity**. The performance standards in middle school develop the cross-cutting core principles with relevant to concept integration and application to designed world.

From Molecules to Organisms: Structures and Processes help students answer the fundamental question-How different cells with different function come together to make a living organism? The Disciplinary Core Idea is organized into four sections: *Structure and Function*, Growth and Development, *Matter and Energy Flow in Organisms*, and *Information Processing*. Students must understand the structure and function relationship of cells, and cell theory. How cells come together to form tissues, how tissues are organized in systems, and how systems work together to support life and impending challenges. Students are expected to understand organizing principles of fundamental processes such as photosynthesis and the flow of matter and energy. Students demonstrate understanding that environmental and genetic factors affect growth, adaptation and survival. Students are able to frame questions distinguishing cause and effect and identify controls and variables.

Interactions, Energy, and Dynamics Relationships in ecosystems help students frame an answer to the question-How does biotic and abiotic systems operate/interact sustain an ecosystem? The disciplinary core Idea is divided into three segments: *Interdependent Relationships in Ecosystems*; *Cycles of Matter and Energy Transfer in Ecosystems*; and *Ecosystem Dynamics, Functioning, and Resilience*. Students observe, analyze and interpret data, develop models, and construct arguments and demonstrate a deeper understanding of resources and the cycling of matter and the flow of energy in ecosystems. They study interaction patterns between organisms within an ecosystem. They consider biotic and abiotic factors in an ecosystem and the effects these factors have on population. They evaluate competing design solutions for maintaining biodiversity and ecosystem services.

Heredity: Inheritance and Variation of *Traits* help students answer to the question, "How do organisms pass traits from one generation to the next?" The disciplinary core Idea includes two sub-ideas: *Trait Inheritance*, and *Trait Variation*. Students use models to describe how gene mutations and sexual reproduction contributes to genetic variation. Organizing concepts of cause and effect and structure and function provide students with a deeper understanding of how genes and alleles determine functional and structural differences.

Biological Evolution: Students are able to explain, "How organisms change over time in response to changing environmental pressure?" How do we know that evaluation is happening? Why are biologists sure about evaluation even though some media reject evaluation flat out as theory? What is the evidence? How do new species develop? Core Ideas are divided into four topics: *Evidence of Common Ancestry and Diversity*, *Natural Selection*, *Adaptation*, and *Biodiversity and Humans*. Students engage in evidence-based argument synthesis to support understandings of natural selection and evolution. Students explain how genetic variation and advantageous traits enhance survival? They use fossil records and comparative anatomy to determine homologues structure, function and evolutionary relationships to describe evolution.

Middle School Earth and Space Sciences

Middle school develop understanding of a range of topics in Earth and space science (ESS) divided into six-standard topics: *Space Systems, History of Earth, Earth's Interior Systems, Earth's Surface Systems, Weather and Climate, and Human Impacts*. The content strongly reflect the many societally relevant aspects of ESS (resources, hazards, environmental impacts) as well as related connections to engineering and technology.

Space Systems help students explain: What is Earth's location in the Universe? What constitutes solar system and how seasons and eclipses created?" Middle school standard expectations examine Earth's location in relation to the solar system, Milky Way galaxy, and universe. Students use a systems approach to explain astronomical and cyclic patterns such as eclipses, tides, and seasons. Students demonstrate understanding of engineering and technology allowing space exploration, and obtain data that support theories that explain formation and evolution of the universe. Students apply crosscutting concepts of patterns; scale, proportion, and quantity; systems and system models; and interdependence of science, engineering, and technology. Students are expected to demonstrate proficiency in developing/using models and analyzing and interpreting data.
History of Earth helps students understand the development of planet earth from its formation to present day. Students are able to explain- "How scientist figure out that the Earth and life on Earth have changed over time?" and "How does tectonics plate movement impact Earth's surface? Four topics constitute the core expected standards. Students examine geoscience data to comprehend processes and events in Earth's history. Important concepts in this topic are "Scale, Proportion, and Quantity" and "Stability and Change," in relation to the different ways geologic processes operating over the geologic scale of time. Students are able to explain that geologic events and conditions have shaped the evolution, and that different life forms have also played critical roles in influencing Earth's systems. Students demonstrate proficiency in analyzing and interpreting data, and constructing explanations. Students use these practices to demonstrate understanding of the core underlying principles. The performance expectations in Earth's Systems help students answer "How do materials in and on Earth's crust change over time?" and "How does water influence weather, and change Earth's surface?" Students understand how geosystems operate by modeling the flow of energy and cycling of matter within and among different systems. Students investigate the properties of important materials and construct explanations based on the analysis of real geoscience data. Of special importance in both topics are the ways that geoscience processes provide resources needed by society but also cause natural hazards that present risks to society; both involve technological challenges, for the identification and development of resources and for the mitigation of hazards. In the *Earth's Systems*, students demonstrate proficiency in developing and using models and constructing explanations.

'Weather and Climate' section help students answer the question: "What factors interact and influence weather and climate?" Three sub-ideas are addressed in these performance expectations: Students construct and use models to develop understanding of the factors that control weather and climate. Taking systems approach students examining the feedbacks between systems as energy from the sun is transferred between systems and circulates though the ocean and atmosphere. Students are able to distinguish cause and effect, understand systems and system models, and stability and change for these disciplinary core ideas.
In the *Weather and Climate* students are expected to demonstrate proficiency in asking questions, developing and using models, and planning and carrying out investigations; and to use these practices to demonstrate understanding of the core ideas.
Human Impacts help students answer- "How can natural hazards be predicted?" and "How do human activities affect Earth systems"? Students understand the ways that human activities impact Earth's other systems. Students use many different practices to understand the significant and complex issues surrounding human uses of land, energy, mineral, and water resources and the resulting impacts of their development. Students become competent in crosscutting concepts of patterns of cause and effect; and interdependence of science, engineering, and technology. Students are able to identify bias and critique published literature.

Middle School Engineering Design

By middle school students should have had numerous experiences in engineering design. The goal is to define problems precisely, to conduct a thoroughly researched process choosing the best solution, and optimizing the final design. Defining the problem with "precision" involves rationale thinking about problems, goals and design solution, readout and evaluation? Also at middle school level students are expected to consider not only the end user, but also the broader society and the environment. Every technological change is likely to have both intended and unintended effects. It is up to the designer to try to anticipate the effects it may have, and to behave responsibly in developing a new or improved technology. These considerations may take the form of either criteria or constraints. on possible solutions. Students evaluate proposed ideas and challenges by testing, evaluating and optimizing different solutions to improve currently existing solutions.

Improving designs at the middle school level involves an iterative process practiced in science, technology and engineering. Students connect science disciplines to develop capabilities in various contexts. For example, in the life sciences students apply their engineering design capabilities to evaluate plans for maintaining biodiversity and ecosystems. In physical sciences students define and solve problems involving crosscutting ideas in physical science, chemical processes, Newton's third law of motion, and energy transfer. In the Earth and space sciences students apply their engineering design capabilities to problems related the impacts of humans on Earth systems. By the end of 8th grade students are expected to achieve performance expectations related to a single problem in order to recognize and apply interrelated concepts in engineering design. These include problem identification by precisely specifying criteria and constraints for solutions, evaluating potential impact on society and the natural environment, systematically evaluating alternative solutions, use technology and tools to test data and combining the best ideas into an improved solution, and developing a model and iteratively testing and improving it to reach an optimal solution.

- **Structure and properties of atoms**: Atomic composition of simple molecules such as sodium chloride, ammonia, methanol, diamond; 3-D ball and stick models, physical and chemical properties, modeling with math, computational analysis, ratio, rates, positive and negative numbers in data reporting and analysis, integer with power of 10, and expressing very large and small quantities
- **Chemical reactions, atomic arrangements and regrouping**; analysis and interpretation on the properties before and after chemical reaction such as burning sugar or steel wool, fat reacting with sodium hydroxide or mixing zinc with hydrochloric acid; conservation of mass and number of atoms in chemical reaction; devices that absorb or releases thermal energy; effect of factors such as reactant concentration and temperature on the rate of reaction; relationship between macroscopic pattern and atomic changes; synthetic materials, medicine, food and fuels;
- **Forces and Interaction**: Particle motion, temperature, state of pure substance, molecular models of solids, liquids and gases; internal energy, thermal energy and kinetic energy of particles before and after phase change, inert atoms, collisions and Newton's third Law, forces, magnitude and quantitative analysis, electric and magnetic field strengths, electromagnets, strength of interactions-effect of number of turns of the wire on the strength of electromagnet, electric motors and generators; proportionate reasoning and algebraic thinking. Quantitative analysis of gravitational force, interactions and its dependence on mass, distance, cause and effect relationship, inputs and outputs, designs demonstrating attractive and repulsive electric and magnetic field, mapping force fields.
- **Energy**: Motion and energy, graphical display, analysis and relationship between kinetic energy, mass and speed; arrangements, position and potential energy, design, test and analyze devices that measure thermal energy; investigations determining relationship between energy transfer, type of matter, mass and changes in kinetic energy of particles; conservation of energy and energy transfer; relationship between energy and forces

- **Waves and electromagnetic radiations**: Wave properties, frequency, electromagnetic radiations; Computational representation and relationship between amplitude of waves and energy in a wave; reflection, absorption and transmittance; waves and digitized signaling for encoding and transmitting signals, and comparison to analog signals.
- **Structure, Function and information processing**: Cells, organization, tissues, systems, organelles, structure-function dependency, interaction with neighboring and distant cells, systems, sensory receptors and stimuli, brain, neurons and behavior.
- **Matter and Energy in Organisms and Systems**: Organization and interdependence of energy flow; Photosynthesis and respiration, rearrangement of atoms during sugar synthesis, energy release, light, effect of resource availability and scarcity on organisms and ecosystems, cycling of matter and energy between biotic and abiotic systems; producers, consumers, and decomposers; ecosystem dynamics, functioning and resilience; chemical nature of energy, complex molecules in living system; biodiversity.
- **Growth, Development and Reproduction**: Sexual and asexual reproduction; Animal behavior, specialized plant structures in reproduction; environmental and genetic factors in growth; genes, chromosomes, mutation, natural selection, traits, inheritance; variance, Common ancestry and diversity, homologous structures and function, Adaptation, patterns of similarities in embryological development; modern and fossil organisms, comparative anatomy, survival
- **Space**: Cyclic patterns of Earth, sun and moon, seasons, role of gravity in motion within galaxies and solar systems, scale properties of objects in the solar system; stars, solar system, spin and orbit, cause and effect relationship; Time, space and energy.
- **History of Earth**: Geologic time scale, planet formation and time frame, earth's changes in time and spatial scales; Earth's material, natural resources and scale; fossil analysis, rocks and continental shapes, plate motions; role of water in Earth's processes, energy flow and cycles
- **Weather and Climate**: Water and its role, weather and climate, temperature, salinity, interactions with latitude, altitude, local and regional geography, ocean currents, atmospheric patterns
- **Human Impact**: Geological forces, natural hazards, catastrophes and technologies to mitigate their effects, forecast; biosphere, natural habitats and the impact of its destruction.
- **Engineering Design**: Defining and delimiting problems, constraints and design optimization through iterative testing and design; use of technology and devices to solve problems