Sparta Area School District

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Course Outcome Summary

Course Information: (SCBIOC) Biochemistry

Description: Biochemistry is designed for students interested in exploring a career in the medical field or health sciences at the university or technical college level. The class gives an overview of the chemistry involved in life's processes. Emphasis is placed on recognizing the structure, physical properties, and chemical reactions of organic molecules in the human body (enzymes, proteins, lipids, carbohydrates, and nucleic acids). The course will include both lecture and lab settings.

Instruction Level: 11-12

Total Credits: 2

Prerequisites: Successful Completion of Biology, Chemistry, Physics

Textbooks: None

Course Standards:

- Chemical elements are fundamental building materials of matter, and all matter can be understood in terms of arrangements of atoms. These atoms retain their identity in chemical reactions.
- Chemical and physical properties of materials can be explained by the structure and the arrangements of atoms, ions, or molecules and the forces between them.
- Any bond or intermolecular attraction that can be formed and can be broken. These two processes are in a dynamic competition sensitive to initial conditions and external perturbations.
- Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis.
- Living systems have multiple mechanisms that are used to store, retrieve and transmit information.
- The subcomponents of biological molecules and their sequence determine the properties of that molecule.
- The student can use representations and models to communicate scientific phenomena and solve problems.
- The student can use mathematics appropriately.
- The student can engage in scientific questioning to extend thinking or to guide investigations within the context of this course.
- The student can plan and implement data collection strategies in relation to a particular scientific question.
- The student can perform data analysis and evaluation of evidence.

- The student is able to connect and relate knowledge across scales, concepts, and representations in and across domains.

Unit

1. **Scientific Method and Measurements**
2. **Basic Chemistry**
3. **Acids and Bases**
4. **Acid-Base Equilibria**
5. **Organic Chemistry**
6. **Cellular Respiration**
7. **Central Dogma**
8. **Evaluating Claims**
9. **Proteins**
10. **Lipids**

Unit Outlines

1. Scientific Method and Measurements

Standards:

- Student can plan and implement data collection strategies in relation to a particular scientific question.

Essential Question:

- How do you form a testable hypothesis that is logically connected to the problem and the design of the experiment?
- How do you design and conduct appropriate types of controlled scientific investigations, using the appropriate tools and techniques, to make observations and gather data to answer various questions?

Essential Knowledge:

- Students can use the scientific method by designing and conducting an investigation.
- Students can identify independent and dependent variables of a scientific experiment by planning and carrying out investigations.

2. Basic Chemistry

Standards:

- Students can explain how chemical elements are fundamental building materials of matter, and all matter can be understood in terms of arrangements of atoms. These atoms retain their identity in chemical reactions.

Essential Question:

- How do you name ionic and molecular compounds and use their names to determine their chemical formulas?
- What are five major types of chemical reactions and their identifying characteristics?
- How does the Law of Conservation of Mass and chemical equations explain the interactions of atoms and molecules both conceptually and mathematically?

Essential Knowledge:

- Students can describe how ionic, covalent, and metallic bonds form by planning and caring out an investigation.
- Students can name compounds and write chemical formulas by evaluating information.
- Students can write a balanced chemical reaction by using mathematics and computational thinking.
- Students can identify evidence and signs of a chemical reaction by interpreting and evaluating data.
- Students can classify chemical reactions by obtaining and evaluating information.

3. Acid and Base Chemistry

Standards:

- Students can explain how chemical and physical properties of materials can be explained by the structure and the arrangement of atoms, ions, or molecules and the forces between them.

Essential Question:

- What gives acids and bases their particular characteristics and properties?
- How do you name acids and bases?
- How do you calculate the pH, pOH, and concentrations of acids and bases?

Essential Knowledge:

- Students can describe how intermolecular forces play a key role in determining the properties of substances, including structures and interactions.
- Students can describe and identify acids, bases and their conjugates in a reaction by developing and using models.
- Students can calculate pH, pOH, $[H_3O^+]$ and $[OH^-]$ by using mathematics and computational thinking.
- Students can identify a given solution as containing a mixture of strong acids/or bases and estimate the pH in the resulting solution.

- Students can connect and relate knowledge across scales, concepts, and representations of acids and bases.

4. Acid-Base Equilibria

Standards:

- Students can discuss how any bond or intermolecular attraction that can be formed and can be broken. These two processes are in a dynamic competition sensitive to initial conditions and external perturbations.

Essential Question:

- How do acid/base reversible reactions shift according to Le Chatelier's principle to reach chemical equilibrium?
- How do buffers limit pH changes?
- How can one determine the concentration of an analyte in a solution through the process of titrating?

Essential Knowledge:

- Students can explain how the current state of a system undergoing a reversible reaction can be characterized by the extent to which reactants have been converted to products. Systems at equilibrium respond to disturbances by partially counteracting the effect of the disturbance (Le Chatelier's principle)
- Students can identify a solution as being a buffer solution and explain the buffer mechanism in terms of the reactions that would occur on addition of acid and base.
- Students can design, and/or interpret data from, an experiment that uses titration to determine the concentration of an analyte in a solution.

5. Organic Chemistry

Standards:

- Students can explain how chemical and physical properties of materials can be explained by the structure and the arrangements of atoms, ions, or molecules and the forces between them.

Essential Question:

- How do you name organic compounds and use their names to determine their chemical formulas?
- What are functional groups and the chemical and physical properties associated with each?

Essential Knowledge:

- Students are able to identify the noncovalent interactions within and between large molecules and connect the shape and function of the large molecule to presence and magnitude of these interactions.
- Students are able to explain how noncovalent and intermolecular interactions play important roles in many biological systems, and are used to determine the properties of substances.

6. Cellular Respiration

Standards:

- Students can explain how biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis
- Students can describe how the subcomponents of biological molecules and their sequence determine the properties of that molecule.

Essential Question:

- How is food digested and what enzymes are involved in this process?
- How does the human body extract energy from the food we consume?
- What is the function of cellular respiration and fermentation?

Essential Knowledge:

- Students describe how energy-related pathways in biological systems are sequential and may be entered at multiple points in pathway.
- Students can model how organisms capture and store free energy for use in biological processes.
- Students can summarize cellular respiration in eukaryotes and the series of coordinated enzyme-catalyzed reactions that harvest free energy from simple carbohydrates.
- Students can model how free energy becomes available for metabolism by the conversion of ATP→ADP, which is coupled to many steps in metabolic pathways.

7. Nucleic Acids

Standards:

- Students can explain how living systems have multiple mechanisms that are used to store, retrieve, and transmit information.

Essential Question:

- How does the process of DNA replication results in the transmission and/or conservation of genetic information?
- How is DNA used to build RNA and finally to build proteins?
- What is the role of mRNA, rRNA and tRNA during the process of translation?

- How do mutations in a DNA strand cause a change in the way a gene is translated into a protein.

Essential Knowledge:

- Students understand that genetic information (DNA) is used to produce proteins that largely determine the traits of an organism. These traits often result from the interactions and expression of genes.
- Students understand that there are various ways in which the transmission of genetic information can be imperfect, and that these imperfections may have positive, negative or no consequences to the organisms.

8. Evaluating Claims

Standards:

- The student can perform data analysis and evaluation of evidence.
- The student can engage in scientific questioning to extend thinking or to guide investigations within the context of this course.

Essential Question:

- What are the component parts of a complete, well-constructed argument?
- How can one analyze a given document (a piece of text, something presented as an argument in a debate round, etc.) in order to locate the claim, the stakeholders, the facts and limitations of the argument.

Essential Knowledge:

- Students can gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.
- Students can write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
- Students will apply important ethical considerations, such as respect for a person, minimizing harms while maximizing benefits, and fairness, in analyzing bioethical problems. Students will also recognize that while there can usually be several answers or approaches to an ethical question, it is important to present a strong, well-reasoned argument for one's position.

9. Proteins

Standards:

- Students can describe how the subcomponents of biological molecules and their sequence determine the properties of that molecule.

Essential Question:

- What are proteins composed of and how does their structure affect their function?
- How does the folding of polypeptides influence the function of the protein?
- What are the different types of proteins and their functions?

Essential Knowledge:

- The student explain how the structure and function of polymers are derived from the way their monomers are assembled.
- The student is able to explain the connection between the sequence and the subcomponents of a biological polymer and its properties.

10. Lipids

Standards:

- Students can describe how the subcomponents of biological molecules and their sequence determine the properties of that molecule.

Essential Question:

- What are lipids composed of and how does their structure affect their function?
- What are the different types of lipids and their functions?

Essential Knowledge:

- The student explain how the structure and function of polymers are derived from the way their monomers are assembled.
- The student is able to explain the connection between the sequence and the subcomponents of a biological polymer and its properties.