Biology

UNIT 1 From Molecules to Organisms: Structures and Processes

Big Ideas:

- Cellular Basis of Life
- Information and Heredity
- Matter and Energy
- Growth, development and reproduction
- Homeostasis

Essential Questions:

What are the goals of science?
What procedures are at the core of scientific methodology?
What scientific attitudes help generate new ideas?
Why is peer review important?
What is a scientific theory?
What is the relationship between science and society?
What characteristics do all living things share?
What are the essential themes of biology?
How do different fields in biology differ in their approach to studying biology?
How did the metric system important in science?
What three subatomic particles make up an atom?
How are isotopes of an element similar?
In what ways do compounds differ from component elements?
What are the three main types of chemical bonds?
How does the structure of water contribute to its unique properties?
How does water's polarity influence its properties as a solvent?
Why is it important for cells to buffer solutions against rapid changes in pH?
What elements does Carbon bond with to make up life's molecules?
What are the functions of each of the four groups of macromolecules?
What happens to chemical bonds during chemical reactions?
How do energy changes affect whether a chemical reaction will occur?
What role do enzymes play in living things and what affects their function?
What is the cell theory?

How do microscopes work?
How are prokaryotic and eukaryotic cells different?
What is the role of the cell nucleus, vacuoles, lysosomes and cytoskeletons
What organelles help make up transport proteins?
What are the functions of the chloroplasts and mitochondria?
What is the function of the cell membrane?
What is passive transport?
What is active transport?
How do individual cells maintain homeostasis?
How do cells of multicellular organisms work together to maintain homeostasis?
Why is ATP useful to cells?
What happens during the process of photosynthesis?
What roles do pigments play in the process of photosynthesis?
What are electron carrier molecules?
What are the reactants and products of photosynthesis?
Where do organisms get energy?
What is cellular respiration?
What is the relationship between photosynthesis and cellular respiration?
What happens during the process of glycolysis?
What happens during the Krebs cycle?
How does electron transport chain use high-energy electrons from glycolysis and the Krebs cycle?
How much ATP does cellular respiration generate?
How do organisms generate energy when oxygen is not available?
How does the body produce ATP during different stages of exercise?
What are some of the difficulties as cell faces as it increases in size?
How do sexual and asexual reproduction compare?

Vocabulary: Science, observation, inference, hypothesis, controlled experiment, independent variable, dependent variable, control group, data, theory, bias, biology, DNA, stimulus, sexual production, asexual production, homeostasis, metabolism, biosphere,
LS1-6 Atom, nucleus, electron, element, isotope, compound, ionic bond, ion, covalent bond, molecule, van der Waals forces, hydrogen bond, cohesion, adhesion, mixture, solution, solute, solvent, suspension, pH scale, acid, base, buffer, monomer, polymer, carbohydrate, monosaccharide, lipid, nucleic acid, nucleotide, protein, amino acid, chemical reaction, reactant, product, activation energy, catalyst, enzyme, substrate, *Cell, cell theory, cell membrane, nucleus, eukaryotes, prokaryote, cytoplasm, organelle, vacuole, lysosomes, cytoskeleton, centriole, ribosome, endoplasmic reticulum, Golgi apparatus, chloroplast, mitochondria, cell wall, lipid bilayer, selectively permeable, diffusion, facilitated diffusion, aquaporin, osmosis, isotonic, hypertonic, hypotonic, osmotic pressure,*

tissue, organ, organ system, receptor,
LS1-5 Adenosine triphosphate (ATP), heterotroph, autotroph, photosynthesis, pigment, chlorophyll, thylakoid, stroma, NADP+, light-dependent reactions, light-independent reactions, photosystem,
LS1-7 Calorie, cellular respiration, aerobic, anaerobic, glycolysis, NAD+, Krebs cycle, matrix, fermentation,

LS1-4 - Cell division, chromosome, chromatin, cell cycle, interphase, mitosis, cytokinesis, prophase, centromere, chromatid, centriole, metaphase, anaphase, telophase, cyclin, growth factor, apoptosis, cancer, tumor, embryo, differentiation, totipotent, blastocyst, pluripotent, stem cell, multipotent,

LS1-2, LS1-3 (stomata lab), LS1-5
Epidermis, lignin, vessel element, sieve tube element, companion cell, parenchyma, collenchyma, sclerenchyma, meristem, apical meristem, root hair, cortex, endodermis, vascular cylinder, root cap, Casparian strip, node, bud, vascular bundle, pith, primary growth, secondary growth, vascular cambium, cork cambium, heartwood, sapwood, bark, blade, petiole, mesophyll, palisade mesophyll, spongy mesophyll, stoma, transpiration, guard cell, adhesion, capillary action, pressure-flow hypothesis

Students who demonstrate understanding can:

HS-LS1-2. **Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.**[Clarification Statement: Emphasis is on functions at the organism system level such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system.] [*Assessment Boundary: Assessment does not include interactions and functions at the molecular or chemical reaction level.*]

HS-LS1-3. **Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.**[Clarification Statement: Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, and root development in response to water levels.] [*Assessment Boundary: Assessment does not include the cellular processes involved in the feedback mechanism.*]

HS-LS1-4. **Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.** [*Assessment Boundary: Assessment does not include specific gene control mechanisms or rote memorization of the steps of mitosis.*]

HS-LS1-5. **Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.**[Clarification Statement: 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 could include diagrams, chemical equations, and conceptual models.] [*Assessment Boundary: Assessment does not include specific biochemical steps.*]

HS-LS1-6. **Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.**[Clarification Statement: Emphasis is on using evidence from models and simulations to support explanations.] [*Assessment Boundary: Assessment does not include the details of the specific chemical reactions or identification of macromolecules.*]

HS-LS1-7. **Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.**[Clarification Statement: Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration.] [*Assessment Boundary: Assessment should not include identification of the steps or specific processes involved in cellular respiration.*]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Developing and Using Models

Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

- Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-2)
- Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-4),(HS-LS1-5),(HS-LS1-7)

Planning and Carrying Out Investigations

Planning and carrying out in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-LS1-3)

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

- Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) 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. (HS-LS1-6)

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Connections to Nature of Science

Scientific Investigations Use a Variety of Methods

- Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. (HS-LS1-3)

Disciplinary Core Ideas

LS1.A: Structure and Function

- *(Note: This Disciplinary Core Idea is also addressed by HS-LS3-1.)*
- Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2)
- Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3)

LS1.B: Growth and Development of Organisms

- In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. (HS-LS1-4)

LS1.C: Organization for Matter and Energy Flow in Organisms

- The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HS-LS1-5)
- The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. (HS-LS1-6)
- As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HS-LS1-6),(HS-LS1-7)
- As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the

Crosscutting Concepts

Systems and System Models

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-2),(HS-LS1-4)

Energy and Matter

- Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-LS1-5), (HS-LS1-6)
- Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS1-7)

Structure and Function

- Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-LS1-1)

Stability and Change

- Feedback (negative or positive) can stabilize or destabilize a system. (HS-LS1-3)

	surrounding environment. (HS-LS1-7)	

Connections to other DCIs in this grade-band:
HS.PS1.B (HS-LS1-5),(HS-LS1-6),(HS-LS1-7); **HS.PS2.B** (HS-LS1-7);**HS.PS3.B** (HS-LS1-5),(HS-LS1-7)

Articulation of DCIs across grade-bands:
MS.PS1.A (HS-LS1-6); **MS.PS1.B** (HS-LS1-5),(HS-LS1-6),(HS-LS1-7); **MS.PS3.D** (HS-LS1-5),(HS-LS1-6),(HS-LS1-7); **MS.LS1.A** (HS-LS1-2),(HS-LS1-3),(HS-LS1-4); **MS.LS1.B** (HS-LS1-4); **MS.LS1.C** (HS-LS1-5),(HS-LS1-6),(HS-LS1-7); **MS.LS2.B** (HS-LS1-5),(HS-LS1-7); **MS.ESS2.E** (HS-LS1-6); **MS.LS3.A** HS-LS1-4); **MS.LS3.B** (HS-LS1-1)

Common Core State Standards Connections:

ELA/Literacy -

RST.11-12.1	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS1-6)
WHST.9-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS1-6)
WHST.9-12.5	Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-LS1-6)
WHST.9-12.7	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-LS1-3)
WHST.11-12.8	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. *(HS-LS1-3)*
WHST.9-12.9	Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS1-6)
SL.11-12.5	Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. *(HS-LS1-2),(HS-LS1-4),(HS-LS1-5),(HS-LS1-7)*

Mathematics -

MP.4	Model with mathematics. *(HS-LS1-4)*
HSF-IF.C.7	Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. *(HS-LS1-4)*
HSF-BF.A.1	Write a function that describes a relationship between two quantities. *(HS-LS1-4)*