Lindenwold Public Schools

# *Food Science Unit 4: Micronutrients, Analogs, and Additives*
# *18 instructional days*

**Targeted Standards**

HS-PS1-2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. [Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.] [Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.]

HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. [Clarification Statement: Emphasis is on the idea that a chemical reaction is a system that affects the energy change. Examples of models could include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved.] [Assessment Boundary: Assessment does not include calculating the total bond energy changes during a chemical reaction from the bond energies of reactants and products.]

HS-PS1-5. Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. [Clarification Statement: Emphasis is on student reasoning that focuses on the number and energy of collisions between molecules.] [Assessment Boundary: Assessment is limited to simple reactions in which there are only two reactants; evidence from temperature, concentration, and rate data; and qualitative relationships between rate and temperature.]

HS-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.* [Clarification Statement: Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.] [Assessment Boundary: Assessment is limited to provided molecular structures of specific designed materials.]

HS-PS3-1 Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. [Clarification Statement: Emphasis is on explaining the meaning of mathematical expressions used in the model.] [Assessment Boundary: Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields.]

HS-PS3-3. 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-PS3-4. Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). [Clarification Statement: Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.] [Assessment Boundary: Assessment is limited to investigations based on materials and tools provided to students.]

**<u>Science and Engineering Practices</u>**

**Developing and Using Models**

Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS1-4)

**Constructing Explanations and Designing Solutions**

Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. (HS-PS1-5)

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-PS1-2)

Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS3-3)

**Obtaining, Evaluating, and Communicating Information**
Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6)

**Planning and Carrying Out Investigations**
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-PS3-4)

**Using Mathematics and Computational Thinking**
Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-PS3-1)

**Disciplinary Core Ideas**
**PS1.A: Structure and Properties of Matter**
The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-2)

A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (HS-PS1-4)

**PS1.B: Chemical Reactions**
Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (HS-PS1-4),(HS-PS1-5)

The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-2)

**PS2.B: Types of Interactions**

Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. (HS-PS2-6)

**PS3.A: Definitions of Energy**
Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HS-PS3-1)

At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS-PS3-3)

**PS3.B: Conservation of Energy and Energy Transfer**
Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1)

Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1), (HS-PS3-4)

Mathematical expressions, which quantify how the stored energy in a system depends on its configuration(e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1)

The availability of energy limits what can occur in any system. (HS-PS3-1)

Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PS3-4)

**PS3.D: Energy in Chemical Processes**
Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (HS-PS3-3), (HS-PS3-4)

**Crosscutting Concepts**

**Patterns**

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS1-2),(HS-PS1-5)

**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-PS1-4),(HS-PS3-3)

**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-PS2-6)

**Systems and System Models**

When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-PS3-4)

Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models. (HS-PS3-1)

**Influence of Science, Engineering, and Technology on Society and the Natural World**

Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-PS3-3)

**Scientific Knowledge Assumes an Order and Consistency in Natural Systems**

Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS3-1)

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| **Rationale and Transfer Goals** :<br><br>In this unit, students will learn about micronutrients, including vitamins and minerals, which are vital to basic human health. Further topics will include food additives and food analogs, which are added to foods to substitute for certain macronutrients or to aid in food processing. In this unit, students will exercise their ability to research topics like the safety of food additives, issues with analog replacements in food, and sources of vitamins and minerals. Their findings will be communicated in class and students will have the opportunity to practice listening and speaking skills, along with other literacy activities. Students will take part in real life activities, like designing nutritious, packageable snack foods that would appeal to their peers, analysis of one's own diet using available technology to assess daily values of vitamins and minerals, and prepare graphic organizers to explain processes for making certain foods. All topics will include the overarching theme of a STEM classroom. |
| **Enduring Understandings:**<br>Vitamins and minerals are very important to maintaining good health and are incorporated into the healthy human diet<br><br>Chemical structure of a macronutrient or analog will determine how the body processes it<br><br>Food analogs are nontraditional replacements for traditional food ingredients, which are developed mainly to replace sugars, fats, and salts<br><br>While analogs are designed to replace certain foods, it is important to know how they react in cooking, storage, and digestion as they will not always react similarly to their intended design<br><br>Additives, which are added to foods to increase shelf life and as processing aids, largely do not have nutritional qualities. Additives and analogs are monitored by governing laws and regulations to protect consumers. |
| **Essential Questions**:<br>Why do laws exist that oversee food production and regulations?<br><br>Salt and sugar are chemical and physically very different, yet they both can be used to preserve food. How? |

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| If two loaves of bread, one made with preservatives and the other without, were in separate unmarked packages, how could you tell them apart from one another?<br><br>There are many artificial sweeteners that exist on the market. Which artificial sweetener would be the best choice for making caramel candies and why?<br><br>What are fat -free foods so expensive when all that is done to make them is cut out the fat?<br><br>If a scientist wanted to develop a new fat-free, sugar-free pancake mix, which analogs would be avoided?<br><br>When artificial sweeteners are used, why are bulking additives necessary to be added to the mixture?<br><br>What are the functions of food analogs?<br><br>How can vegetarians obtain enough iron and protein in their diet while still avoiding both red and white meat? |

| **Content/Objectives** | | **Instructional Actions** | |
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| **Content**<br>***What students will know*** | **Skills**<br>***What students will be able to do*** | **Activities/Strategies**<br>***How we teach content and skills*** | **Evidence (Assessments)**<br>***How we know students have learned*** |

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| • Micronutrients act in the body as a working team to perform vital functions in the human body.<br>• The chemical structure of a vitamin will determine if it is fat or water soluble. This will determine how the vitamin can be administered in the human body.<br>• Food preparation and processing can impact the levels of natural micronutrients found in foods.<br>• Food analogs act as substitutes for sugars, fats, and other macronutrients.<br>• While similar, analogs can behave and perform differently than the original naturally derived macronutrient. | • Differentiate between fat-soluble vitamins and water soluble vitamins.<br>• List functions and sources of major minerals and trace minerals.<br>• Explain the impact food processing and preservation methods have on the nutritive value of food.<br>• Identify non-nutritive functions of vitamins and minerals using food additives.<br>• Describe how to reduce vitamin and mineral losses during home food storage and preparation.<br>• List the four main functions of food analogs<br>• Distinguish between nutritive and nonnutritive sweeteners.<br>• compare the performance of fat replacers to the performance of fat.<br>• Describe advantages and disadvantages of potassium chloride as a salt substitute. | • Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.<br>• Provide students with multiple choices for how they can represent their understanding.<br>• Provide opportunities for students to connect with people of similar backgrounds.<br>• Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures.<br>• Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understanding. | • Labs-<br>  ○ Mineral in Milk<br>  ○ Effects of Calcium on Coagulation<br>  ○ Determining Vitamin C Content<br>  ○ Sugar Substitutes<br>  ○ Low-Fat Ice Cream<br>  ○ Fat Replacers in Muffins<br>  ○ Pectin as a Texturizer<br>  ○ Emulsifiers in Processed Cheese<br>  ○ Preservatives in Cured Meat<br>• Unit Test<br>• Quizzes<br>• Food Science Benchmark #2 |

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| | • Differentiate between intentional and incidental food additives<br>• Describe the four main functions of additives<br>• Weigh the advantages and disadvantages of additives in the food supply. | • Use project-based science learning to connect science with observable phenomena.<br>• Structure the learning around exploring or solving a social or community-based issue.<br>• Provide ELL students with multiple literacy strategies.<br>• Collaborate with after-school programs or clubs to extend learning opportunities. | |

**Spiraling for Mastery**
**Where does this unit spiral back to other units from this or previous years in order to ensure that students retain mastery of what they've learned?**

| Content or Skill for this Unit | Spiral Focus from Previous Unit | Instructional Activity |
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| • List the four main functions of food analogs.<br>• Distinguish between nutritive and nonnutritive sweeteners.<br>• Compare the performance of fat replacers to the performance of fat. | • Describe the basic structure of atoms.<br>• Identify the symbols on the periodic table commonly used in food science.<br>• Define ionic and covalent bonding. | • Coded Vitamins and Minerals<br>• Vitamin and Mineral Challenge<br>• Analog Anagrams<br>• Bread on the side substitutions<br>• Food Additives Puzzle<br>• What additives are you drinking? |

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| • Describe advantages and disadvantages of potassium chloride as a salt substitute. | • Explain the difference between pure substances and mixtures.<br>• Compare the nutritional functions of proteins with the functions of carbohydrates and fats. | |

**Key resources:**
"Principles of Food Science 3rd Edition" Janet Ward

"Understanding food-Principles and preparation" Amy Brown

**21st Century Life & Careers:**

9.2.12.CAP.2: Develop college and career readiness skills by participating in opportunities such as structured learning experiences, apprenticeships, and dual enrollment programs.

9.2.12.CAP.3: Investigate how continuing education contributes to one's career and personal growth.

9.2.12.CAP.4: Evaluate different careers and develop various plans (e.g., costs of public, private, training schools) and timetables for achieving them, including educational/training requirements, costs, loans, and debt repayment.

**Career Readiness, Life Literacies, & Key Skills:**

9.4.12.CT.3: Enlist input from a variety of stakeholders (e.g., community members, experts in the field) to design a service learning activity that addresses a local or global issue (e.g., environmental justice).

9.4.12.CT.4: Participate in online strategy and planning sessions for course-based, school-based, or other projects and determine the strategies that contribute to effective outcomes.

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| 9.4.12.GCA.1: Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others.<br><br>9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources.<br><br>9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.<br><br>9.4.12.IML.4: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience.<br><br>9.4.12.IML.5: Evaluate, synthesize, and apply information on climate change from various sources appropriately.<br><br>9.4.12.IML.6: Use various types of media to produce and store information on climate change for different purposes and audiences with sensitivity to cultural, gender, and age diversity. |
| **Interdisciplinary Connections**<br>**NJSLS ELA**<br>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-PS1-5), (HS-PS2-6), (HS-PS3-4)<br><br>WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS1-2), (HS-PS1-5), (HS-PS2-6)<br><br>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-PS1-2)<br><br>WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a selfgenerated 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-PS3-3), (HS-PS3-4) |

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-PS3-4)

WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS3-4)

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-PS1-4), (HS-PS3-1)

**NJSLS Mathematics**
MP.2 Reason abstractly and quantitatively. (HS-PS1-5), (HS-PS3-1), (HS-PS3-3), (HS-PS3-4)

MP.4 Model with mathematics. (HS-PS1-4), (HS-PS3-1), (HS-PS3-3), (HS-PS3-4)

HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-2), (HS-PS1-4), (HS-PS1-5), (HS-PS2-6), (HS-PS3-1), (HS-PS3-3)

HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS1-4), (HS-PS3-1), (HS-PS3-3)

HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-2), (HS-PS1-4), (HS-PS1-5), (HS-PS3-1), (HS-PS3-3)

**<u>Companion Standards for ELA in Science and Technical Subjects: Reading</u>**
**Key Ideas and Details**
RST.11-12.1. Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.

**<u>Companion Standards for ELA in Science and Technical Subjects: Writing</u>**
**Text Types and Purposes**
WHST.11-12.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

**Production and Distribution of Writing**
WHST.11-12.5. 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.

**Research to Build and Present Knowledge**
WHST.11-12.7. 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 an understanding of the subject under investigation

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.

WHST.11-12.9. Draw evidence from informational texts to support analysis, reflection, and research.