Unit 3: Biochemistry of Food

Content Area: **Science**
Course(s):
Time Period: **MP1**
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-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-PS1-7	Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
9-12.HS-PS2-6	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
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.

Science and Engineering Practices

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)

Using Mathematics and Computational Thinking

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

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' 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 trade-off considerations. (HS-PS3-3)

Obtaining, Evaluating, and Communicating Informaon

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)

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 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),(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

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

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)PS3-4)

Crosscutting Concepts

Patterns

Different paerns 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

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

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

Invesgang 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)

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)

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)

Rationale and Transfer Goals

In this unit, macronutrients will be introduced. These macronutrients include carbohydrates, lipids, and proteins. Having a basic knowledge of these groups is essential to not only having a basic understanding of food chemistry but also to maintaining good nutrition for students. With the activities in this unit, students will conduct research and present their findings on topics such as the amino acid composition in foods, and phenylketonuria. Students will demonstrate financial literacy as they plan menus with low-cost forms of proteins or find the best value for thickening starches and agents for gravy. Real-life application of their research will be displayed in editorial writing on several topics concerning issues like the benefits and detriments of cholesterol. All topics will include the overarching theme of a STEM classroom.

Enduring Understandings

- Carbohydrates are the main source of energy in people.
- Simple carbohydrates (aka sugars) play a large role in food preparation as a sweetener.
- Crystal formations in sugar are determined by several factors including temperature and moisture content.
- The chemical structure of simple carbohydrates determines what class of sugar they are and how the body metabolizes them.
- Lipids play several roles in food preparation, ranging from cooking methods to taste.
- Lipids can be found in many sources including both plants and animals.
- Complex carbohydrates are made of thousands of linked simple carbohydrates and include starches, pectins, gums, and cellulose.
- Proteins are complex molecules built of many organic acids called amino acids.
- Proteins can unfold, or denature, without breaking bonds, as a result of both chemical and physical methods.
- Food shortages are predicted for the future and research on finding available protein needs will be important

Essential Questions

- Why does brown sugar tend to dry out and become hard?
- Why are there different flavors and colors of honey and what differenates the forms of available sugar?
- What factors affect the solubility of sugars? How is food heated in deep fat frying and what forms of heat transfer are exhibited?
- What is butter, how is it made, and how can it be any different from milk?
- Why can’t all fat be used for frying?
- Why do beaten egg whites make a stable foam?
- Why were copper bowls once commonly used to whip egg-white foams, and why is it no longer recommended?
- How do starches thicken a liquid mixture?

- What are the functions of complex carbohydrates in food preparation?
- Why is carbohydrate loading recommended for athletes but not for everyone else?
- Why does sucrose appear to taste less sweet than fructose in terms of chemical structure?
- Why can stale bread be made more palatable by sprinkling water on it and heating it?

Content - What will students know?

- Carbohydrates, both complex and simple, are derived from plants and are created using photosynthesis and are a main source of energy for the human body.
- Simple carbohydrates, and sugars, are monoglycerides. Complex carbohydrates are also known as polyglycerides and are made of chains of monoglycerides.
- The physical properties of starches are what determine which type should be used in food preparation.
- The physical characteristics of lipids, along with their chemical structure, are what differentiate the types of available fats used in cooking.
- Unique to proteins, proteins can denature, which involves the unfolding of peptide bonds.
- Proteins, carbohydrates, and fats are all essential to a healthy diet and serve a different purpose.

Skills - What will students be able to do?

- Summarize how carbohydrates are produced through the process of photosynthesis
- Idenfy the monosaccharides that are combined to form each of the disaccharides
- Explain the chemical process of hydrolysis
- Evaluate the role of sugar in a nutritious diet
- Describe the characteristics of the four categories of complex carbohydrates
- Identify the functions of complex carbohydrates in food
- List the five physical properties of starch and liquid mixtures that affect the selection of starches used in food products.
- Relate the physical characteristics of lipids to their performance in foods
- Describe the molecular structure of glycerides, phospholipids, and sterols.
- Apply basic principles of the chemistry of protein to cooking eggs, milk, and meat products.
- Compare the nutritional functions of proteins with the functions of carbohydrates and fats

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 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 solving a social or community-based issue.
- Provide ELL students with multiple literacy strategies.
- Collaborate with aer-school programs or clubs to extend learning opportunities.

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

- Labs
    - Testing for simple sugars
    - Forming sugar crystals ○ Interfering with crystal formation
    - Characteristics of starch ○ Which fruits contain pectin?
    - Comparing thickeners in fruit sauce
    - Testing vegetable oils for frying
    - Fat in ground meat products
    - Fats in dropped cookies
    - Working with egg white foams
    - Making Gluten balls
    - Proteins, pH, and Coagulation
- UNIT Test
- Quizzes
- Food Science Benchmark #1

Spiraling for Mastery

Content or Skill for this Unit	Spiral Focus from Previous Unit	Instructional Activity
• Idenfy the monosaccharides that are combined to form each of the disaccharides • Explain the chemical process of hydrolysis • Relate the physical characteristics of lipids to their performance in foods • Describe the molecular structure of glycerides,	• Explain the difference between pure substances and mixtures. • Compare physical and chemical reactions in laboratory experiments. • differentiate among various forms of energy. • explain the relationship between heat and temperature.	• A coded phone message worksheet • Sorting Protein Facts • Fat Labels • Lipids Crossword • Sweet Expressions • Sugar Facts • Carbohydrates as Ingredients • Carbohydrate Pyramid

phospholipids, and sterols. • Apply basic principles of the chemistry of protein to cooking eggs, milk, and meat products.	• summarize three basic ways heat is transferred. • list factors affecting the rate of reaction in food preparation.	

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.