7th Grade Science

UNIT 1 MOLECULES TO ORGANISMS:

The Building Blocks of Life

ESSENTIAL QUESTION	BIG IDEAS
How do cells contribute to the function of living organisms?	• Students can gather information to explain the relationship between the structure and function of cells. • Students can communicate an understanding of cell theory. • Students have a basic understanding that life functions are regulated by cells. • Students have a basic understanding that cells support body systems, which work together to support the life functions of the organism. • Students have a basic understanding of photosynthesis and the cycling of matter and energy at the cellular level. • Students will use the concepts of cause and effect, structure and function, and matter and energy to understand the processes of living organisms.

GUIDING QUESTIONS

- Content:
  - How can we distinguish between living and nonliving things?
  - How can we distinguish between unicellular and multicellular organisms?
  - What is cell theory? (*Misconception Alert*: the meaning of "scientific theory" is often confused with the common meaning of the word "theory", emphasize the difference in meanings)
  - What is the function of a cell as a whole, including the contributions of the most important structures (emphasis on nucleus, chloroplasts, mitochondria, cell membrane, and cell wall)?
  - What is the role of photosynthesis and cellular respiration in the cycling of matter and flow of energy into and out of organisms?
  - How does the structure (e.g. size, shape, parts, etc.) of specialized cells (e.g. nerve, muscle, bone, red blood cell, white blood cell, etc.) affect their function?

- Process
  - Can you plan and conduct an investigation to prove that living things are made of cells?
  - Can you develop a model to help you describe the function of a cell as a whole and the ways the parts of cells help it to function? (emphasis on nucleus, chloroplasts, mitochondria, cell membrane, and cell wall)
  - Can you develop a model to help you describe the movement of matter (food) and flow of energy through an organism, including chemical reactions (e.g. photosynthesis and respiration) that form new molecules that support growth and/or release energy?
  - Can you argue a claim using evidence and reasoning that the body is a system of interacting subsystems composed of groups of cells (emphasis on interactions among circulatory, excretory, digestive, respiratory, muscular, and nervous systems)?

- Can you gather and synthesize information to show that animals have sensory receptors that help them respond to stimuli by sending messages to the brain for immediate behavior or storage as memories?

- Reflective
  - What makes water both essential to life and also very deadly? (e.g. pond water, ocean water, etc.)
  - What do you have in common with pond scum?
  - When (if) aliens are discovered, will they be made of cells? Explain.
  - Can antibiotics help you get over colds or influenza more quickly? Are viruses really alive?
  - What would happen if all living things, even animals, could photosynthesize? What would happen if none could, like if/when the sun no longer shined?
  - Can you trace everything you ate today back to the sun's energy?
  - Why are breathing and holding your breath both voluntary and involuntary actions? How about opening and closing your eyes?

FOCUS STANDARDS

Mastered and Assessed in this Unit:

- MS-LS1-1. Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.
- MS-LS1-2. Develop and use a model to describe the function of a cell as a whole and ways the parts of cells contribute to the function.
- MS-LS1-6. Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.
- MS-LS1-7. Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.
- MS-LS1-3. Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.
- MS-LS1-8. Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.

  Performance Expectations (PEs) above integrate the following 3-Dimensions of NGSS:
  - LS1.A: Structure and Function (MS-LS1-1)
  - PS3.D: Energy in Chemical Processes and Everyday Life (secondary to MS-LS1-6 & MS-LS1-7)
  - LS1.A: Structure and Function (MS-LS1-1), (MS-LS1-2), (MS-LS1-3)
  - LS1.C: Organization for Matter and Energy Flow in Organisms (MS-LS1-6), (MS-LS1-7)
  - LS1.D: Information Processing (MS-LS1-8)
  - SEP: Developing and Using Models-Develop a model to describe phenomena. (MS-LS1-2) Develop a model to describe unobservable mechanisms. (MS-LS1-7)
  - SEP: Planning and Carrying Out Investigations- Conduct an investigation to produce data to serve as the basis for evidence that meet the goals of an investigation. (MS-LS1-1)
  - SEP: Constructing Explanations and Designing Solutions- Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-LS1-6)
  - SEP: Engaging in Argument from Evidence- Use an oral and written argument supported by evidence to support or refute an explanation or a model for a phenomenon. (MS-LS1-3)

- SEP: Obtaining, Evaluating, and Communicating Information- Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. (MS-LS1-8)
- Connections to Nature of Science- Science knowledge is based upon logical connections between evidence and explanations. (MS-LS1-6)
- CCC: Cause and Effect- Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS1-8) Phenomena that can be observed at one scale may not be observable at another scale. (MS-LS1-1)
- CCC: Systems and System Models- Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. (MS-LS1-3)
- CCC: Energy and Matter- Matter is conserved because atoms are conserved in physical and chemical processes. (MS-LS1-7) Within a natural system, the transfer of energy drives the motion and/or cycling of matter. (MS-LS1-6)
- CCC: Structure and Function- Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function. (MS-LS1-2)
- Connections to Engineering, Technology, and Applications of Science- Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems. (MS-LS1-1)
- Connections to Nature of Science- Science Is a Human Endeavor: Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas. (MS-LS1-3)

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UNIT 2 Heredity:

Inheritance & Variation of Traits

ESSENTIAL QUESTION	BIG IDEAS
How do living organisms pass traits from one generation to the next?	• Students can use models to describe ways gene mutations and sexual reproduction contribute to genetic variation of traits. • Students will use the concepts of cause and effect and structure and function to understand how traits are controlled by genes, which determine the functioning of organisms. • Students can construct an explanation for how environmental and genetic factors affect growth of organisms. • Students can connect the role of animal behaviors with the reproduction of animals as well as the dependence of some plants on animal behaviors for their reproduction.

GUIDING QUESTIONS

- Content
    - How are traits passed down to offspring? What evidence can we use to prove that traits are passed to offspring?
    - What is the role of DNA in organisms?
    - Can you explain how mutations affect individual species?
    - Can you explain how both sexual and asexual reproduction impact genetic variation in individual offspring? Can you compare/contrast their impact on variation in entire populations?
    - Can you describe how plant and animal actions and/or behaviors ensure successful reproduction?
    - Can you construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms?

- Process
    - Can you develop a model (e.g. Punnett squares, diagrams, simulations) to help you describe the genetic results of both sexual and asexual reproduction?
    - Can you develop a model to help you describe the relationship between mutations and the effects on the organism, including: genes, protein structure/function, and traits of organisms.
    - Can you develop a model to help you describe how mutations may result in observable effects in the organism, including why structural changes to genes may affect protein structure and function?
    - Can you argue a claim using evidence and reasoning that certain characteristic animal behaviors and specialized plant structures affect reproductive success of animals and plants respectively?

- Reflective
    - If we compared you and your biological ancestors with an E.coli cell (a bacteria cell) and its ancestors, how would they (lineages) be similar/different in terms of genes and traits?
    - Scientists estimate that each of us have about 5-10 potentially deadly mutations in our genes, but it's very rare for any of us to actually have signs or symptoms of those diseases. How can both of these be true?
    - How is it possible that lactose intolerance is a recessive trait, but also common in our population that consumes so much dairy (65% of the human population has a reduced ability to digest lactose after infancy)?
    - Would a mutation make you a superhero?
    - How do we alter DNA? How will genetic engineering change human life?
    - Why do some species of fish (cichlids) hold their offspring in their mouth as they grow and develop? Where else do you see animal behaviors with this kind of purpose?
    - How are flowers with ultraviolet (UV) patterns on their petals like the top surface of an aircraft carrier? What's the purpose of these patterns which are not visible to our eyes?
    - Can you explain tree rings and why some wood is harder than others, even with the same kind of tree?
    - How do antibiotic medications help us, but also cause more problems in people and populations?
    - How does the use of hand sanitizer and antibiotic soap help individuals stay healthy, but also helps develop populations of antibiotic resistant bacteria?
    - Why is red-green color blindness (among others like hemophilia, congenital night blindness, Fragile X syndrome, etc.) more of a problem for individuals who have XY chromosomes than for those that have XX?

FOCUS STANDARDS

- MS-LS3-2. Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.
- MS-LS3-1. Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.
- MS-LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.
- MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

Performance Expectations (PEs) above integrate the following:

- LS1.B: Growth and Development of Organisms (MS-LS1-4), (MS-LS1-5), (secondary to MS-LS3-2)
- LS3.A: Inheritance of Traits (MS-LS3-1), (MS-LS3-2)
- LS3.B: Variation of Traits (MS-LS3-2), (MS-LS3-1)
- SEP: Developing and Using Models- Develop and use a model to describe phenomena. (MS-LS3-1), (MS-LS3-2)
- SEP: Constructing Explanations and Designing Solutions- Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own

experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-LS1-5)

- SEP: Engaging in Argument from Evidence- Use an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-LS1-4)
- CCC: Cause and Effect- Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS3-2) Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-LS1-4), (MS-LS1-5)
- CCC: Structure and Function- Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function. (MS-LS3-1)

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UNIT 3 Biodiversity and Changes Over Time:

Unity & Diversity

ESSENTIAL QUESTION	BIG IDEAS
How do organisms change over time in response to changes in the environment?	• Students understand that individual traits best suited to an environment are most likely to be passed on. • Students explain how genetic variation in a population affects the survival and reproduction of species, leading to changes over time. • Students can use fossil records and anatomical similarities to show relationships among organisms and species. • Students will use the concepts of patterns and structure and function to describe how species change over time.

GUIDING QUESTIONS

- Content
  - What causes the predominance of certain traits in a population?
  - How does artificial selection work to change a species?
  - How does a trait, like antibiotic resistance in certain bacteria, become more common in a population?
  - What can we learn about diversity, extinction, and the change of many life forms by placing a collection of fossils in chronological order?
  - What anatomical similarities (structures) do you have with other organisms living today? How do the functions of these similar structures compare?

- Process
  - Can you construct an explanation based on evidence that genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment?
  - Can you gather and synthesize information about technologies that have changed the way humans influence the inheritance of desired traits in organisms?
  - Can you use mathematical representations to explain how natural selection may lead to increases and decreases of specific traits in populations over time?
  - Can you analyze and interpret data for patterns in the fossil record that show the existence, diversity, extinction, and change of life forms throughout the history of life on Earth?
  - Can you construct an explanation for 1.) the anatomical similarities and differences among modern organisms and 2.) between modern and fossil organisms to infer evolutionary relationships?
  - Can you analyze pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not obvious in the adult animals?

- Reflective
    - Lions are big. Tigers are bigger. Why are lion/tiger hybrids (ligers bred by humans) the biggest?
    - How did the wolf (*Canis lupus*) become the domestic dog (*Canis familiaris*)? How can any species turn into another over many generations?
    - Is modern medicine causing a buildup of “bad” genes in the human population?
    - How much of what we eat is truly natural and not genetically altered from human activity? Does it matter? What are the impacts on human populations?
    - How is an orca more like you than like a great white shark?
    - How does your hand, a bat’s wing, a cat’s paw, and a whale’s fin compare, structurally and functionally?

FOCUS STANDARDS

- MS-LS4-4. Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals’ probability of surviving and reproducing in a specific environment.
- MS-LS4-5. Gather and synthesize information about technologies that have changed the way humans influence the inheritance of desired traits in organisms.
- MS-LS4-6. Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.
- MS-LS4-1. Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.
- MS-LS4-2. Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.
- MS-LS4-3. Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.

    PEs above integrate the following:
    - LS4.A: Evidence of Common Ancestry and Diversity (MS-LS4-1), (MS-LS4-2), (MS-LS4-3)
    - LS4.B: Natural Selection (MS-LS4-4), (MS-LS4-5)
    - LS4.C: Adaptation (MS-LS4-6)
    - SEP: Analyzing and Interpreting Data- Analyze displays of data to identify linear and nonlinear relationships. (MS-LS4-3) Analyze and interpret data to determine similarities and differences in findings. (MS-LS4-1)
    - SEP: Using Mathematics and Computational Thinking- Use mathematical representations to support scientific conclusions and design solutions. (MS-LS4-6)
    - SEP: Constructing Explanations and Designing Solutions- Construct an explanation that includes qualitative or quantitative relationships between variables that describe phenomena. (MS-LS4-4) Apply scientific ideas to construct an explanation for real-world phenomena, examples, or events. (MS-LS4-2)
    - SEP: Obtaining, Evaluating, and Communicating Information- Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and

possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. (MS-LS4-5)

- Connections to Nature of Science - Science Knowledge Is Based on Empirical Evidence - Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-LS4-1)
- CCC: Patterns- Graphs, charts, and images can be used to identify patterns in data. (MS-LS4-1), (MS-LS4-3) Patterns can be used to identify cause-and-effect relationships. (MS-LS4-2)
- CCC: Cause and Effect- Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-LS4-4), (MS-LS4-5), (MS-LS4-6)
- Connections to Engineering, Technology, and Applications of Science - Interdependence of Science, Engineering, and Technology- Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems. (MS-LS4-5)
- Connections to Nature of Science - Scientific Knowledge Assumes an Order and Consistency in Natural Systems- Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-LS4-1), (MS-LS4-2) Science Addresses Questions About the Natural and Material World
- Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-LS4-5)

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UNIT 4 ECOSYSTEMS AND RELATIONSHIPS:

Energy, Interactions, & Dynamics

ESSENTIAL QUESTION	BIG IDEAS
How does a system of living and non-living things operate to meet the needs of the organisms in an ecosystem?	• Students understand biotic and abiotic factors in an ecosystem and the effects they have on populations. • Students will discover and evaluate patterns of interactions among organisms in an ecosystem. • Students demonstrate an understanding of resources and the cycling of matter and the flow of energy in ecosystems through data analysis, modeling, and argumentation. • Students evaluate competing design solutions for maintaining ecosystem health and biodiversity.

GUIDING QUESTIONS

- Content
  - How does resource availability affect populations of organisms?
  - How does resource availability affect individual organisms?
  - Can you recognize patterns in data to make inferences about the relationship between changes in populations and changes to ecosystems?
  - How does a system of living and non-living things operate to meet the needs of the organisms in an ecosystem?

- Process
  - Can you organize, analyze, and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem?
  - Can you predict consistent patterns of interactions across different ecosystems in terms of the relationships among and between organisms and abiotic factors (e.g. competitive, predatory, and mutually beneficial)?
  - Can you develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem (including defining boundaries of the system, and the conservation of matter and flow of energy into and out of various ecosystems)?
  - Can you evaluate competing design solutions for maintaining biodiversity and ecosystem services (e.g. water purification, nutrient recycling, prevention of soil erosion, etc.)?

- Reflective
  - What would planet earth be like without humans?
  - Can human population growth continue like it has forever? How will we know when we have too many?
  - How can we protect biodiversity in a capitalistic world?
  - If extinction is a natural part of life on earth, why should we care about protecting endangered

species?
- What would happen if we cured all human illness and disease?
- What were conservationists most concerned with a hundred years ago? How will that be different a hundred years from now?
- Are renewable sources of energy, like wind and solar, truly superior to fossil fuels?

FOCUS STANDARDS

- MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
- MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.
- MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
- MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
- MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

PEs above integrate the following:
LS2.A: Interdependent Relationships in Ecosystems (MS-LS2-1), (MS-LS2-2)
LS2.B: Cycles of Matter and Energy Transfer in Ecosystems (MS-LS2-3)
LS2.C: Ecosystem Dynamics, Functioning, and Resilience (MS-LS2-4), (MS-LS2-5)
LS4.D: Biodiversity and Humans (secondary to MS-LS2-5)
ETS1.B: Developing Possible Solutions (secondary to MS-LS2-5)
SEP: Developing and Using Models- Develop a model to describe phenomena. (MS-LS2-3)
SEP: Analyzing and Interpreting Data- Analyze and interpret data to provide evidence for phenomena. (MS-LS2-1)
SEP: Constructing Explanations and Designing Solutions- Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. (MS-LS2-2)
SEP: Engaging in Argument from Evidence- Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-LS2-4) Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-LS2-5)
Connections to Nature of Science- Science Knowledge Is Based on Empirical Evidence Science disciplines share common rules of obtaining and evaluating empirical evidence. (MS-LS2-4)
CCC: Patterns- Patterns can be used to identify cause-and-effect relationships. (MS-LS2-2)
CCC: Cause and Effect- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-LS2-1)
CCC: Energy and Matter- The transfer of energy can be tracked as energy flows through a natural system. (MS-LS2-3)
CCC: Stability and Change- Small changes in one part of a system might cause large changes in another part. (MS-LS2-4), (MS-LS2-5)
Connections to Engineering, Technology, and Applications of Science- The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as

climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-LS2-5)
Connections to Nature of Science- Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-LS2-5)