NextGen Middle School Science Education Standards for Food Computers

Credit: Jordan Rogoff, ILP for M.Ed, General Science; Cambridge College (2016)

Grade 5: NextGen Science Education Standards - Food Computer

5-PS3-1	Energy	Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun. [Clarification Statement: Examples of models could include diagrams, and flow charts.]	see 4-PS3-4 connect: create a flowchart of how energy moves through the food computer and into you.
5-LS1-1	From Molecules to Organisms: Structures and Processes	Support an argument that plants get the materials they need for growth chiefly from air and water. [Clarification Statement: Emphasis is on the idea that plant matter comes mostly from air and water, not from the soil.]	run a growth cycle with the food computer and one in a pot with soil. compare growth
5-LS2-1	Ecosystems: Interactions, Energy, and Dynamics	Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.[Clarification Statement: Emphasis is on the idea that matter that is not food (air, water, decomposed materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and the Earth.] [Assessment Boundary: Assessment does not include molecular explanations.]	connect use the FC to prove how raw materials like air/water/nutrients can come together to form food in the food computer.
5-ESS3-1	Earth and Human Activity	Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.	How does the Food Computer help protect earth's resources and the environment. Think big picture.

Grade 6-8: NextGen Science Education Standards - Food Computer

MS-PS3-3	Energy	Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.* [Clarification Statement: Examples of devices could include an insulated	Have students examine thermal shell and insulation in the FC. Have them think

		box, a solar cooker, and a Styrofoam cup.] [*Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.*]	about materials with the same properties.
MS-PS4-3	Waves and Their Applications in Technologies for Information Transfer	Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals. [Clarification Statement: Emphasis is on a basic understanding that waves can be used for communication purposes. Examples could include using fiber optic cable to transmit light pulses, radio wave pulses in wifi devices, and conversion of stored binary patterns to make sound or text on a computer screen.] [*Assessment Boundary: Assessment does not include binary counting. Assessment does not include the specific mechanism of any given device.*]	
MS-LS1-1	From Molecules to Organisms: Structures and Processes	Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells. [Clarification Statement: Emphasis is on developing evidence that living things are made of cells, distinguishing between living and non-living things, and understanding that living things may be made of one cell or many and varied cells.]	connect: cut slices of plants grown in the food computer and try to view them under a microscope. What do you notice?
MS-LS1-2	From Molecules to Organisms: Structures and Processes	Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function. [Clarification Statement: Emphasis is on the cell functioning as a whole system and the primary role of identified parts of the cell, specifically the nucleus, chloroplasts, mitochondria, cell membrane, and cell wall.] [*Assessment Boundary: Assessment of organelle structure/function relationships is limited to the cell wall and cell membrane. Assessment of the function of the other organelles is limited to their relationship to the whole cell. Assessment does not include the biochemical function of cells or cell parts.*]	seeMS LS1-1 connect: explain plant cell parts in relation to plants grown in the food computer. nucleus, chloroplast, mitochondria, membrane, cell wall. What do the plant/animal cells look like? What is their function?
MS-LS1-4	From Molecules to Organisms: Structures	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	Grow a round of plants with a lot of variety. Compare and contrast structures

	and Processes	successful reproduction of animals and plants respectively. [Clarification Statement: Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, herding of animals to protect young from predators, and vocalization of animals and colorful plumage to attract mates for breeding. Examples of animal behaviors that affect the probability of plant reproduction could include transferring pollen or seeds, and creating conditions for seed germination and growth. Examples of plant structures could include bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.]	and speculate cases of advantage and disadvantage. -flowers -thorns -strong smell -big leaves -root vegetable -fruit with seeds -something with hard shell or rigid structure
MS-LS1-5	From Molecules to Organisms: Structures and Processes	Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. [Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.] [*Assessment Boundary: Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.*]	run a standard grow cycle and make observations. Run the same grow cycle but severely limit one resource (light or EC are good ones) and see what qualities did or did not change about the food grown.
MS-LS1-6	From Molecules to Organisms: Structures and Processes	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. [Clarification Statement: Emphasis is on tracing movement of matter and flow of energy.] [*Assessment Boundary: Assessment does not include the biochemical mechanisms of photosynthesis.*]	see 4-PS3-4 and 5-PS3-1 what are the inputs and outputs of photosynthesis. what raw materials come together? how does energy flow in the FC?
MS-LS1-7	From Molecules to Organisms: Structures	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. [Clarification Statement: Emphasis is on describing	connect: study cellular and chemical makeup of plants in the food

	and Processes	that molecules are broken apart and put back together and that in this process, energy is released.] [*Assessment Boundary: Assessment does not include details of the chemical reactions for photosynthesis or respiration.*]	computer. where is energy stored? What molecules are reused when eaten and what parts pass through.
MS-LS2-1	Ecosystems: Interactions, Energy, and Dynamics	Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. [Clarification Statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.]	Have students design a food computer experiment with 3 plants of differing heights. Have them try to design a setup in which they all survive and one in which only some survive. What is the limiting resource?
MS-LS2-5	Ecosystems: Interactions, Energy, and Dynamics	Evaluate competing design solutions for maintaining biodiversity and ecosystem services.* [Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.]	connect: see MS-LS2-1 How can indoor farming help to maintain biodiversity? Emphasis on re-wilding.
MS-LS3-1	Heridity: Inheritance and Variation of Traits	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.[Clarification Statement: Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins.] [*Assessment Boundary: Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.*]	connect: what if plants made a pigment that suddenly made them a different color? Made them grow taller? Have bigger leaves?
MS-LS3-2	Heridity: Inheritance and Variation of Traits	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. [Clarification Statement: Emphasis is on using models such as	Mock Mendel experiments? Using punnett squares to compare asexual vs. sexual reproduction.

		Punnett squares, diagrams, and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.]	
MS-LS4-4	Biological Evolution: Unity and Diversity	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. [Clarification Statement: Emphasis is on using simple probability statements and proportional reasoning to construct explanations.]	See 3LS4-2 have students run a grow cycle with varieties of the same plant with different color, size, or smells. have them figure out which would be better at certain survival tasks.
MS-LS4-5	Biological Evolution: Unity and Diversity	Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. [Clarification Statement: Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, gene therapy); and, on the impacts these technologies have on society as well as the technologies leading to these scientific discoveries.]	Have students think about artificial selection in agriculture. What qualities are valued in outdoor agriculture (transportability, ability to endure weather, productivity) vs. what qualities would we value in FC grown food?
MS-ESS3-3	Earth and Human Activity	Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.*[Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).]	See MS-LS4-5 connect: Have students examine a range human environmental impacts and speculate ways in which the FC helps reduce those impacts. Are there any ways that it harms the environment?
MS-ESS3-4	Earth and Human Activity	Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. [Clarification Statement: Examples of	connect: what systems can FC growing help to ease

		evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.]	strain on natural resources? emphasis on land use, transportation, water consumption.
MS-ESS3-5	Earth and Human Activity	**Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.** [Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.]	
MS-ETS1-1	Engineering Design	**Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.**	
MS-ETS1-2	Engineering Design	**Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.**	
MS-ETS1-3	Engineering Design	**Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.**	
MS-ETS1-4	Engineering Design	**Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design**	

		can be achieved.	

Grade 9-12: NextGen Science Education Standards - Food Computer

HS-PS3-3	Energy	Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.* [Clarification Statement: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency.] [*Assessment Boundary: Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.*]	
HS-PS4-2	Waves and their Applications in Technologies for Information Transfer	Evaluate questions about the advantages of using a digital transmission and storage of information. [Clarification Statement: Examples of advantages could include that digital information is stable because it can be stored reliably in computer memory, transferred easily, and copied and shared rapidly. Disadvantages could include issues of easy deletion, security, and theft.]	
HS-LS1-1	From Molecules to Organisms: Structures and Processes	Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells. [*Assessment Boundary: Assessment does not include identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the biochemistry of protein synthesis.*]	
HS-LS1-2	From Molecules to Organisms: Structures and Processes	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	From Molecules to Organisms: Structures and Processes	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	From Molecules to Organisms: Structures and Processes	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	From Molecules to Organisms: Structures and Processes	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-LS1-7	From Molecules to Organisms: Structures and Processes	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.*]	

HS-LS2-4	Ecosystems: Interactions, Energy, and Dynamics	Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. [Clarification Statement: Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem.] [*Assessment Boundary: Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.*]	
HS-LS2-7	Ecosystems: Interactions, Energy, and Dynamics	Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.* [Clarification Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.]	
HS-LS3-1	Heredity: Inheritance and Variation of Traits	Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring. [*Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.*]	
HS-LS3-2	Heredity: Inheritance and Variation of Traits	Make and defend a claim based on evidence that inheritable 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. [Clarification Statement: Emphasis is on using data to support arguments for the way variation occurs.] [Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.]	
HS-LS3-3	Heredity: Inheritance and Variation of Traits	Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population. [Clarification Statement: Emphasis is on the use of mathematics to describe the probability of traits as it relates to genetic and environmental factors in the	

		expression of traits.] [*Assessment Boundary: Assessment does not include Hardy-Weinberg calculations.*]	
HS-LS4-2	Biological Evolution: Unity and Diversity	Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment. [Clarification Statement: Emphasis is on using evidence to explain the influence each of the four factors has on number of organisms, behaviors, morphology, or physiology in terms of ability to compete for limited resources and subsequent survival of individuals and adaptation of species. Examples of evidence could include mathematical models such as simple distribution graphs and proportional reasoning.] [*Assessment Boundary: Assessment does not include other mechanisms of evolution, such as genetic drift, gene flow through migration, and co-evolution.*]	
HS-LS4-4	Biological Evolution: Unity and Diversity	Construct an explanation based on evidence for how natural selection leads to adaptation of populations.[Clarification Statement: Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations.]	
HS-LS4-6	Biological Evolution: Unity and Diversity	Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.*[Clarification Statement: Emphasis is on designing solutions for a proposed problem related to threatened or endangered species, or to genetic variation of organisms for multiple species.]	
HS-ESS2-6	Earth's Systems	Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.	

		[Clarification Statement: Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.]	
HS-ESS3-2	Earth and Human Activity	Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.* [Clarification Statement: Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems—not what should happen.]	
HS-ESS3-3	Earth and Human Activity	Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. [Clarification Statement: Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning.] [*Assessment Boundary: Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.*]	
HS-ESS3-4	Earth and Human Activity	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.* [Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such	

		as altering global temperatures by making large changes to the atmosphere or ocean).]	
HS-ETS1-1	Engineering Design	Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.	
HS-ETS1-2	Engineering Design	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.	
HS-ETS1-3	Engineering Design	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.	
HS-ETS1-4	Engineering Design	Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.	