# Standard 1: Life Science

As a basis for understanding Life Science, students will develop the following knowledge, skills and understandings:

## 1.1 Students understand the principles of heredity and its related concepts.

## 1.2 Students understand the structure and function of cells and organisms.

- **1.2.1** Understand the processes of photosynthesis and respiration in plants.
  - **1.2.1.1** Chloroplasts in plant cells use energy from sunlight to combine molecules of carbon dioxide and water into complex, energy-rich organic compounds and release oxygen to the environment.
  - **1.2.2** Know that the complexity and organization of the organisms accommodates the need for obtaining, transforming, transporting, releasing, and eliminating the matter and energy used to sustain the organism.

## 1.3 Students understand relationships among organisms and their physical environment.

- **1.3.1** Know the interrelationship and interdependencies among organisms generate stable ecosystems that fluctuate around a state of rough equilibrium for hundreds or thousands of years.
  - **1.3.1.1** Growth of a population is held in check by environmental factors such as depletion of food or nesting sites, increased loss due to larger numbers of predators or parasites.
- **1.3.2** Understand how the amount of life and environment can support is limited by the availability of matter and energy and the ability of the ecosystem to recycle materials.
- **1.3.3** Know that as matter and energy flow through different levels of organization in living systems and between living systems and the physical environment, chemical elements (e.g., carbon, nitrogen) are recombined in different ways.
- **1.3.4** Know that because all matter tends toward more disorganized states, living systems require continuous input of energy to maintain their chemical and physical organizations.
- **1.3.5** Know ways in which human can alter the equilibrium of ecosystems, causing potentially irreversible effects:
  - **1.3.5.1** Human population growth, technology, and consumption.
  - **1.3.5.2** Human destruction of habitats through direct harvesting, pollution, and atmospheric changes.

## 1.4 Students understand biological evolution and the diversity of life.

- **1.4.1** Know that heritable characteristics, which can be biochemical and anatomical, largely determine what capabilities an organism will have, how it will behave, and how likely it is to survive and reproduce.
- **1.4.2** Understand the concept of natural selection:
  - **1.4.2.1** When an environment changes, some inherited characteristics become more or less advantageous or neutral.
  - **1.4.2.2** Change alone can result in characteristics having no survival or reproductive value.
1.4.2.3  This process results in organisms that are well suited for survival in particular environments.

1.4.3  Know how variation of organisms within a species increases the chance of survival of the species, and how the great diversity of species on earth increases the chance of survival of life in the event of major global change.

1.4.4  Know that the basic idea of evolution is that the earth’s present-day life forms have evolved from earlier, distinctly different species as a consequence of the interactions of:
- 1.4.4.1  The potential for a species to increase its numbers
- 1.4.4.2  The genetic variability of offspring due to mutation and recombination of genes
- 1.4.4.3  A finite supply of the resources required for life
- 1.4.4.4  The ensuing selection by the environment of those offspring better able to survive and leave offspring

1.4.5  Know the history of the origin and evolution of life on earth:
- 1.4.5.1  Life on earth is thought to have begun 3.5-4 billion years ago as simple, unicellular organisms.
- 1.4.5.2  Cells with nuclei evolved about a billion years ago, after which increasingly complex multicellular organisms evolved.

1.4.6  Understand how natural selection and its evolutionary consequences provide a scientific explanation for the diversity and unity of past and present life forms on earth:
- 1.4.6.1  Recurring patterns of relationship exist throughout the fossil record.
- 1.4.6.2  Molecular similarities exist among the diverse species of living organisms; the millions of different species living today appear to be related by descent from common ancestors.

1.4.7  Know how organisms are classified into hierarchy of groups and subgroups based on similarities that reflect their evolutionary relationships:
- 1.4.7.1  Shared derived characteristics inherited from a common ancestor.
- 1.4.7.2  Degree of kinship estimated from the similarity of DNA sequences.

### Standard 2: Physical Science

*As a basis for understanding Physical Science, students will develop the following knowledge, skills and understandings:*

#### 2.1 Students understand the structure and the properties of matter.

- **2.1.1** Know the Law of Conservation of Matter, that matter can never be created nor destroyed, but may change from high quality matter to low quality matter
- **2.1.2** Understand implications of the phrase: “There is no way” in regards to resources use and solid waste management
- **2.1.3** Know the variety of structures that may be formed from the bonding of carbon atoms (e.g., synthetic polymers, oils, the large molecules essential to life) and their roles in various chemical reactions, including those required for life processes
- **2.1.4** Understand radical reactions and their role in natural and human processes:
  - **2.1.4.1** Ozone and green house gases in the atmosphere
  - **2.1.4.2** Burning and processing of fossil fuels
  - **2.1.4.3** Formation of polymers
  - **2.1.4.4** Explosions

*Adapted from National (NSES), McRel and California State Standards*
2.2 Students understand chemical reactions.

2.3 Students understand the sources and properties of energy.

2.3.1 Understand the concept of entropy:
   2.3.1.1 Although the total energy of the universe remains constant, matter tends to become steadily less ordered as various energy transfers occur.
   2.3.1.2 The energy tends to spread out uniformly, thereby decreasing the amount of useful energy.

2.3.2 Know that all energy can be considered to be either:
   2.3.2.1 Kinetic energy (energy of motion)
   2.3.2.2 Potential energy (depends on relative position)
   2.3.2.3 Energy contained by a field (electromagnetic waves)

2.3.3 Know that nuclear reactions convert a fraction of the mass of interacting particles into energy (fission involves the splitting of a large nucleus into smaller pieces; fusion is the joining of two nuclei at extremely high temperature and pressure) and release much greater amounts of energy than atomic interactions.

2.3.4 Know benefits and drawbacks of renewable and non-renewable energy resources including distribution, ownership, use and degradation of conventional and alternative sources of energy.

2.4 Students understand forces and motion.

2.5 Students understand waves and optics.

2.6 Students understand electricity and magnetism.

Standard 3: Earth and Space Science

As a basis for understanding Earth and Space Science, students will develop the following knowledge, skills and understandings:

3.1 Students understand Earth’s composition and structure.

3.2 Students understand the composition and structure of the atmosphere.

3.2.1 Know how winds and oceans and currents are produced on the Earth’s surface:
   3.2.1.1 Effects of unequal heating of the earth’s land masses, oceans, and air by the sun.
   3.2.1.2 Effects of gravitational forces acting on layers of different temperatures and densities in the oceans and air.
   3.2.1.3 Effects of the rotation of the earth.

3.2.2 Understand heat and energy transfer in and out of the atmosphere and its involvement in weather and climate:
   3.2.2.1 Radiation
   3.2.2.2 Conduction
### 3.2.3 Know the evolution of life on earth has changed the composition of the earth’s atmosphere through time:
- 3.2.3.1 The evolution of photosynthesizing organisms produced most of the oxygen in the modern atmosphere.

### 3.2.4 Know higher order interactions and their consequences of global atmospheric pollution:
- 3.2.4.1 Global warming
- 3.2.4.2 Increasing ultraviolet radiation due to loss in Stratospheric O3

### 3.3 Students understand the composition and structure of the universe.

#### 3.3.1 Understand the concept of plate tectonics:
- 3.3.1.1 The outward transfer of the earth’s internal heat and the action of gravitational forces on regions of different density drive convection circulation in the mantle.
- 3.3.1.2 These convection currents propel the earth’s crustal plates, which move very slowly, pressing against one another in some places and pulling apart in other places.

#### 3.3.2 Know effects of the movement of crustal plates:
- 3.3.2.1 Earthquakes occur along the boundaries between colliding plates.
- 3.3.2.2 Sea floor spreading occurs where plates are moving apart.
- 3.3.2.3 Mountain building occurs where plates are moving together.
- 3.3.2.4 Volcanic eruptions release pressure created by molten rock beneath the earth’s surface.

#### 3.3.3 Know that elements exist in fixed amounts and move through the solid earth, oceans, atmosphere, and living things as part of geochemical cycles:
- 3.3.3.1 Carbon cycle
- 3.3.3.2 Nitrogen cycle
- 3.3.3.3 Hydrologic cycle

#### 3.3.4 Know the conditions of earth that enable it to support life:
- 3.3.4.1 Force of gravity that enables the planet to retain and adequate atmosphere, intensity of radiation from the sun that allows water to cycle between liquid and vapor

#### 3.3.5 Know the major external and internal sources of energy on the earth:
- 3.3.5.1 The decay of radioactive isotopes and gravitational energy from the earth’s original formation are primary sources of internal energy.
- 3.3.5.2 Solar energy is the primary source of external energy.
Standard 4: Nature of Science

As a basis for understanding the nature of science as it relates to scientific knowledge, scientific inquiry, and scientific enterprise and to address content in the other standards students will:

4.1 Apply proper scientific measures when solving problems.
   4.1.1 Know and employ metric units when measuring and problem solving:
   4.1.1.1 Identify the seven major SI and laboratory metric units, i.e., meter, kilogram, second, ampere, Kelvin, mole, and candela.
   4.1.1.2 Convert between prefixes nano to mega within the metric system.
   4.1.1.3 Differentiate and convert between the two temperature scales; Celsius and Kelvin.
   4.1.1.4 Contribute and solve derived values (volume and density) using correct SI units.
   4.1.1.5 Use problem solving strategies (including dimensional analysis) to solve mathematical problems
   4.1.1.6 Identify the potentially important information given in a problem when choosing an appropriate solution.
   4.1.1.7 Determine the true question and/or conceptual premise; applying appropriate units when applicable
   4.1.1.8 Properly manipulate conversion factors to dimensional analysis questions

4.1.2 Reason sources of error when discussing accuracy and precision (uncertainty) of results; examples include human, instrumental, systematic, and random errors.
   4.1.2.1 Reason the number of significant digits, accuracy, and precision in problems and laboratory tools.
   4.1.2.2 Answer mathematical operations using scientific notation.

4.1.3 Demonstrate safety procedures within lab situations.
   4.1.3.1 Demonstrate proper lab safety.
   4.1.3.2 Locate and explain how to properly use safety equipment in the lab.

4.1.4 Use technology and mathematics (e.g., measurement, formulas, charts, graphs) to perform accurate scientific investigations and communications.
   4.1.4.1 Use appropriate lab tools, measuring devices, calculators, computers, Probeware, etc. correctly during investigations.
   4.1.4.2 Utilize appropriate measurements, formulas, charts, graphs, etc. when analyzing laboratory data.

4.2 Investigate the natural world using scientific inquiry.
   4.2.1 Effectively contribute to a collaborative group; including accepting roles, following norms, and successfully communicating.
   4.2.2 Design and conduct open ended scientific investigations; confirming scientific laws, theories, and models; or to explore new aspects of the natural world and new areas of science:
   4.2.3 Devise investigations that:
      4.2.3.1 Identify a focused problem or research question.
      4.2.3.2 Formulate testable hypotheses that relate to the research question; supporting it quantitatively when appropriate.
      4.2.3.3 Select relevant independent and dependent variables.
      4.2.3.4 Identify and clarify the method and controls; using appropriate apparatus.
      4.2.3.5 Demonstrate competence in using laboratory equipment (seeking assistance when required); paying attention to safety issues.

Adapted from National (NSES), McRel and California State Standards
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Sub-standards in gray are not addressed in this course.
Adopted by the Board on January 29, 2009
4.2.3.6 Adapt to new and unforeseen circumstances while following instructions.
4.2.3.7 Employ methods that collect sufficient and relevant quantitative and/or qualitative data; using appropriate units.
4.2.3.8 Organize and display raw data for easier interpretation and analysis data.
4.2.3.9 Determine errors, their quantitative/qualitative effects they have on results, and calculate percent error when possible.
4.2.3.10 Formulate a conclusion based on interpretation of results with an explanation, and, where appropriate, compare results with literature values.
4.2.3.11 Receive critical response from others.

4.2.4 Reason that when conditions of an investigation cannot be controlled, it may be necessary to discern patterns by observing a wide range of natural occurrences.

4.2.5 Know that conceptual principles and knowledge guide scientific inquiries; historical and current scientific knowledge influence the design and interpretation of investigations and the evaluation of proposed explanations made by other scientists.

4.2.6 Comprehend why scientists conduct investigations:
4.2.6.1 To discover new aspects of the natural world
4.2.6.2 To explain recently observed phenomena
4.2.6.3 To test the conclusions of prior investigations
4.2.6.4 To test predictions of current theories

4.2.7 Appreciate that investigations and public communication among scientists must meet specific criteria in order to be accepted as new knowledge and methods:
4.2.7.1 Strive for certainty of proposed solutions using experimental standards.
4.2.7.2 Pursue arguments that are logical and do demonstrate connections between natural phenomena, investigations, and the historical body of scientific knowledge.
4.2.7.3 Convey explanations with logical structure and rules of evidence.
4.2.7.4 Show commitment to making public their methods, procedures and conclusions.
4.2.7.5 Methods and procedures used to obtain evidence are clearly reported to enhance opportunities for further investigation.
4.2.7.6 Understand the logical and empirical communication among scientists and the public leads to new accountable information.
4.2.7.7 Continually test, revise, and occasionally discards theories, therefore allow for continual critical response from others.
4.2.7.8 Know that all current scientific knowledge in principle is subject to change, as new evidence becomes available.

4.2.8 Understand the Nature of Science Inquiry is driven by the desire to understand the natural world and seeks to answer questions that may or may not directly influence humans.

4.3 Evaluate the acquisition, development, and modification of scientific knowledge in the past, present, and future.

4.3.1 Know ways in which science distinguishes itself from other bodies of knowledge, through use of empirical standards and logical arguments.
4.3.2 Be aware that scientific explanations must meet certain criteria to be considered valid:
4.3.2.1 Must be consistent with experimental and observational evidence about nature
4.3.2.2 Make accurate predictions about systems being studied
4.3.2.3 Be logical

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4.3.2.4 Respect rules of evidence
4.3.2.5 Be open to criticism
4.3.2.6 Report methods and procedures
4.3.2.7 Make a commitment to making knowledge public

4.3.3 Reason how scientific knowledge changes and accumulates over time:
4.3.3.1 All scientific knowledge is subject to change as new evidence becomes available
4.3.3.2 Some scientific ideas are incomplete and opportunity exists in these areas for new advances
4.3.3.3 Scientific knowledge is continually tested, revised, and occasionally discarded as new evidence is obtained.

4.3.4 Accept and anticipate that from time to time, major shifts occur in the scientific view of how the world works, but usually the changes that take place in the body of scientific knowledge are usually small modifications of prior knowledge.

4.4 Examine how science and its enterprises impact society.
4.4.1 Compare and contrast Science and Technology
4.4.2 Reflect that, throughout history, diverse cultures have developed scientific ideas and solved human problems through technology
4.4.3 Understand that individuals and teams contribute to scientific knowledge and understanding at different levels of complexity:
4.4.3.1 Conducting basic field studies or improving advanced technology
4.4.3.2 Creating New Technologies
4.4.3.3 Solving technological problems
4.4.3.4 Collaborating (sometimes between hundreds of people) on a major scientific question or technological problem
4.4.4 Comprehend the free and rapid interplay of theoretical ideas and experiments results in published scientific literature maintains crucial links between scientific fields
4.4.5 Develop information and technology skills which are essential in modern scientific endeavors.
4.4.6 Appreciate that progress in Science/Technology can relate to social issues and challenges (eg. Funding priorities, health problems)
4.4.7 Understand that there are ethical traditions associated with the scientific enterprise:
4.4.7.1 Be committed to peer review
4.4.7.2 Report truthfully about methods and outcomes of investigations
4.4.7.3 Publish results of work with the expectation of peer review
4.4.7.4 Scientists who violate these traditions are censored by their peers
4.4.8 Consider that scientists and engineers can only conduct research on human subjects or stem cells if they have the consent of the subjects or governing bodies.
4.4.9 Accept that technology is often driven by the desire to help meet human needs, solve human problems, and fulfill human aspirations.
4.4.10 Be able to assess a proposal from a scientific enterprise; including questions about: alternatives, risks, costs, benefits, consideration of who benefits, who suffers, who pays, who gains, and who bears the risks
4.4.11 Validate that credible technological resources come from professional presentations, journal publications, and data bases.
4.4.12 Understand that science and technology are essential social enterprises, but alone they can only indicate what can happen, not what should happen.
4.4.13 Acknowledge science is interdependent on different fields of study in different disciplines.

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4.4.13.1 Scientists in different disciplines ask different questions, use different methods of investigation and accept different types of evidence to support their explanations.

4.4.13.2 Many scientific investigations require the contributions of individuals from different disciplines.

4.4.13.3 New disciplines of science (such as geophysics, biochemistry, and genomics) often emerge at the interface of older disciplines.

4.4.14 Undergo searches for current areas where data, information, and understanding are incomplete; therefore providing the best opportunity for students to advance in the science related career opportunities.

4.4.15 Comprehend that creativity, imagination, and a good knowledge base are all required in the work of science and engineering.

4.5 Students understand the connections among science, global issues and sustainable solutions.

As a basis for this, students will understand:

4.5.1 Climate Change (Global Warming)
4.5.2 Biodiversity and Ecosystem Losses
4.5.3 Fisheries Depletion
4.5.4 Deforestation
4.5.5 Water Deficits
4.5.6 Air, Water and Soil Pollution
4.5.7 Global Infectious Diseases
4.5.8 Natural Disaster Prevention and Mitigation
4.5.9 Human Population Dynamics
4.5.10 Unsustainable Land Use (unsustainable agriculture, livestock grazing, urban sprawl, landfills, hazardous waste, mining and mineral extraction)
4.5.11 Solid Waste Management (waste minimization, recycling, closed loop systems)
4.5.12 Energy Conservation, alternative energy, alternative fuels