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Food Science Unit 3: Biochemistry of Food
18 instructional days

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-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-PS3-3. 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.]

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' 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 trade off 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)

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),(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)

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
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
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)

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 for 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 to 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 have a tendency to dry out and become hard?

Why are there different flavors and colors of honey and what differentiates the forms of available sugar?

What factors affect 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?

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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/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***
• Carbohydrates, both complex and simple, are derived from plants and are created by means of photosynthesis and are a main source of energy for the human body. • Simple carbohydrates, 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	• Summarize how carbohydrates are produced through the process of photosynthesis • Identify 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	• Structure lessons around questions that are authentic, 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	• 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

structure, are what differentiate the types of available fats used in cooking. ● Unique to protein, proteins can denature, which involves the unfolding of peptide bonds. ● Proteins, carbohydrates, and fats are all essential to a healthy diet and serve each a different purpose.	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.	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 after-school programs or clubs to extend learning opportunities.	○ Making Gluten balls ○ Proteins, pH, and Coagulation ● Units Test ● Quizzes ● Food Science Benchmark #1

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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 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, phospholipids, and sterols. • Apply basic principles of the chemistry of protein to cooking eggs, milk, and meat products.	• 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. • summarize three basic ways heat is transferred. • list factors affecting the rate of reaction in food preparation.	• A coded phone message worksheet • Sorting Protein Facts • Fat Labels • Lipids Crossword • Sweet Expressions • Sugar Facts • Carbohydrates as Ingredients • Carbohydrate Pyramid
Key resources: "Principles of Food Science 3rd Edition" Janet Ward "Understanding food-Principles and preparation" Amy Brown		

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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.

9.4.12.IML.7: Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change.

Interdisciplinary Connections/Companion Standards:

NJSLS ELA

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)

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)

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)

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)

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)

NJSLS Mathematics

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

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

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-PS1-7), (HS-PS2-6), (HS-PS3-3)

HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS1-4), (HS-PS1-7), (HS-PS2-6), (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-PS1-7), (HS-PS3-3)

Companion Standards for ELA in Science and Technical Subjects: Reading

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.

Companion Standards for ELA in Science and Technical Subjects: Writing

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.