Minnesota Science

Life Science

Exploring phenomena or engineering problems 9.L.1

1 Asking questions and defining problems. 9L.1.1

1 Students will be able to ask questions about aspects of the phenomena they observe, the conclusions they draw from their models or scientific investigations, each other's ideas, and the information they read. 9L.1.1.1

1 Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring. (P: 1, CC: 2, CI: LS3) Examples of relationships may include relationships between mutated DNA sequences or chromosomal deletions and their effect on traits. 9L.1.1.1.1

1 Planning and carrying out investigations. 9L.1.2

1 Students will be able to design and conduct investigations in the classroom, laboratory, and/or field to test students' ideas and questions, and will organize and collect data to provide evidence to support claims the students make about phenomena. 9L.1.2.1

1 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. (P: 3, CC: 7, CI: LS1) Examples of investigations may include heart rate response to exercise, stomata response to moisture and temperature, and root development in response to water levels. 9L.1.2.1.1

Looking at data and empirical evidence to understand phenomena or solve problems 9L.2

2 Analyzing and interpreting data 9L.2.1

2 Students will be able to represent observations and data in order to recognize patterns in the data, the meaning of those patterns, and possible relationships between variables. 9L.2.1.1

2 Apply concepts of probability to explain and predict the variation and distribution of expressed traits in a population. (P: 4, CC: 3, CI: LS3) Examples of traits in human groups may include lactose intolerance, or high-altitude adaptation. 9L.2.1.1.1

2 Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait. (P: 4, CC: 1, CI: LS4) Emphasis is on analyzing shifts in the numerical distribution of traits and using these shifts as evidence to support explanations. Examples of advantageous traits may antibiotic resistance in bacteria, or the coloration and camouflage of animals in response to changing environmental conditions. 9L.2.1.1.2

2 **Using mathematics and computational thinking** 9L.2.2

2 Students will be able to use mathematics to represent physical variables and their relationships, compare mathematical expressions to the real world, and engage in computational thinking as they use or develop algorithms to describe the natural or designed worlds. 9L.2.2.1

2 Use a computational model to support or revise an evidence-based explanation for factors that have ecological and economic impacts on different sized ecosystems, including factors caused by the practices of various human groups.** (P: 5, CC: 3, CI: LS2) Examples of ecological impacts might include changes in the carrying capacity, species numbers and/or types of organisms present in an environment. Examples of human practices that can have positive or negative impacts, such as stream restoration versus deforestation as an ecological example. Examples of computational models may include online simulations of population dynamics, population ecology, or population growth. 9L.2.2.1.1

2 Use a computational model to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.** (P: 5, CC: 5, CI: LS2) Examples of claims about matter cycles may include how carbon, nitrogen, or water cycles through the environment, and/or how disruptions to those systems affect matter cycling. Examples of energy flow may include the transfer of the sun's energy into and among organisms, and/or connections between fossil fuel burning and the carbon cycle. Examples of computational models may include online simulations and animated representations. 9L.2.2.1.2

Developing possible explanations of phenomena or designing solutions to engineering problems. 9L.3

3 **Developing and using models** 9L.3.1

3 Students will be able to develop, revise, and use models to represent their understanding of phenomena or systems as they develop questions, predictions and/or explanations and communicate ideas to others. 9L.3.1.1

3 Develop and use a model to illustrate the levels of organization of interacting systems and how that translates into specific functions in multicellular organisms. (P: 2, CC: 6, CI: LS1) Emphasis is on specific functions at the organ system level such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. Examples of models may include real (e.g. fish, birds, insects, etc.) or imaginary organisms with attention to the various structures and systems that assist the organism in performing necessary life functions. 9L.3.1.1.1

3 Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. (P: 2, CC: 2, CI: LS1) Examples of models may include diagrams and conceptual models. 9L.3.1.1.2

3 Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. (P: 2, CC: 4, CI: LS1) Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. Examples of models may include diagrams, chemical equations, and conceptual models. 9L.3.1.1.3

3 Use a model to illustrate that cellular respiration is a chemical process in which energy from food is used to create new compounds. (P: 2, CC: 5, CI: LS1) Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration. 9L.3.1.1.4

3 **Constructing explanations and designing solutions** 9L.3.2

3 Students will be able to apply scientific principles and empirical evidence (primary or secondary) to explain the causes of phenomena or identify weaknesses in explanations developed by the students or others. 9L.3.2.1

3 Construct an explanation based on evidence for how the structure of DNA determines the structure of the proteins that carry out the essential functions of life. (P: 6, CC: 6, CI: LS1). 9L.3.2.1.1

3 Construct and revise an explanation based on evidence for how various elements combine with carbon to form molecules that form the basis for life on Earth. (P: 6, CC: 5, CI: LS1) Emphasis is on using evidence from models and simulations to support explanations. Examples of molecules may include proteins, lipids, carbohydrates and nucleic acids. 9L.3.2.1.2

3 Construct and revise an explanation based on evidence about the role of photosynthesis and cellular respiration (including anaerobic processes) in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere. (P: 6, CC: 7, CI: LS2) Emphasis is on the importance of biological processes in the global scale cycling of carbon and on a conceptual understanding of the role of aerobic and anaerobic respiration in different environments. 9L.3.2.1.3

3 Construct an explanation based on evidence that the process of evolution primarily results from four factors: reproduction within a species, heritable genetic variation of individuals in that species, competition for limited resources, and increased survival and reproduction of the individuals best suited for the environment. (P: 6, CC: 2, CI: LS4) Emphasis is on using evidence to explain the influence each of the four factors has on the number, behavior, morphology, or physiology of organisms, in terms of their ability to compete for limited resources and subsequent survival of individuals and adaptation of their species. Examples of evidence may include mathematical models such as simple distribution graphs and proportional reasoning. 9L.3.2.1.4

3 Construct an explanation based on evidence for how natural selection leads to the adaptation of populations. (P: 6, CC: 2, CI: LS4) Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems contribute to a change in gene frequency over time, leading to adaptation of populations. Examples of selective forces may include long-term climate change, or variations in seasonal temperatures, pH, light cycles, geographic barriers, or in response to the evolution of other organisms. 9L.3.2.1.5

Communicating reasons, arguments, and ideas to others 9L.4

4 **Arguing from evidence** 9L.4.1

4 Students will be able to engage in argument from evidence for the explanations the students construct, defend and revise their interpretations when presented with new evidence, critically evaluate the scientific arguments of others, and present counter arguments. 9L.4.1.1

4 Evaluate evidence for the role of group behavior on an individual's and species' chances to survive and reproduce. (P: 7, CC: 2, CI: LS2) Emphasis of the practice is on identifying evidence supporting the outcomes of group behavior, and developing logical and reasonable arguments based on evidence. Emphasis of the core idea is on distinguishing between group and individual behavior. Examples of group behavior may include herding, migratory behaviors, or various symbioses . 9L.4.1.1.1

4 Make and defend a claim based on evidence that heritable genetic variations may result from (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors. (P: 7, CC: 2, CI: LS3) Emphasis is on using data to support arguments for the ways variation occurs. 9L.4.1.1.2

4 Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species (P: 7, CC: 2, CI: LS4) Emphasis is on determining cause and effect relationships for (1) how changes to the environment such as deforestation, fishing, application of fertilizers, drought, flood, and (2) the rate of change of the environment affect distribution or disappearance of traits in species 9L.4.1.1.3

- **Obtaining, evaluating and communicating information** 9L.4.2
  - Students will be able to read and interpret multiple sources to obtain information, evaluate the merit and validity of claims and design solutions, and communicate information, ideas, and evidence in a variety of formats. 9L.4.2.1
    - Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. (P: 8, CC: 1, CI: LS4) Emphasis is on conceptual understanding of the role each line of evidence has relating to common ancestry and biological evolution. Examples of evidence may include similarities in DNA sequences, the fossil record, artificial selection, anatomical structures, and the order of appearance of structures in embryological development. 9L.4.2.1.1
  - Students will be able to gather information about and communicate the methods that are used by various cultures, especially those of Minnesota American Indian Tribes and communities, to develop explanations of phenomena and design solutions to problems. 9L.4.2.2
    - Obtain and communicate information about how Minnesota American Indian Tribes and communities and other cultures construct solutions to mitigate threats to biodiversity.* (P: 8, CC: 7, CI: LS2, ETS1) Examples of cultures may include those within the local context of the learning community and within the context of Minnesota . Examples of threats to biodiversity may include climate change, deforestation, urbanization, dam construction or removal, invasive species, human population growth, threatening/endangering species, agricultural practices , extraction, and the use of fossil fuels. 9L.4.2.2.1