Fairfield Public Schools

Science Curriculum

Nutritional Chemistry

Course

Course: Description

Students in high school continue to develop their understanding of physical science, specifically chemistry with a focus on nutrition. The high school performance expectations in Chemistry build on the middle school ideas and skills and allow high school students to explain more in-depth phenomena. There are three disciplinary core ideas in high school chemistry as it applies to nutrition: 1) Structure and Property of Matter 2) Energy 3) Chemical Reactions. 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. These performance expectations blend the core ideas with scientific and engineering practices and crosscutting concepts to support students in developing useable knowledge to explain ideas across the science disciplines. In the nutritional chemistry performance expectations at the high school level, there is a focus on several scientific practices. These include developing and using models, planning and conducting investigations, analyzing and interpreting data, using mathematical and computational thinking, and constructing explanations; students will use these practices to demonstrate understanding of the core ideas. Students are also expected to demonstrate understanding of several engineering practices, including design and evaluation.

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

Disciplinary Core Ideas: 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: 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.

Cross-cutting 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.

CROSS CUTTING CONCEPTS

Patterns: Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

Cause and effect: Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

Scale, proportion, and quantity. In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

Systems and system models. Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.

Energy and matter: Flows, cycles, and conservation. Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.

Structure and function. The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.

Stability and change. For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

Chemistry of Nutrition: Overview

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?

Course: Year-at-a Glance

Unit	Title	Unit Essential Questions
1	Micronutrients: Minerals	• HS-PS 1-2: 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? • HS-LS1-3: What types of investigations can provide evidence that feedback mechanisms maintain homeostasis? • HS-PS1-1: 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	• HS-PS1-1: 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? • HS-PS1-6: How and why do changing conditions in a chemical system increase the amounts of products at equilibrium?

		• HS-PS1-5: 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	• HS-LS1-7: 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? • HS-PS3-1: 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? • HS-LS1-6: How do carbon, hydrogen, and oxygen from sugar molecules combine with other elements to form amino acids and/or other large carbon-based molecules?

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.

Unit Content Objectives

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

- Explain how simple chemical reactions occur based on the outermost electron states of atoms, trends in the periodic table, and demonstrate knowledge of the patterns of chemical properties.
- Plan and conduct an inquiry based investigation to provide evidence that feedback mechanisms maintain homeostasis.
- Use the periodic table as a model to predict the relative properties of elements and their chemical reactivity based on electrons in the outermost energy level

Unit Essential Questions

- How can one explain the structure, properties, and interactions of matter?

NGSS Unit Standards

DISCIPLINARY CORE IDEAS (DCI):

PS1.A: 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 structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3),(secondary to HS-PS2-6)
- 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)

LS1.A: 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):

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS1-8)
- Use a model to predict the relationships between systems or between components of a system. (HS-PS1-1)

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

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.

Unit Content Objectives

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

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

Unit Essential Questions

- How can one explain the structure, properties, and interactions of matter?

NGSS Unit Standards

DISCIPLINARY CORE IDEAS (DCI):

PS1.A: 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),(HS-PS1-2)
- The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3),(secondary to HS-PS2-6)
- 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)

SCIENCE AND ENGINEERING PRACTICES (SEP):

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS1-8)
- Use a model to predict the relationships between systems or between components of a system. (HS-PS1-1)

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

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.

Unit Content Objectives

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

- HS-PS 3-4: Evaluate the evidence needed to show 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.
- 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-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.

Unit Essential Questions

- How is energy transferred and conserved?

NGSS Unit Standards

DISCIPLINARY CORE IDEAS (DCI):

- 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)
- 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 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)

SCIENCE AND ENGINEERING PRACTICES (SEP):

- Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-5),(HS-LS1-7)
- Develop a model based on evidence to illustrate the relationships between systems or components of a system. (HS-LS2-5)

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