Lindenwold Public Schools

Food Science Unit 5: Engineering and Careers in Food Science
18 instructional days

Content Standards

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-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-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. [Clarification Statement: Emphasis is on using mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale. Emphasis is on assessing students' use of mathematical thinking and not on memorization and rote application of problem-solving techniques.] [Assessment Boundary: Assessment does not include complex chemical reactions.]

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.]

Science and Engineering Practices

Constructing Explanations and Designing Solutions

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)

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

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 trade off considerations. (HS-PS3-3)

Using Mathematics and Computational Thinking

Use mathematical representations of phenomena to support claims. (HS-PS1-7)

Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-PS3-1)

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)

Disciplinary Core Ideas
LS1.C: Organization for Matter and Energy Flow in Organisms
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)

PS1.A: Structure and Properties of Matter
The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (secondary to HS-PS2-6)

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-PS1-5)

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-PS1-7)

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)

<u>**Crosscutting Concepts**</u>

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-LS1-6), (HS-PS3-3)

The total amount of energy and matter in closed systems is conserved. (HS-PS1-7)

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-PS1-5)

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)

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-PS1-7), (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)

<u>Rationale and Transfer Goals</u> :

In this unit, students will be introduced to food microbiology, including sources of contamination in foods, foil spoiling, and how foods can be preserved through heating and cooling. More complicated descriptions of the makeup of foods will be discussed as the topic of foods acting as solutions, colloids, dispersions, and suspensions is gone into greater detail. In this section, students will go into greater depth into the chemical makeup of the homogeneous and heterogeneous mixtures which many food products are classified as. Further research into how chemical compounds will be gone into greater depth as students will look into real world recipes and discuss why certain ingredients are necessary for the recipe. Students will apply findings to real world situations concerning the history of food preservation and its effect on the population. Students will also exhibit financial literacy in researching and developing comparisons of fresh, frozen, and canned foods. This unit is also designed to provide students with real world experience in terms of what employment opportunities are available in the field of food production, going into depth into what attributes are appealing to employers and how students can make themselves more attractive to those employers. All topics will include the overarching theme of a STEM classroom.

<u>Enduring Understandings:</u>

The food industry is one of the largest in the country and many jobs are related to the production and sale of food.

Food becomes spoiled when contamination causes undesirable changes, and is usually caused by enzymes or microbes naturally found in foods.

Pathogens have been found to enter the food supply in several different ways during food production and preservation.

Methods of food preservation through heating and cooling can extend the shelf life of foods for months.

Most foods are complex mixtures consisting of at least one dispersed phase of particles scattered through a continuous phase.

Knowing the nature of mixtures can help both home cooks and food scientists produce more consistent, high quality foods.

Most foods can be preserved through heat or cold processing, which involves the transfer of heat energy either to or away from food.

<u>Essential Questions</u>:

Which qualities or skills that you find in yourself best support a food science career?

After you pay for a meal at a restaurant, are you paying for just the food?

The government sponsors and is involved with industry to develop new foods for space travel and combat. Why would the government not leave this solely up to the business sector?

If the entire class went home and made muffins from a premade muffin mix, would each student's muffins turn out exactly the same?

If all available packaging materials were unsuitable for a new product, what variables would the product developers consider when designing a new material for packaging?

How can the solubility of salt explain why pure salt dissolves faster than rock salt?

Oil and vinegar are used in salad dressings and are known to not be miscible. Some brands of salad dressing need to be shaken to mix up these ingredients, while others do not. Using chemical structure, explain the differences between these two.

Why are dented, corroded, or damaged cans of food not a bargain at any price?

Why is it likely that ears of corn sold at the supermarket are likely fresher and of a better quality than those sold at a roadside farm stand, in terms of preservation?

Why is it best to sweeten an infant's hot breakfast cereal with sugar rather than honey?

Content/Objectives		**Instructional Actions**	
Content ***What students will know***	**Skills** ***What students will be able to do***	**Activities/Strategies** ***How we teach content and skills***	**Evidence (Assessments)** ***How we know students have learned***
• Biological hazards in food include bacteria, molds, viruses, and parasites. Chemical threats can come from compounds naturally found in plants, or those that included unintentionally.	• Identify three main types of food contaminants. • Differentiate among the types of foodborne illnesses. • Name pathogens that cause foodborne illnesses.	• Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.	• Labs ○ Mold Growths in foods ○ Growing Bacterial Cultures ○ The Gram's stain test for bacteria

- To ensure food is preserved from preparation to purchase, methods of preservation through heating or freezing are utilized. - Food packaging has several purposes, including protecting the food from biological and chemical hazards, increasing preservation of the food, and to decrease the cost of production for a company. - The solubility of macronutrients found in food can affect many variables concerning the food, including shelf life and taste. - Research is central to the development of every new food product. - The food industry is the largest in the United States and 1 in 4 jobs will be connected to the production, distribution, or sale of food.	- Describe the two main ways pathogens enter the food supply. - Use food handling procedures that will help prevent the growth of illness-causing microbes. - Contrast the various methods used for commercial freezing and heat preservation. - Evaluate variables that must be controlled to maintain the quality of refrigerated foods. - Design packaging for various food types. - Calculate the mass percent of solute in a solution. - Compare colloids and solutes. - Describe the factors that can affect the stability of foods. - Identify and evaluate the steps involved in developing a new food product. - Evaluate career opportunities related to foods in business,	- 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. - Use project-based science learning to connect science with observable phenomena. - Structure the learning around exploring or	- Comparing Canned and frozen foods - Packaged design project - Measuring calories in a complex mixture - Extracting Gelatin and Fat - Developing a new food product - Preparing for a Job Interview - Agrotechnology Research and Application - Unit Tests - Quizzes - Food Science Benchmark #2

	education, and government.	solving a social or community-based issue. ● Provide ELL students with multiple literacy strategies. ● 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
● Identify three main types of food contaminants. ● Differentiate among the types of foodborne illnesses. ● Contrast the various methods used for commercial freezing and heat preservation. ● Identify and evaluate the steps involved in developing a new food product.	● Explain the difference between pure substances and mixtures. ● Compare physical and chemical reactions in laboratory experiments. ● Identify sources of energy as potential or kinetic. ● Differentiate among various forms of energy.	● Food Safety Tips ● Food Preservation Options ● Processing Pyramid ● Mixture Matching Worksheet ● Separating Mixtures ● Calculating Mass Percent ● Comparing Food Science careers

• Evaluate career opportunities related to foods in business, education, and government.	• Explain the relationship between heat and temperature.	

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.

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.

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.

9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.

9.4.12.IML.4: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience.

9.4.12.IML.5: Evaluate, synthesize, and apply information on climate change from various sources appropriately.

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/Companion Standards:
NJSLS ELA
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. (HS-LS1-6), (HS-PS1-5), (HS-PS2-6), (HS-PS3-4)

WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS1-6), (HS-PS1-5), (HS-PS2-6)

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 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-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-PS3-1)

NJSLS Mathematics
MP.2 Reason abstractly and quantitatively. (HS-PS1-5), (HS-PS1-7), (HS-PS3-1), (HS-PS3-3), (HS-PS3-4)

MP.4 Model with mathematics. (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-PS1-5), (HS-PS1-7), (HS-PS2-6), (HS-PS3-1), (HS-PS3-3)

HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS1-7), (HS-PS2-6), (HS-PS3-1), (HS-PS3-3)

HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-5), (HS-PS1-7), (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.

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.