HS. Matter and Energy in Organisms and Ecosystems

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A Performance Expectations HS.LS1.ME

1. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. HS.LS1.5
2. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements such as nitrogen, sulfur, and phosphorus to form amino acids and other carbon-based molecules. HS.LS1.6
3. Use a model to illustrate that aerobic 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. HS.LS1.7
4. Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in ecosystems. HS.LS2.3
5. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. HS.LS2.4
6. Develop a model to illustrate the role of various processes in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere. HS.LS2.5

B Science and Engineering Practices HS.ME.SEP

1. Developing and Using Models HS.ME.SEP.1
   - a. Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-5),(HS-LS1-7) HS.ME.SEP.1A
   - b. Develop a model based on evidence to illustrate the relationships between systems or components of a system. (HS-LS2-5) HS.ME.SEP.1B
2. Using Mathematics and Computational Thinking HS.ME.SEP.2
   - a. Use mathematical representations of phenomena or design solutions to support claims. (HS-LS2-4) HS.ME.SEP.2A
3. Constructing Explanations and Designing Solutions HS.ME.SEP.3
   - a. 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),(HS-LS2-3) HS.ME.SEP.3A
4. Scientific Knowledge is Open to Revision in Light of New Evidence HS.ME.SEP.4
   - a. Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-3) HS.ME.SEP.4A

C Disciplinary Core Ideas HS.ME.DCI

1. LS1.C: Organization for Matter and Energy Flow in Organisms HS.ME.DCI.LS1.C
   - a. The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HSLS1-5) HS.ME.DCI.LS1.C.1
   - b. As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. (HS-LS1-6),(HS-LS1-7) HS.ME.DCI.LS1.C.2
   - c. (NYSED) Sugar molecules contain carbon, hydrogen, and oxygen. Their hydrocarbon backbones combine with other elements to make amino acids and other carbon-based molecules that can be assembled into larger molecules, such as proteins or DNA. (HS-LS1-6) HS.ME.DCI.LS1.C.3
   - d. (NYSED) Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed. In this process ATP is produced, which is used to carry out life processes. (HS-LS1-7) HS.ME.DCI.LS1.C.4
2. LS2.B: Cycles of Matter and Energy Transfer in Ecosystems HS.ME.DCI.LS2.B
   - a. Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (HS- LS2-3) HS.ME.DCI.LS2.B.1
   - b. Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (HS-LS2-4) HS.ME.DCI.LS2.B.2
   - c. (NYSED) When matter is cycled through organisms and ecosystems, some of the matter reacts to release energy for life functions, some is stored in newly made structures, and some is eliminated as waste. (HS-LS2-4) HS.ME.DCI.LS2.B.3
   - d. (NYSED) Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, hydrosphere, and geosphere through chemical, physical, geological, and biological processes. (HS-LS2-5) HS.ME.DCI.LS2.B.4
3. PS3.D: Energy in Chemical Processes HS.ME.DCI.PS3.D
   - a. The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. (secondary to HS-LS2-5) HS.ME.DCI.PS3.D.1

D Crosscutting Concepts HS.ME.CC

1. Systems and System Models HS.ME.CC.1
   a. 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-LS2-5) HS.ME.CC.1A
2. Energy and Matter HS.ME.CC.2
   a. 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) HS.ME.CC.2A
   b. Energy can be transferred between one place and another place, between objects and/or fields, or between systems. (HS-LS1-7),(HS-LS2-4) HS.ME.CC.2B
   c. Energy drives the cycling of matter within and between systems. (HSLS2-3) HS.ME.CC.2C