Unit Title: Ecology-Cycles of Matter	**Content Area:** Biology	**Grade Level:** 9-12

Unit Summary: This unit focuses on student understanding the movement of matter and nutrients in the ecosystem and the role that photosynthesis and cellular respiration play in the movement of nutrients and energy among living things.
Cross Cutting Concepts: Energy and Matter, System and System Models, Patterns
Science and Engineering Practices: Planning and Carrying Out Investigations, Analyzing and Interpreting Data, Obtaining, Evaluating and Communicating Information, Engaging in Argument from Evidence, Asking Questions and Defining Problems, Constructing Explanations and Designing Solutions

Unit Essential Questions:

- How does the sun contribute to the process of Photosynthesis and life on earth?
- How do the living and nonliving parts of an environment contribute to cycles of matter?
- What are the processes of Photosynthesis and Cellular Respiration and how do both processes cycle energy and nutrients in an environment.

Unit Enduring Understandings:

- Plants have the capability to take continual energy from sun light to form sugar molecules containing carbon, hydrogen and oxygen.
- All organisms must break the high-energy chemical bonds in food molecules during cellular respiration to obtain the energy needed for life processes.
- As matter cycles and energy flows through different levels of organization within living systems (cells, organs, organisms, communities), and between living systems and the physical environment, chemical elements are recombined into different products.

Possible Student Misconceptions: Students may find difficult the concept that natural processes occur automatically when materials and conditions are right. Students may have difficulty tracking the direction of molecules into and out of the light dependent reaction and Calvin Cycle. Students may find it difficult to understand the concept of 38 ATP production versus 36 ATP yield from Cellular Respiration.

NJCCCS: 5.3.12.B.4, 5.3.12.B.5, 5.3.12.B.6

NGSS Performance Expectations: *Students who demonstrate understanding can…*

- 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.
- 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.
- HS-LS1-5. Use a model to illustrate how photosynthesis transforms light energy into stored chemical 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.
- 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.

Primary CCSS ELA/Literacy Connections: RST. 11-12.7, RST.11-12.8, WHST.9.12-2, WHST.9.12-5, WHST.9.12-7, CCSS.ELA-LITERACY.RI.9-10.1, CCSS.ELA-LITERACY.RI.9-10.2, CCSS.ELA-LITERACY.RI.9-10.4, CCSS.ELA-LITERACY.RI.9-10.10	**Primary CCSS Mathematics Connections:** CCSS.MATH.CONTENT.HSN.Q.A.2,

Lesson Pace & Sequence

Lesson Title/Number: Cycles of Matter	**Learning Objective(s):** All learners will be able to describe the cycles of matter	**Lesson Duration:** 80 minutes

Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	What is a cycle?				

Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Why would it be important for things to cycle/recycle in an ecosystem?				
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Cycles JIG SAW: Students are broken into groups, each group is asked to master one of the 4 cycles (Water, Nitrogen, Phosphorous and Carbon Cycle) using text. Then groups are broken up and reformed so members are able to share knowledge of information gathered to complete cycles of matter activity		Obtaining, Evaluating and Communicating Information	LS2.B: Cycles of Matter and Energy Transfer in Ecosystems	Energy and Matter: Flows, Cycles, and Conservation: tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Cycles of Matter Activity completed in small groups of Carbon Cycle, Nitrogen Cycle, Water Cycle and Phosphorous Cycle experts.	• Cycles of Matter Activity: http://sr2.k12.mo.us/hoover/Ch.%2013/cyclesmatteractivity09.pdf		LS2.B: Cycles of Matter and Energy Transfer in Ecosystems	Energy and Matter: Flows, Cycles, and Conservation: tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.
Extend: How will students deepen their conceptual understanding through use in new context?	What cycle do you believe is most important for the survival of producers? Which is the most important for consumer survival? Provide a full explanation citing evidence from the textbook and cycles of matter activity.		Engage in Argument from Evidence		

Lesson Pace & Sequence

Lesson Title/Number: Photosynthesis Intro		**Learning Objective(s):** All learners will be able to explain where plants get the energy they need to produce food, describe the role of ATP in cellular activities and investigate the factors that affect the rate of Photosynthesis.			**Lesson Duration:** 120 minutes
Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Where does the energy for primary producers come from?				

Explain: How will you help students connect their exploration to the concept/topic under investigation?	Intro to Photosynthesis Presentation/Discussion Students aim to answer individually by reading text. Where do plants get the energy they need to produce food? What is the role of ATP in cellular activities? Autotrophs vs. Heterotrophs review Intro to ATP:3ATP(charged battery) ADP (uncharged battery)	• Miller and Levine Chapter 8 section 8-1	Obtaining, Evaluating and Communicating Information	PS3.D:Energy in Chemical Processes	Energy and Matter: Flows, Cycles, and Conservation: tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Students will engage in a lab to answer the Essential Question: What factors affect the rate of photosynthesis? Students will be asked to develop hypothesis on 3 factors that affect the rate of photosynthesis. Students will design a lab to test the 3 factors and use data provided by teacher on the affects of :co2, heat, light, water, oxygen etc. on photosynthesis to complete results and conclusion, evaluate their hypothesis and clear up misconceptions		Planning and Carrying out Investigations, Analyzing and Interpreting Data, Obtaining, Evaluating and Communicating Information	PS3.D:Energy in Chemical Processes	Energy and Matter: Flows, Cycles, and Conservation: tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior. Systems and System Models: A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems
Extend: How will students deepen their conceptual understanding through use in new context?	What factor had the most effect on the rate of Photosynthesis and which had the least affect. Use evidence from the text and lab investigation to explain the possible cause of the different effects		Engage in Argument from Evidence		

Lesson Pace & Sequence

Lesson Title/Number: Photosynthesis I	**Learning Objective(s):** All learners will be able to state the overall equation of for photosynthesis, describe the role of light, chlorophyll and chloroplast in the light dependent reactions.	**Lesson Duration:** 80 minutes

Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Think/Pair/Share: Why are plants at the bottom of the energy pyramid?				
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Class discussion on answers to Think/Pair/Share				
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Create a poster describing the process of photosynthesis including reactants and products. Make sure to highlight the factors that have the most effect on the rate.			LS2.B: Cycles of Matter and Energy Transfer in Ecosystems	Energy and Matter: Flows, Cycles, and Conservation: tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.
Explain: How will you help students connect their exploration to the concept/topic under investigation?	Review Photosynthesis equation: In small groups students will read text and identify 5 vocabulary terms needed to describe the light dependent reactions and explain the relevance of each term to the process using small white boards/poster paper.		Obtaining, Evaluating and Communicating Evidence	LS2.B: Cycles of Matter and Energy Transfer in Ecosystems	Energy and Matter: Flows, Cycles, and Conservation: tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Create a tally of the vocabulary words identified by students and lead class discussion of relevance and use of vocabulary words in describing the light dependent reactions. Clear up misconceptions.				

Extend: How will students deepen their conceptual understanding through use in new context?	Exit ticket: Students will use the five terms individually to answer the question: What is the significance of the light dependent reaction to life on earth.				
Lesson Pace & Sequence					
Lesson Title/Number: Photosynthesis II		**Learning Objective(s):** All learners will be able to differentiate between the light dependent and light independent reactions of Photosynthesis			**Lesson Duration:** 80 minutes
Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	What is the difference between the terms dependent and independent? Give an example of each term.				
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Class discussion focused on meaning of light dependent and light independent.				
Explore: What hands-on/minds-on common experience(s) will you provide for students?	What is the purpose of the light independent reaction and where does the energy to run the light independent reactions/Calvin Cycle come from? Students are to complete CLAIM-EVIDENCE-WARRANT using evidence from text to answer question		Engaging in Argument from Evidence	LS2.B: Cycles of Matter and Energy Transfer in Ecosystems	Energy and Matter: Flows, Cycles, and Conservation: tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

Explain: How will you help students connect their exploration to the concept/topic under investigation?	Review/Discussion of Calvin Cycle: Students will aim to summarize the Calvin Cycle and state the molecules that enter and exit it.			LS2.B: Cycles of Matter and Energy Transfer in Ecosystems	Energy and Matter: Flows, Cycles, and Conservation: tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Students are put into small groups and provided with white poster paper and colored markers to create large Venn diagrams. They are to compare and contrast the light dependent and independent reactions of photosynthesis using visuals and key vocabulary and present to the class. The class will vote on the best representation and explanation.			LS2.B: Cycles of Matter and Energy Transfer in Ecosystems	Energy and Matter: Flows, Cycles, and Conservation: tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior. Systems and System Models: A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems
Extend: How will students deepen their conceptual understanding through use in new context?	Name at least 2 ideas that were included in the Venn diagrams of other groups that you didn't think about and explain why that information is important in understanding Photosynthesis		Obtaining, Evaluating and Communicating Information		

Lesson Pace & Sequence

Lesson Title/Number: Cellular Respiration Intro		**Learning Objective(s):** All learners will be able to explain how living things release energy through the process of cellular respiration.			**Lesson Duration:** 120 minutes
Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	How do living things release energy? List of answers written on board				

Engage: How will you capture students' interest and get students' minds focused on the concept/topic? ***Explore: What hands-on/minds-on common experience(s) will you provide for students?***	Students will complete Inquiry Activity How do living things release energy? In pairs/ small groups: Students will create a table and evaluate 5 items including themselves on: activities, energy source and energy release. Questions: Was it easier to describe how living things use energy or how nonliving things use energy? What is the most common energy source for living things? How do you thin living things release the energy they need	• Miller and Levine Chapter 9 page 220	Analyzing and Interpreting Data	LS2.B: Cycles of Matter and Energy Transfer in Ecosystems	Energy and Matter: Flows, Cycles, and Conservation: tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior. Systems and System Models: A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems
Explain: How will you help students connect their exploration to the concept/topic under investigation?	Presentation/Discussion on Cellular Respiration with questions embedded, Students should be able to answer individually: What is cellular respiration? What happens during the process of glycolysis? How is pyruvate formed? What is the difference between aerobic and anaerobic? What are the two main types of fermentation?			LS2.B: Cycles of Matter and Energy Transfer in Ecosystems	Energy and Matter: Flows, Cycles, and Conservation: tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

Evaluate: How will students demonstrate their mastery of the learning objective(s)?	In pairs students will complete Problem solving on page 224. Students will aim to define a problem, organize information, create a solution and present a plan to increase the bubbles of carbon dioxide while making bread.		Asking Questions and Defining Problems, Planning and Carrying Out Investigations, Constructing Explanations and Designing Solutions.	LS2.B: Cycles of Matter and Energy Transfer in Ecosystems	Energy and Matter: Flows, Cycles, and Conservation: tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

Lesson Pace & Sequence

Lesson Title/Number: Cellular Respiration vs. Photosynthesis		**Learning Objective(s):** All learners will be able to describe what happens during the Krebs Cycle and Electron Transport Chain. Compare and contrast cellular respiration and photosynthesis.			**Lesson Duration:** 160 minutes
Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Why does it make sense that Cellular Respiration mostly takes place in the mitochondria?				
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Quick Lab: How does exercise affect disposal wastes from cellular respiration? pg. 231 Students will use and observe bromthymol blue solution to demonstrate the increase production of carbon dioxide after exercise by blowing into tube with chemical before and after exercise and noting difference.	• Miller and Levine Chapter 9 pg. 231	Planning and Carrying Out Investigations, Analyzing and Interpreting Data	LS2.B: Cycles of Matter and Energy Transfer in Ecosystems	Energy and Matter: Flows, Cycles, and Conservation: tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior. Systems and System Models: A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems

Explain: How will you help students connect their exploration to the concept/topic under investigation?	Present illustrations of Cellular Respiration pg. 222. Students will work in pairs to complete table in notebooks. Table will answer: Where does it happen, What molecules enter, What molecules exit and How many ATP molecules are produced for the processes of Glycolysis, Krebs Cycle and Electron Transport Chain.		Obtaining, Evaluating and Communicating Information	LS2.B: Cycles of Matter and Energy Transfer in Ecosystems	Energy and Matter: Flows, Cycles, and Conservation: tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Cellular Respiration in Yeast Lab	• Cellular Respiration in Yeast Lab: http://www.paec.org/biologypartnership/assets/february%2022/Cellular%20Respiration%20Protocol%20-%20Balloon%20Lab.pdf	Developing and Using Models, Planning and Carrying Out Investigations, Analyzing and Interpreting Data, Obtaining, Evaluating and Communicating Information	LS2.B: Cycles of Matter and Energy Transfer in Ecosystems	Systems and System Models: A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.
Extend: How will students deepen their conceptual understanding through use in new context?	Create a concept map to compare and contrast the process of Photosynthesis and Cellular Respiration and their roles in the Carbon and Water cycle. Use the following vocabulary terms: carbon, carbon dioxide, oxygen ,hydrogen, water, glucose, energy, ATP, producer (s), consumer (s),human activity, decomposition, respiration, transpiration, evaporation, runoff, seepage, root uptake, deposition.		Obtaining, Evaluating, and Communicating Information	LS2.B: Cycles of Matter and Energy Transfer in Ecosystems	Energy and Matter: Flows, Cycles, and Conservation: tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior. Systems and System Models: A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.