Unit 04: Cellular Energetics - Photosynthesis and Cellular Respiration

Content Area: **Science**
Course(s):
Time Period: **Marking Period 2**
Length: **5-6 Weeks**
Status: **Published**

Summary

Introduction:

The focus of this unit is the cellular processes (photosynthesis and cellular respiration) that cells use to produce and utilize energy. Students will relate the cellular structures involved in each process to the metabolic pathways used by cells to generate cellular energy. Students will conduct laboratory inquiries for which they will manipulate variables to examine the impacts on the rates of each process. Conclusions about trends in data will be supported by evidence from data and reasoning from an understanding of the metabolic pathways involved in cellular respiration and photosynthesis. Students will also explore the connection between photosynthesis and cellular respiration. Students will connect the unit to climate change by investigating how deforestation impacts photosynthesis and atmospheric carbon dioxide levels.

Revised June 2022

Standards

PFL.9.1.12.CFR	Civic Financial Responsibility
LA.RL.9-10.1	Cite strong and thorough textual evidence and make relevant connections to support analysis of what the text says explicitly as well as inferentially, including determining where the text leaves matters uncertain.
MA.A-REI.A	Understand solving equations as a process of reasoning and explain the reasoning
MA.A-REI.B	Solve equations and inequalities in one variable
LA.W.9-10.2.E	Establish and maintain a style and tone appropriate to the audience and purpose (e.g., formal and objective for academic writing) while attending to the norms and conventions

	of the discipline in which they are writing.
LA.W.9-10.2.F	Provide a concluding paragraph or section that supports the information or explanation presented (e.g., articulating implications or the significance of the topic).
MA.A-REI.D	Represent and solve equations and inequalities graphically
	Obtaining, Evaluating, and Communicating Information
SCI.HS-LS1	From Molecules to Organisms: Structures and Processes
	Planning and Carrying Out Investigations
SCI.HS.LS1.C	Organization for Matter and Energy Flow in Organisms
SCI.HS-LS2	Ecosystems: Interactions, Energy, and Dynamics
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.
SCI.HS.LS2.B	Cycles of Matter and Energy Transfer in Ecosystems
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.
SCI.HS.LS2.B	Cycles of Matter and Energy Transfer in Ecosystems
SCI.HS.PS3.D	Energy in Chemical Processes
WRK.9.2.12.CAP.3	Investigate how continuing education contributes to one's career and personal growth.
TECH.9.4.2.CI.2	Demonstrate originality and inventiveness in work (e.g., 1.3A.2CR1a).
TECH.9.4.2.CT	Critical Thinking and Problem-solving
TECH.9.4.2.CT.2	Identify possible approaches and resources to execute a plan (e.g., 1.2.2.CR1b, 8.2.2.ED.3).
TECH.9.4.2.CT.3	Use a variety of types of thinking to solve problems (e.g., inductive, deductive).
TECH.9.4.2.IML	Information and Media Literacy
	Information is shared or conveyed in a variety of formats and sources.
	Individuals from different cultures may have different points of view and experiences.
	Critical thinkers must first identify a problem then develop a plan to address it to effectively solve the problem.
	Collaboration can simplify the work an individual has to do and sometimes produce a better product.
	Individuals should practice safe behaviors when using the Internet.
	Career planning requires purposeful planning based on research, self-knowledge, and informed choices.
	Brainstorming can create new, innovative ideas.

Essential Questions/ Enduring Understanding

Essential Questions:

How is energy generated during photosynthesis and cellular respiration and how are the two processes related as energy is transformed as it moves between autotrophs and heterotrophs?

How can altering the structure of the mitochondria or chloroplasts alter specific steps in metabolic processes and altering the environment impact on the rate of photosynthesis and respiration

What evidence supports the endosymbiotic theory?

How are deforestation and photosynthesis connected and how does deforestation impact atmospheric carbon dioxide?

Enduring Understanding:

ATP is the energy source used by cells.

Chloroplast and mitochondria have evolved certain structures to enhance the efficiency of energy production.

Cellular respiration and photosynthesis are interconnected.

Reaction rates are affected by manipulating environmental factors.

Objectives

Students will know the processes used by cells to generate ATP.

Students will know that energy is transformed from one form to another as it moves through an ecosystem.

Students will know how first and second laws of thermodynamics relate to cellular metabolism.

Students will know how pigments absorb and reflect light of different wavelengths.

Students will know the mechanisms involved in each step of photosynthesis.

Students will know how the structures of the chloroplast enhance the process of photosynthesis.

Students will know how plants have adapted to various environments to efficiently produce energy.

Students will know how deforestation and photosynthesis are connected.

Students will know the mechanisms involved in each step of cellular respiration.

Students will know how the structures of the mitochondria enhance the process of cellular respiration.

Students will know the availability of oxygen determines the metabolic pathway used in respiration.

Students will know that the processes of cellular respiration and photosynthesis are complementary and essential to all living organisms.

Students will know the evidence that supports the endosymbiotic theory.

Students will be skilled at explaining how the structure of chloroplasts enhances the steps of photosynthesis.

Students will be skilled at explaining how the structure of mitochondria enhances the steps of cellular respiration.

Students will be skilled at designing and conducting experiments to investigate how manipulating variables affect the rates of metabolic reactions.

Students will be skilled at depicting how the processes of photosynthesis and cellular respiration are interconnected.

Students will be skilled at developing hypotheses and designing experimental protocols to test the hypotheses.

Students will be skilled at gathering data and analyzing data to find trends and draw conclusions that are supported by an understanding of content information.

Learning Plan

Unit Notes: Students will record detailed notes in a notebook that covers the learning goals of the unit.

Plant Chromatography: Students will investigate the pigments present in plant leaves by utilizing paper chromatography. Students will generate a hypothesis and a prediction about if plants contain more than one pigment. The solvent font will be analyzed to determine if additional pigments are present in the leaves. Students will connect lab results to why certain leaves change color in the fall.

Photosynthesis Reaction Rate Lab: Students will design an experiment to investigate how manipulating variables affects the rate of photosynthesis in plants. Students can change the temperature, light, or carbon dioxide levels plant leaf disks are exposed to and calculate the rate of photosynthesis by timing how long it takes leaf disks to float to the top of a test tube. Students will generate a claim that they will justify with evidence from the calculated reaction rats and reasoning from the understanding of the mechanisms involved in photosynthesis.

Deforestation CER: Students will create a claim about how deforestation and photosynthesis are related. Students will support their claim by conducting online research to gather data from evidence from peer-reviewed papers. Students must make connections between deforestation and their understanding of photosynthesis.

Cellular Respiration Lab: Students will hypothesize how exercise affects rates of cellular respiration. To test this hypothesis, students will perform different exercises and time the color change of an acid indicator solution to determine the rate of cellular respiration. Students will analyze trends in data to conclude how anaerobic versus aerobic exercise impacts the metabolic rate. Conclusions will be supported using data and scientific reasoning.

Fermentation Lab: Students will observe how the rate of fermentation can be manipulated by comparing the amount of carbon dioxide gas produced by yeast. Students will measure the circumference of balloons attached to flasks with various combinations of yeast and sugar. The resulting circumference of each balloon is representative of the reaction rate of aerobic respiration. Students will collect and analyze data. Trends in data will be supported with an explanation of the chemical reactions underlying fermentation.

Photosynthesis and Cellular Respiration Flow Chart: Students will make connections between photosynthesis and cellular respiration by drawing flowcharts. The products and reactants of each step in both metabolic pathways will be depicted and labeled.

Photosynthesis Plant Growth Project: Students will design their own experiment to test how manipulating a factor of their choice affects plant growth. Students will generate a hypothesis about how their chosen variable will impact photosynthesis, and therefore plant growth. They will then design and implement an experiment to test their hypothesis. Plant growth will be measured and analyzed for trends on if certain variables have an impact on the amount of plant growth.

Assessment

Formative:

Do Now Questions

Exit Ticket Questions

Quizzes (Energy and ATP quiz, Photosynthesis quiz, Cellular Respiration quiz)

Student participation in class discussions

Worksheets (Chloroplast and Mitochondria Packet)

Laboratory Investigations (chromatography lab, photosynthesis virtual labs, cellular respiration lab, fermentation lab)

Independent Assignments (Cellular Respiration and Photosynthesis Flowchart)

Summative:

Unit Assessment

Formal Lab Reports (Photosynthesis Lab, Cellular Respiration Lab)

Benchmark:

Honors Biology Midterm Examination

Alternative Assessments:

Deforestation CER Poster

Cellular Respiration and Exercise Research Paper

Photosynthesis Experimental Project

Mission to Mars Project

Materials

Textbook: Biology Concepts and Connections (Pearson Education) by Campell, Reece, Taylor, Simon, Dickey (2009)

Unit Learning Outline

Technology: computers for student and teacher, SmartBoard projector

Teacher Slide Presentations

Whiteboard + Accessories

Guided Notes/Worksheets

Lab Report Outline and Rubric

Personal Protective Equipment: safety glasses, gloves

Lab Equipment: beakers, water, chromatography solution, bromothylmol blue, yeast, sugar, leaves, baking soda

Graphing paper, rulers, colored pencils/markers