Unit 4: Micronutrients, Analogs, and Additives

Content Area: **Science**
Course(s):
Time Period: **MP2**
Length: **18 days**
Status: **Published**

NJSLS - Science

9-12.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.
9-12.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.
9-12.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.
9-12.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).
9-12.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.
9-12.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.
9-12.HS-PS2-6	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

Science and Engineering Practices

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, and 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 Invesgaons

Plan and conduct an invasion 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, me), 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

Aracon 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 quantitive property of a system that depends on the moon and interactions of matter and radiation within that system. That there is a single quantity called energy is because 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, and 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 the connections of components to reveal their 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)

Rationale and Transfer Goals

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 diet using available technology to assess daily values of vitamins and minerals, and preparing graphic organizers to explain processes for making certain foods. All topics will include the overarching theme of a STEM classroom.

Enduring Understandings

- Vitamins and minerals are very important to maintaining good health and are incorporated into the healthy human diet
- The chemical structure of a macronutrient or analog will determine how the body processes it
- Food analogs are nontraditional replacements for traditional food ingredients, which are developed mainly to replace sugars, fats, and salts
- 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
- 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

- Why do laws exist that oversee food production and regulations?
- Salt and sugar are chemically and physically very different, yet they both can be used to preserve food. How?
- 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?
- many artificial sweeteners exist on the market. Which artificial sweetener would be the best choice for making caramel candies and why?
- Why are fat-free foods so expensive when all that is done to make them is cut out the fat?

- If a scientist wanted to develop a new fat-free, sugar-free pancake mix, which analogs would be avoided?
- When artificial sweeteners are used, why are bulking additives necessary to be added to the mixture?
- What are the functions of food analogs?
- How can vegetarians obtain enough iron and protein in their diet while still avoiding both red and white meat?

Content - What will students know?

- Micronutrients act in the body as a working team to perform vital functions in the human body.
- 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.
- Food preparation and processing can impact the levels of natural micronutrients found in foods.
- Food analogs act as substitutes for sugars, fats, and other macronutrients.
- While similar, analogs can behave and perform differently than the original naturally derived macronutrient.

Skills - What will students be able to do?

- Differentiate between fat-soluble vitamins and water-soluble vitamins.
- List functions and sources of major minerals and trace minerals.
- Explain the impact food processing and preservation methods have on the nutritive value of food.
- Identify non-nutritive functions of vitamins and minerals using food additives.
- Describe how to reduce vitamin and mineral losses during home food storage and preparation.
- List the four main functions of food analogs.
- Distinguish between nutritive and nonnutritive sweeteners.
- compare the performance of fat replacers to the performance of fat.
- Describe the advantages and disadvantages of potassium chloride as a salt substitute.
- Differentiate between intentional and incidental food additives
- Weigh the advantages and disadvantages of additives in the food supply

Activities - How will we teach the content and skills?

- Structure lessons around questions that are authentic, and relate to students ’ interests, social/ family background, and knowledge of their community.

- Provide students with multiple choices for how they can represent their understanding.
- Provide opportunities for students to connect with people of similar backgrounds.
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures.
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understanding.

Evidence/Assessments - How will we know what students have learned?

- Labs
  - Mineral in Milk
  - Effects of Calcium on Coagulation
  - Determining Vitamin C Content
  - Sugar Substitutes
  - Low-Fat Ice cream
  - Fat replacers in Muffins
  - Pectin as a texturizer
  - Emulsifiers in Processed Cheese
  - Preservatives in Cured Meat
- UNIT Test
- Quizzes
- Food Science Benchmark #2

Spiraling for Mastery

Content or Skill for this Unit	Spiral Focus from Previous Unit	Instructional Activity
• List the four main functions of food analogs • Distinguish between nutritive and nonnutritive sweeteners • Compare the performance of fat replacers to the performance of fat • Describe the advantages and disadvantages of potassium chloride as a salt substitute	• Describe the basic structure of atoms • Identify the symbols on the periodic table commonly used in food science • Define ionic and covalent bonding • Explain the difference between pure substances and mixtures • Compare the nutritional functions of proteins with the functions of carbohydrates and fats	• Coded vitamins and minerals • Vitamin and Mineral Challenge • Analog Anagrams • Bread on the side substitutions • Food additives puzzle • What additives are you drinking?

Key Resources

"Principles of Food Science 3rd Edition" Janet Ward

"Understanding Food- Principles and Preparation" Amy Brown

Career Readiness, Life Literacies, & Key Skills

TECH.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).
TECH.9.4.12.CT.4	Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
TECH.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 (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1, 7.1.IH.IPERS.6, 7.1.IL.IPERS.7, 8.2.12.ETW.3).
TECH.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 (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources.
TECH.9.4.12.IML.3	Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8).
TECH.9.4.12.IML.4	Assess and critique the appropriateness and impact of existing data visualizations for an intended audience (e.g., S-ID.B.6b, HS-LS2-4).
TECH.9.4.12.IML.5	Evaluate, synthesize, and apply information on climate change from various sources appropriately (e.g., 2.1.12.CHSS.6, S.IC.B.4, S.IC.B.6, 8.1.12.DA.1, 6.1.12.GeoHE.14.a, 7.1.AL.PRSNT.2).
TECH.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 (e.g., NJSLSA.SL5).
TECH.9.4.12.IML.7	Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change (e.g., NJSLSA.W1, 7.1.AL.PRSNT.4).

Interdisciplinary Connections/Companion Standards

LA.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.
LA.WHST.11-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.