Fairfield Public Schools
Science Curriculum

Nutritional Chemistry

Nutritional Chemistry: Description

The Chemistry of Nutrition is a one-semester course using applications of chemistry. In the nutritional chemistry performance expectations at the high school level, there is a focus on several scientific practices. A study of the basic concepts of chemistry applied to metabolism: carbohydrates, lipids, amino acids: enzymes and metabolic control; vitamins and cofactors. Emphasis is placed on metabolic pathways, the interrelationships of major nutrients and the relation of metabolic processes to the overall nutritional health of an individual.

Standards for this course are taken from the *Next Generation Science Standards* and are of three types:

Disciplinary Core Ideas (DCIs): Shown as content objectives, these standards define what students should know about the most essential ideas in the major science disciplines. The focus is on a limited number of core ideas in science and engineering both within and across the disciplines to avoid the shallow coverage of a large number of topics and to allow more time for teachers and students to explore each idea in greater depth. Reduction of the sheer sum of details to be mastered is intended to give time for students to engage in scientific investigations and argumentation and to achieve depth of understanding of the core ideas presented.

Science and Engineering Practices (SEP): These standards enable students to apply the content in the DCI's and the skills of practicing scientists and engineers to explain phenomena and solve real world problems. Engaging in the practices of science helps students understand how scientific knowledge develops; such direct involvement gives them an appreciation of the wide range of approaches that are used to investigate, model, and explain the world. Engaging in the practices of engineering likewise helps students understand the work of engineers, as well as the links between engineering and science.

Crosscutting Concepts: These standards provide students with connections and intellectual tools that are related across the differing areas of disciplinary content and can enrich their application of practices and their understanding of core ideas. These broad concepts tie together the influence of engineering, technology, and science on society and the natural world.
http://www.nextgenscience.org/next-generation-science-standards

Chemistry of Nutrition: Overview

Enduring Understandings
The structure of basic nutrition molecules (lipids, proteins, and carbohydrates) directly affects the functions of enzymes and hormones. Proper body homeostasis is a result of a balanced intake of nutrients. Nutritional deficiencies result in malnutrition and disease and have social and economic implications.

Course Essential Questions
● How does the structure and function of basic nutrition molecules affect cell structure and basic anatomy? ● Why does having balanced nutrition affect our overall health? ● How do different nutritional deficits manifest in your body and what are the social implications?

Chemistry of Nutrition: Semester-at-a-Glance

Unit	Title	Unit Essential Questions
1	Micronutrients: Minerals	● How can the outcome of simple chemical reactions be explained based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties? ● What types of investigations can provide evidence that feedback mechanisms maintain homeostasis? ● How can the periodic table be used as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms?
2	Micronutrients: Vitamins	● How can the periodic table be used as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms? ● How and why do changing conditions in a chemical system increase the amounts of products at equilibrium? ● How can scientific principles and evidence be applied 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?

3	Macronutrients and Energy	● How can cellular respiration be a model of a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy? ● How can models be used 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? ● How do carbon, hydrogen, and oxygen from sugar molecules combine with other elements to form amino acids and/or other large carbon-based molecules?

Unit 1: Micronutrients: Minerals

Overview

In Micronutrients: Minerals, students are expected to develop understanding of atomic structure and function to provide an explanation of the properties of substances as they relate to maintaining homeostasis.

Performance Expectations

At the conclusion of this unit, students will be able to:

HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

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.

HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis**.**

Unit Essential Question

- How can the outcome of simple chemical reactions be explained based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties?
- What types of investigations can provide evidence that feedback mechanisms maintain homeostasis?
- How can the periodic table be used as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms?

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-PS1-1),(HS-PS1-2),(HS-PS1-3),(HSPS1-5)

Stability and Change

- Feedback (negative or positive) can stabilize or destabilize a system. (HSLS1-3)

NGSS Unit Standards

DISCIPLINARY CORE IDEAS (DCI):

Structure and Properties of Matter

- Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1)
- 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-PS1-1)

Chemical Reactions

- 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)

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. (secondary to HS-PS1-1),(secondary to HS-PS1-3)

Structure and Function

- Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3)

SCIENCE AND ENGINEERING PRACTICES (SEP):

Developing and Using Models

- Use a model to predict the relationships between systems or between components of a system. (HS-PS1-1**)**

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-PS1-2)

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-LS1-3)

Corresponding CT Core Standards:

ELA/Literacy – RST.9-10.7, RST.11-12.1, WHST.9-12.2, WHST.9-12.7

Mathematics – HSN-Q.A.1, HSN-Q.A.2, HSN-Q.A.3

Unit 2: Micronutrients: Vitamins

Overview

In Micronutrients: Vitamins, students are expected to develop an understanding of the forces within and between molecules. Students also will be able to predict how the three-dimensional arrangement of atoms within a molecule affect the physical and chemical properties of various substances.

Performance Expectations

At the conclusion of this unit, students will be able to:

HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

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.

HS-PS1-6. Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.

Unit Essential Questions

- How can the periodic table be used as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms?
- How and why do changing conditions in a chemical system increase the amounts of products at equilibrium?
- How can scientific principles and evidence be applied 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?

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-PS1-1),(HS-PS1-2),(HS-PS1-3),(HSPS1-5)

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 the 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. (HSPS1-4),(HS-PS1-5)

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6)

NGSS Unit Standards

DISCIPLINARY CORE IDEAS (DCI):

Structure and Properties of Matter

- Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1)
- 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-PS1-1)

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. (secondary to HS-PS1-1),(secondary to HS-PS1-3)

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 the 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. (HSPS1-4),(HS-PS1-5)
- In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. (HS-PS1-6)

SCIENCE AND ENGINEERING PRACTICES (SEP):

Developing and Using Models

- Use a model to predict the relationships between systems or between components of a system. (HS-PS1-1)

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)
- Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence prioritized criteria, and tradeoff considerations. (HS-PS1-6)

Corresponding CT Core Standards:

ELA/Literacy – RST.9-10.7, RST.11-12.1, WHST.9-12.2, WHST.9-12.7, WHST.11-12.8, WHST.9-12.9

Mathematics – MP.4, HSN-Q.A.1, HSN-Q.A.2 , HS-PS1-8,HS-PS2-6, HSN-Q.A.3

Unit 3: Macronutrients and Energy

Overview

In Macronutrients and Energy, students will understand the quantitative and qualitative properties of energy as they relate to the structure and function of basic macromolecules. Students will be able to evaluate the process of metabolism and the flow of energy from macromolecules to life processes.

Performance Expectations

At the conclusion of this unit, students will be able to:

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.

HS-LS1-7. Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed, resulting in a net transfer of energy.

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.

Unit Essential Questions

- How can cellular respiration be a model of a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy?
- How can models be used 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?
- How do carbon, hydrogen, and oxygen from sugar molecules combine with other elements to form amino acids and/or other large carbon-based molecules?

Crosscutting Concepts

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-LS1-5),(HS-LS1-6)
- Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS1-7)

Systems and System Models

- 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. (HSPS3-1)

NGSS Unit Standards

DISCIPLINARY CORE IDEAS (DCI):

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),(HS-LS1-7)
- As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. (HS-LS1-7)

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. (HSPS3-1),(HS-PS3-2)

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)

SCIENCE AND ENGINEERING PRACTICES (SEP):

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)

Developing and Using Models

- Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HSLS1-4),(HS-LS1-5),(HS-LS1-7)

Corresponding CT Core Standards:

ELA/Literacy – RST.11-12.1, WHST.9-12.7, WHST.11-12.8, WHST.9-12.9, SL.11-12.5, WHST.9-12.5

Mathematics – MP.2, MP.4, HSN.Q.A.1, HSN.Q.A.2, HSN.Q.A.3