Unit 2 | Nutrients, Energy, & Biochemistry

Living Environment | **25 - 30 days**

Food that humans eat are made of complex macromolecules that are broken down, transported, and rebuilt through the actions of physical and chemical changes. In this unit, students will investigate the contents of different foods (including crickets), the breakdown of those foods through digestion, and the ways in which body systems supply nutrients and energy to cells. Students practice carrying out experiments to test biochemical processes including digestion and respiration, and they will design experiments by manipulating variables and posing questions.

What kinds of food do humans need to consume in order to have a healthy diet? Are there different ways to create a healthy diet?

UNIT STORYLINE SNAPSHOT

Anchor Phenomenon: Diverse Diets, Eating Crickets

Why do different cultures prefer and eat different foods? How do we determine if different types of food can be nutritious and provide humans with sufficient energy?

Performance Task: Crickets in our lunch??!

Photosynthesis

3E Instructional Model Plan

How do plants generate their own food?

Cellular Respiration

5E Instructional Model Plan

How does food provide energy for life processes?

Macronutrient Transport ***5E Instructional Model Plan*** ***How do substances move into and out of cells?***	**Assembly & Breakdown (Enzymes)** ***5E Instructional Model Plan*** ***How is food broken down and used by the body to fuel life processes?***

PLANNING RESOURCES

- Knowledge and Enduring Understandings
- Storyline and Pacing Guide
- Common Core Standards
- NY State Regents Exam Readiness
- NY State Science Standards
- Unit Vocabulary

KNOWLEDGE AND ENDURING UNDERSTANDINGS

Knowledge: (Students will know. . .)	Enduring Understandings

High priority content - required	Mid-priority content - recommended	Low-priority content - not required	
• Macronutrients assembly, breakdown, and transport • Respiration and photosynthesis • Human digestive system; enzymes (Std. 4, Key Idea 1 - PI 1.2; Key Idea 5 - PI 5.1)	• Cycles of matter and energy flow (Std. 4, Key Idea 6 - PI 6.1) • Human circulatory system (Std. 4, Key Idea 1 - PI 1.2)	• Cell Theory and organelles (review) (Std. 4, Key Idea 1 - PI 1.2)	• Only producers synthesize organic molecules from raw materials, but all organisms use these molecules to do respiration • Macronutrients are assembled in the cell using pieces that are broken down during digestion • For cellular processes to occur the right molecules need to be in the right place

✦Storyline and Pacing Guide

	Time	Teacher Resource	Driving Questions	What students figure out *Ideas that contribute to student thinking about the anchor phenomenon and performance task*

	**Launch Anchor Phenomenon**	**1 -2 Days**	**Link**	*Why do different groups of people have different food preferences?* *How can we determine if different types of foods are healthy or provide the nutrients and energy humans need to thrive?*	• People have different food preferences based on cultural norms; but many foods also overlap between different groups of people • Understanding what food is composed of, and how the body uses different types of foods, can help us identify healthful and efficient food sources.
	**Introduce Performance Task**	**1 Day**	**Link**	*Should crickets be added to school lunches? Why or why not?*	• Scientists and businesses are investigating shifting agriculture towards insect-based protein sources (such as cricket flour) -- there maybe pros and cons to this approach
	**Photosynthesis**	**2-3 Days**	**3E Plan**	*What is food? How and where is food created?*	• Plants / autotrophs are the only organisms that are able to photosynthesize (make their own food) and serve as the base of the food chain • Photosynthesis is the process of transferring energy from the sun into chemical bonds that form carbohydrates (glucose) • Photosynthesis requires sunlight, carbon dioxide, and water; it produces glucose (food) and oxygen as a waste product
	**Cellular Respiration**	**5-8 Days**	**5E Plan**	*How does food provide us with energy?* *How can we design investigations to further our understanding of biochemical processes?*	• Glucose from food is broken down, in the process of cellular respiration, to release energy that is then stored as ATP • ATP is used as the energy source for all life processes • Cellular respiration can be aerobic or anaerobic; carbon dioxide and water are released as a waste product • Controlled experiments allow one to investigate factors that impact processes such as cellular respiration and photosynthesis

Return to the performance task and engage students in revising their flow diagram, and initial response to the guiding prompt on crickets, based on the new evidence and ideas generated in the Photosynthesis and Cellular Respiration instructional sequences. At this point in the unit, students should have been able to clarify their understanding that all food has its origins in photosynthesis and that cells use glucose (food) from plants or other organisms in order to generate cellular energy.

Revisit the **Unit Driving Question Board** - are there questions that have been addressed in these instructional sequences? -- have new questions been brought to the forefront?

Macronutrient Transport	**5-8 Days**	**5E Plan**	*How do different combinations of macronutrients combine to form food?* *How do different foods support life processes?* *How do macronutrients and other substances get into and out of cells in order to facilitate life processes?*	• All food is broken down into its' component subunits (polymers) and nutrients • Substances move into and out of cells through a semipermeable cell membrane • Small molecules, such as oxygen or glucose, can diffuse across the cell membrane along the concentration gradient (high to low) • Water can move passively across the cell membrane, towards a higher concentration of solute -- called osmosis • Substances may cross the cell membrane against the concentration gradient (low to high) with an input of energy (ATP)

Return to the performance task and engage students in revising their flow diagram, and initial response to the guiding prompt on crickets, based on the new evidence and ideas generated in the Macronutrient and Transport instructional sequence. At this point in the unit, students should have been able to clarify their understanding that all food is made of different macronutrients that serve an organism in different ways, including providing energy, and these molecules must move across cell membranes to be used by the cell.

Revisit the **Unit Driving Question Board** - are there questions that have been addressed in these instructional sequences? -- have new questions been brought to the forefront?

	**Macronutrient Assembly & Breakdown (Enzymes)**	**5-8 Days**	**5E Plan**	*How is food broken down and used by the body to fuel life processes?* *How are molecules, that originated in food, reassembled in order to complete life processes?*	• Food is made up of different amounts macro and micro nutrients that supply energy and materials needed for life processes • Enzymes are proteins that serve as catalyst for life processes; both aiding in the assembly of materials and in the breaking down of materials • Enzymes have a specific shape that enables them to fulfil their role, if they lose their specific shape (become denatured) they are no longer able to do their job efficiently, or at all.
	**Complete Culminating Task**	**2 Days**	**Link**	*Should crickets be added to school lunches? Why or why not?* *How can we determine if different types of foods are healthy or provide the nutrients and energy humans need to thrive?*	• Crickets can be an efficient and nutritious protein source • All food (or the molecules found in food) are initially generated by plants and then subsequently broken down and assimilated by humans can help us investigate the nutritive value of different types of food • All of the food we eat, regardless of the source, follows a similar pathway: energy from the sun → plants convert sun's energy into glucose → plants are the food source for animals → food is broken down into macronutrients → energy is released and used for life processes → nutrients are transported through the body and into / out of cells → cells use nutrients to create proteins and perform life functions

✦NY State Regents Exam Readiness

Regents Topics (from 1996 standards)	**Historical Coverage** (over the last 5 administrations of LE Regents)[1]	**More Details** ***How is this addressed in the unit?***
Individual and Population Growth	6%	In this unit, the foundation needed for the later topics in Ecology is built. Although students do not explore energy transfer at the ecosystem level in depth here (it is spiraled back to in Unit 7) the idea that energy flows from sun to plants and then on to other organisms is introduced. Additionally the concepts of the cycling of matter and the relationship between photosynthesis and cellular respiration are explored (**Performance Indicator 6.1**).
Dynamic equilibrium and biochemistry	6%	Biochemical processes and their importance in maintaining homeostasis is a consistent thread across all of the 5E plans in this unit (**Performance Indicator 5.1**). For example, the Cellular Respiration 5E instructional sequence investigates how the energy in stored in organic molecules (from food) is released during cellular respiration.
Human body structure and function	4%	This unit builds on the prior unit, which introduced the idea that organelles perform specific functions that enable life processes for the cell and the organism. In this unit, student build on these ideas, in order to understand how complex, multicellular organisms, such as humans require coordination between cells, tissues, and organs to maintain homeostasis (**Performance Indicator 1.2**). For example, in the Macronutrient Transport 5E plan, students explore how molecules from food (and other substances) move into and out of cells across the cell membrane.
Standard 1: Analysis, Inquiry, & Design	4%	In the 5E, Cellular Respiration, students are introduced to the experimental design process, and how to collect and analyze data. The 5E plan on Enzymes, as provides an opportunity for students to revisit experimental design within this unit. Experimental design, analysis, and inquiry are spiraled throughout the remainder of the course.
NYS Lab: Diffusion Across	3%	In the Macronutrient Transport 5E, students complete a portion of this required lab; returning to the remaining sections in Unit 3.

[1] Regents Tool; Awesome table

A Membrane		

Unit 2 Regents Item Bank

New York State Science Standards

NY State MST Standards (1996) *This unit was designed to address the following NY State 1996 Standards.*	**NYSSLS (2017)** *As designed, this unit works towards the following NYSSLS Performance Expectations, with partial alignment.*

Key Idea 1: Living things are both similar to and different from each other and from nonliving things. PI 1.1 Explain how diversity of populations within ecosystems relates to the stability of ecosystems. PI 1.2 Describe and explain the structures and functions of the human body at different organizational levels (e.g., systems, tissues, cells, organelles). **Key Idea 5: Organisms maintain a dynamic equilibrium that sustains life.** PI 5.1 - Explain the basic biochemical processes in living organisms and their importance in maintaining dynamic equilibrium. **Key Idea 6: Plants and animals depend on each other and their physical environment** PI 6.1 - Explain factors that limit growth of individuals and populations. New York State Core Curriculum Standards Crosswalk - Living Environment	**HS-LS1-5. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.** [Clarification Statement: 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.Assessment does not include specific biochemical steps. **HS-LS1-6. 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.** [Clarification Statement: Emphasis is on using evidence from models and simulations to support explanations.Assessment does not include the details of the specific chemical reactions or identification of macromolecules. **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.** [Clarification Statement: Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration. Assessment should not include identification of the steps or specific processes involved in cellular respiration.

✦Common Core Learning Standards

Reading	Writing

9-10.R.ST.2 **Reading: Key Ideas and Details** Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text. **9-10.R.ST.3** **Reading: Key Ideas and Details** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks attending to special cases or exceptions defined in the text. **9-10.R.ST.9** **Reading: Integration of Knowledge and Ideas** Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.	**9-10.W.HST.10** **Writing: Range of Writing** Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences. **9-10.W.HST.10** **Writing: Text Types and Purposes** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
Listening	**Speaking**

✦Unit Vocabulary

Consider using this list to guide the Explain or Elaborate portions of the 5E plans, and use it as reference for peer to peer vocabulary based discussions.

Unit Vocabulary by 5E / Topic	Domain Specific	Tier II
3E: PHOTOSYNTHESIS	photosynthesis molecules atoms bonds glucose, $C_6H_{12}O_6$ carbon dioxide, CO_2 oxygen, O_2 water, H_2O chloroplast chlorophyll light energy carbohydrate* producer / autotroph* consumer / heterotroph* food chain	process capture products reactants reaction hypothesis phenomena transfer
5E: CELLULAR RESPIRATION	sugar glucose carbohydrate adenosine triphosphate (ATP) mitochondrion cellular respiration aerobic, anaerobic bonds glucose, $C_6H_{12}O_6$ carbon dioxide, CO_2 oxygen, O_2 water, H_2O	input, output reactants products extract exhale waste

5E: CR (SCIENTIFIC METHOD)		hypothesis questions experiment control, controlled variables independent variable dependent variable support refute evidence trials
5E: MACRONUTRIENT TRANSPORT	nutrients macromolecules protein carbohydrate (simple / complex) starch iodine building blocks amino acid monomer / polymer lipids, fats, oils fatty acid, glycerol indicator semipermeable selectively permeable concentration gradient diffusion passive / active transport calories / calorimetry ATP protein channel osmosis	composition food equilibrium concentration transport

5E: ASSEMBLY & BREAKDOWN (ENZYMES)	acidic / basic pH enzyme catalyst / catalyze substrate lock and key model reaction rate active site binding denature hydrogen peroxide H_2O_2 -ase lysosome digestion	assemble breakdown temperature optimal function specific, specificity