Unit 07: Cellular Energy - Photosynthesis and Cellular Respiration

Content Area: **Science**
Course(s):
Time Period: **Marking Period 4**
Length: **3-4 weeks**
Status: **Published**

Summary

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The main focus of this unit is the production and utilization of cellular energy. Students will develop an understanding of how energy is transformed during the processes of cellular respiration and photosynthesis. Students will demonstrate this understanding by applying the first and second laws of thermodynamics to real world phenomena. In addition to learning the steps and purpose of photosynthesis and cellular respiration, students will make connections between the processes and the cellular structures in which they take place. Students will participate in laboratory inquires for which they will manipulate variables and evaluate the effects of the rate of energy production. Students will develop hypotheses, which they will test during these investigations, and make conclusions based on collected data and understanding of the underlying processes of cellular respiration and photosynthesis. This unit will be connected to climate change when students investigate the connection between photosynthesis and atmospheric carbon. More specifically, students will examine the impacts of increased use of fossil fuels and increased rates of deforestation on the amount of atmospheric carbon and the rate of photosynthesis.

Revision Date: July 2021

Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. They consider analogous problems, and try special cases and simpler forms of the original problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. Older students might, depending on the context of the problem, transform algebraic expressions or change the viewing window on their graphing calculator to get the information they need. Mathematically proficient students can explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends. Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves, “Does this make sense?” They can understand the approaches of others to solving complex problems and identify correspondences between different approaches.

Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to decontextualize—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to contextualize, to pause as needed during the manipulation process in order to probe into

	the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.
LA.WHST.9-10.1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant sufficient textual and non-textual evidence.
	Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.
	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.
LA.WHST.9-10.8	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
LA.WHST.9-10.9	Draw evidence from informational texts to support analysis, reflection, and research.
SCI.HS-LS1-5	Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
	Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. Examples of models could include diagrams, chemical equations, and conceptual models.
SCI.HS.LS1.C	Organization for Matter and Energy Flow in Organisms
	The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.
SCI.HS-LS2-3	Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
	Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes.
SCI.HS-LS2-5	Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.
	Examples of models could include simulations and mathematical models.
	Assessment does not include the specific chemical steps of photosynthesis and respiration.
	Developing and Using Models
	Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show how relationships among variables between systems and their components in the natural and designed worlds.
	Develop a model based on evidence to illustrate the relationships between systems or components of a system.
SCI.HS.LS2.B	Cycles of Matter and Energy Transfer in Ecosystems
	Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.
	Systems and System Models
	Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

CS.9-12.8.1.12.AP.2	Create generalized computational solutions using collections instead of repeatedly using simple variables.
CS.9-12.8.1.12.DA.2	Describe the trade-offs in how and where data is organized and stored.
CS.9-12.8.2.12.EC.2	Assess the positive and negative impacts of emerging technologies on developing countries and evaluate how individuals, non-profit organizations, and governments have responded.
CS.9-12.8.2.12.EC.3	Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.
CRP.K-12.CRP1.1	Career-ready individuals understand the obligations and responsibilities of being a member of a community, and they demonstrate this understanding every day through their interactions with others. They are conscientious of the impacts of their decisions on others and the environment around them. They think about the near-term and long-term consequences of their actions and seek to act in ways that contribute to the betterment of their teams, families, community and workplace. They are reliable and consistent in going beyond the minimum expectation and in participating in activities that serve the greater good.
CRP.K-12.CRP2.1	Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive. They make connections between abstract concepts with real-world applications, and they make correct insights about when it is appropriate to apply the use of an academic skill in a workplace situation.
CRP.K-12.CRP3.1	Career-ready individuals understand the relationship between personal health, workplace performance and personal well-being; they act on that understanding to regularly practice healthy diet, exercise and mental health activities. Career-ready individuals also take regular action to contribute to their personal financial well-being, understanding that personal financial security provides the peace of mind required to contribute more fully to their own career success.
CRP.K-12.CRP4.1	Career-ready individuals communicate thoughts, ideas, and action plans with clarity, whether using written, verbal, and/or visual methods. They communicate in the workplace with clarity and purpose to make maximum use of their own and others' time. They are excellent writers; they master conventions, word choice, and organization, and use effective tone and presentation skills to articulate ideas. They are skilled at interacting with others; they are active listeners and speak clearly and with purpose. Career-ready individuals think about the audience for their communication and prepare accordingly to ensure the desired outcome.
CRP.K-12.CRP5.1	Career-ready individuals understand the interrelated nature of their actions and regularly make decisions that positively impact and/or mitigate negative impact on other people, organization, and the environment. They are aware of and utilize new technologies, understandings, procedures, materials, and regulations affecting the nature of their work as it relates to the impact on the social condition, the environment and the profitability of the organization.
CRP.K-12.CRP6.1	Career-ready individuals regularly think of ideas that solve problems in new and different ways, and they contribute those ideas in a useful and productive manner to improve their organization. They can consider unconventional ideas and suggestions as solutions to issues, tasks or problems, and they discern which ideas and suggestions will add greatest value. They seek new methods, practices, and ideas from a variety of sources and seek to apply those ideas to their own workplace. They take action on their ideas and understand how to bring innovation to an organization.
CRP.K-12.CRP7.1	Career-ready individuals are discerning in accepting and using new information to make decisions, change practices or inform strategies. They use reliable research process to search for new information. They evaluate the validity of sources when considering the use and adoption of external information or practices in their workplace situation.

Essential Questions/ Enduring Understanding

Essential Questions:

How is energy transformed as it moves through an ecosystem?
How does the structure of mitochondria and chloroplast enhance the rates of energy production?
How does manipulating certain variables impact the rate of energy production?
How does deforestation relate to photosynthesis and effect climate change?
How can one differentiate between aerobic and anaerobic energy production?
How are photosynthesis and cellular respiration connected?

Enduring Understanding:

Cells produce and use ATP.
First and Second law of thermodynamics relate to real world phenomenon
The overall process and purpose of photosynthesis relates to various aspects such as deforestation and cellular respiration

Objectives

Students will know how cells produce and use ATP.
Students will know the first and second laws of thermodynamics and how they relate to real world phenomena.
Students will know how energy is transformed as it moves through an ecosystem.
Students will know energy us lost as heat.
Students will know how pigments absorb and reflect light of different wavelengths.
Students will know the process and purpose of photosynthesis.
Students will know how plants are adapted to efficiently produce energy.
Students will know how deforestation relates to photosynthesis.
Students will know the process and purpose of cellular respiration.
Students will know the process and purpose of fermentation.
Students will know how cellular respiration and photosynthesis are connected.

Students will be skilled at explaining the steps of photosynthesis.
Students will be skilled at explaining the steps of cellular respiration.
Students will be skilled at manipulating variables to test their effects on the rates of energy production.
Students will be skilled at creating diagrams that connect the steps of photosynthesis and cellular respiration.
Students will be skilled at developing hypotheses and designing experimental protocol to test the hypotheses.
Students will be skilled at conducting on ine research to gather supporting scientific evidence and data.
Students will be skilled at analyzing experimental results to develop conclusions about trends in data.

Learning Plan

ATP Model: Students will draw and label the components of ATP. Then, students will discuss the purpose of

ATP and the process of releasing energy from ATP.

Chloroplast and Mitochondria Packet: Students will read about chloroplast and mitochondria and answer questions about each. Students will also have to color and label the structures of the chloroplast and mitochondria.

Plant Chromatography: Students will first generate a hypothesis about if plants contain pigments other than chlorophyll. Then, students will conduct a lab inquiry by separating the pigments in a plant leave and a marker ink line using chromatography. Students will analyze the solvent font to determine if other pigments are or are not present and report their findings on a lab sheet.

Photosynthesis Virtual Labs: Students will complete virtual lab simulations that manipulate variables to determine their impact on photosynthesis by measuring resulting plant growth. For one simulation, students will grow plants under different colored lights to determine the effect of light color on plant growth. Another virtual lab will enable students to manipulate the light intensity and amount of carbon dioxide to measure the effect on plant growth. For each simulation, students will develop hypotheses, gather data, and summarize their findings. Data will be graphed and analyzed for trends. Students will have to justify whether or not their hypotheses were supported using evidence from data and reasoning from an understanding of the process of photosynthesis. This lab may be used for a formal lab report.

Deforestation CER: Students will write a claim about how deforestation is related to photosynthesis and atmospheric carbon. Students will then conduct online research to gather data and evidence about the rate of deforestation and its impact on atmospheric carbon. Students will then make a Claim Evidence Reasoning poster that depicts their findings. The poster will include their claim, an image, and data. Lastly, students will write a reasoning section which uses logic to connect the rate of deforestation to photosynthesis and atmospheric carbon dioxide. Students will share and discuss their findings as a class. This project will act as a climate change connection.

Cellular Respiration Lab: For this lab inquiry, students will measure the rate of cellular respiration before and after exercise. Students will measure heart rate, blood pressure, and carbon dioxide production by means of time to change the color of bromothymol blue by blowing into solution with a straw. Each variable will be measured before and after five minutes of exercise. Students will predict how exercise will impact the rate of cellular respiration. Data will be graphed and analyzed for trends. Trends in data will be connected to student understanding of the process of cellular respiration. Students will be asked to make connections to how their bodies react physiologically to exercise. This lab may be used for a formal lab report.

Fermentation Lab: Students will complete a lab inquiry that models fermentation. Students will prepare flasks with various amounts of yeast and glucose, yeast and no glucose, and glucose and no yeast. The flasks will be covered with balloons to capture and measure gas production. Students will measure and compare the circumferences of each balloon to calculate the amount of carbon dioxide produced. Data will be graphed and analyzed for trends. Students will determine whether of not a reaction occurred in each beaker using their understanding of the properties of chemical reactions. Students will furthermore explain the results of the lab using their understanding of the process of fermentation.

Photosynthesis and Cellular Respiration Flow Chart: Students will create a flowchart that depicts the steps of photosynthesis and cellular respiration within the chloroplast and mitochondria, respectively. Students will draw and label each step. Lastly, students will connect the products of cellular respiration to the reactants of photosynthesis, and visa versa.

Photosynthesis Project: for this project, students will develop their own controlled experiment on how manipulating a chosen variable impacts the rate of photosynthesis. The rate of photosynthesis will be evaluated by measuring plant growth and biomass. Students will generate a hypothesis about how the chosen variable will effect plant growth. Students will then design and conduct the experiment, collecting

measurements and recording data at set intervals. At the conclusion of the project, students will analyze their results by creating tables and graphs. They will report their findings in a presentation and connect their experimental results to their understanding of the process and purpose of photosynthesis.

Assessment

Formative:

- Do Now Questions
- Exit Ticket Questions
- Quizzes
    - Energy and ATP quiz
    - Photosynthesis quiz
    - Cellular Respiration quiz
- Student participation in class discussions
- Chloroplast and Mitochondria Packet
- Worksheets
- Lab analysis questions (chromatography lab, photosynthesis virtual labs, cellular respiration lab, fermentation lab)
- Cellular Respiration and Photosynthesis Flowchart

Summative:

- Unit Assessment
- Formal Lab Reports
    - Virtual Photosynthesis Lab
    - Cellular Respiration Lab

Benchmark:

- CP Biology Final Examination

Alternative Assessments:

- Deforestation CER Poster
- Cellular Respiration and Exercise Research Paper
- Photosynthesis Experimental Project

Materials

- Textbook - Biology Glencoe
- SmartBoard and computers
- PowerPoint
- Guided notes
- Worksheets
- Lab materials
    - goggles
    - gloves
    - beakers
    - graduated cylindars
    - timers
    - rulers
    - potting soil
    - seeds
    - bromothymol blue solution
    - straws
    - yeast
    - glucose
    - flasks
    - balloons
- paper, colored pencils, markers

Modifications

See attached document.
https://docs.google.com/spreadsheets/d/1uDlwQcgdvbrOcLnMAKouOe1gQph5rWDWxM74UFeuACM/edit?usp=sharing