NEW MILFORD PUBLIC SCHOOLS

New Milford, Connecticut

Advanced Placement Biology

June 2022

BOE Approved Aug 2022

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New Milford's Mission Statement

The mission of the New Milford Public Schools, a collaborative partnership of students, educators, family and community, is to prepare each and every student to compete and excel in an ever-changing world, embrace challenges with vigor, respect and appreciate the worth of every human being, and contribute to society by providing effective instruction and dynamic curriculum, offering a wide range of valuable experiences, and inspiring students to pursue their dreams and aspirations.

AP Biology Course Description

Grades 10-12

The AP Biology course is an equivalent to an introductory college-level biology course. The AP Biology course is organized into commonly taught units of study that provide a suggested sequence for the course. These units comprise the content and skills colleges and universities typically expect students to master to qualify for college credit and/or placement. Students cultivate their understanding of biology through inquiry-based investigations as they explore the following topics: evolution, cellular processes, energy and communication, genetics, information transfer, ecology, and interactions. This content is grounded in four Big Ideas, which are crosscutting concepts that build conceptual understanding and spiral throughout the course. In addition, there are six Science Practices that spiral throughout the course and are central to the study and practice of biological concepts. These practices make up the basis of many of the tasks required of students and are developed throughout the course.

Key for College Board Standards

Big Ideas

1. **(EVO) Evolution** - The process of evolution drives the diversity and unity of life.
2. **(ENE) Energetics** - systems use energy and molecular building blocks to grow, reproduce, and maintain dynamic homeostasis.
3. **(IST) Information Storage and Transmission** - Living systems store, retrieve, transmit, and respond to information essential to life processes.
4. **(SYI) Systems Interactions** - Biological systems interact, and these systems and their interactions exhibit complex properties.

Science Practices

1. Concept Explanation
2. Visual Representations
3. Questions and Methods
4. Representing and Describing Data
5. Statistical Tests and Data Analysis
6. Argumentation

Pacing Guide

Units	Number of Blocks
Unit 1 - Chemistry of Life	5 - 6 blocks
Unit 2 - Cell Structure and Function	8 - 10 blocks
Unit 3 - Cellular Energetics	10 - 11 blocks
Unit 4 - Cell Communication and Cell Cycle	8 - 9 blocks
Unit 5 - Heredity	8 blocks
Unit 6 - Gene Expression and Gene Tech	14 blocks
Unit 7 - Natural Selection	12 - 14 blocks
Unit 8 - Ecology	10 - 12 blocks

Unit 1 - Chemistry of Life

Stage 1 Desired Results

ESTABLISHED GOALS

SYI-1.A Explain how the properties of water that result from its polarity and hydrogen bonding affect its biological function.

ENE-1.A Describe the composition of macromolecules required by living organisms.

SYI-1.B Describe the properties of the monomers and the type of bonds that connect the monomers in biological macromolecules

SYI-1.B Describe the properties of the monomers and the type of bonds that connect the monomers in biological macromolecules.

SYI-1.C Explain how a change in the subunits of a polymer may lead to changes in structure or function of the macromolecule.

IST-1.A Describe the structural similarities and differences between DNA and RNA.

Transfer

Students will be able to independently use their learning to…

Science Practice 1 – Concept Explanation Explain biological concepts, processes, and models presented in written format.

Science Practice 2 – Visual Representations Analyze visual representations of biological concepts and processes.

Science Practice 6 - Argumentation Develop and justify scientific arguments using evidence.

Meaning

UNDERSTANDINGS

Students will understand that…

- Living systems are organized in a hierarchy of structural levels that interact.
- The highly complex organization of living systems requires constant input of energy and the exchange of macromolecules.
- Living systems are organized in a hierarchy of structural levels that interact.
- Heritable information provides for continuity of life.

ESSENTIAL QUESTIONS

Students will keep considering…

- What is the role of energy in the making and breaking of polymers?
- How do living systems transmit information in order to ensure their survival?
- How would living systems function without the polarity of the water molecule?

	Acquisition	
	Students will know…	*Students will be skilled at…*
	SYI-1.A.1 The subcomponents of biological molecules and their sequence determine the properties of that molecule. SYI-1.A.2 Living systems depend on properties of water that result from its polarity and hydrogen bonding. SYI-1.A.3 The hydrogen bonds between water molecules result in cohesion, adhesion, and surface tension. ENE-1.A.1 Organisms must exchange matter with the environment to grow, reproduce, and maintain organization. ENE-1.A.2 Atoms and molecules from the environment are necessary to build new molecules— a. Carbon is used to build biological molecules such as carbohydrates, proteins, lipids, and nucleic acids. Carbon is used in storage compounds and cell formation in all organisms. b. Nitrogen is used to build proteins and nucleic acids. Phosphorus is used to build nucleic acids and certain lipids. SYI-1.B.1 Hydrolysis and dehydration synthesis are used to cleave and form covalent bonds between monomers. SYI-1.B.2 Structure and function of polymers are derived from the way their monomers are assembled— SYI-1.C.1 Directionality of the subcomponents influences structure and function of the polymer— IST-1.A.1 DNA and RNA molecules have structural similarities and differences related to their function—	● Explaining how the properties of water that result from its polarity and hydrogen bonding affect its biological function. ● Describing the composition of macromolecules required by living organisms. ● Describing the properties of the monomers and the type of bonds that connect the monomers in biological macromolecules ● Describing the properties of the monomers and the type of bonds that connect the monomers in biological macromolecules. ● Explaining how a change in the subunits of a polymer may lead to changes in structure or function of the macromolecule. ● Describing the structural similarities and differences between DNA and RNA.

Stage 2 – Evidence

Code	Evaluative Criteria	Assessment Evidence
T, A	Scored according the College Board rubric: **(A) 6 points maximum** Water's role as a medium for the metabolic processes of cells (2 points maximum): ● Diffusion—allows for movement of materials through an aqueous solution down the concentration gradient ● Osmosis—movement of water across membranes due to water potential differences (down the gradient) ● Solvent—dissociation/ionization of materials ● Buffer—explanation of role water plays in formation of bicarbonate ion Water's ability to moderate temperature within living organisms/environments (2 points maximum): ● Specific heat—moderates climates, maintains stable temperature in cells, constant internal environment ● High heat of vaporization—perspiration cooling, evaporative cooling ● Ice forming and acting as insulator for lakes, keeping water in liquid state Water from the roots to the leaves of plants (2 points maximum): ● Transpiration—moving water away from leaves due to water potential differences/evaporation through stomata ● Capillary action of water due to adhesion and cohesion ● Root pressure—driven by osmosis/movement of water into roots ● Negative pressure potential—caused by surface tension of water as it is pulled up xylem **(B) 4 points maximum** Chemical composition -**1 point** ● **1 point** amino acids the building blocks of protein contain amino, carboxyl and R groups **OR** correct structural formula showing amino, carboxyl, and R group attached to central carbon Levels of structure - **2 points** Primary structure - **.5 point** ● sequence (chain, string) of amino acids or the number and order of amino acids ● amino acids linked by peptide bonds ● amino acids bonded through dehydration synthesis Secondary structure - **.5 point** ● helix and/or pleated sheet ● hydrogen bonds (between carboxyl and amino groups) Tertiary structure - **.5 point** ● hydrogen, ionic, disulfide, and van der Waals bonds, and/or hydrophobic interactions (if hydrogen must have more than one) ● interaction between R groups Quaternary structure - **.5 point** ● more than one polypeptide or subunit ● hydrogen, ionic, disulfide, and van der Waals bonds, and/or hydrophobic interactions (if hydrogen must have more than one) Function - **1 point** ● if the structure is altered, then the protein may not be able to carry out it's function (ex: enzymes, cell transport proteins, cell receptors, etc.)	PERFORMANCE TASK(S): *Students will show that they really understand evidence of…* **Free Response Question** - Students will answer the following **FRQ** to demonstrate their understanding of the properties of water and organic macromolecules. Water is important for all living organisms. The functions of water are directly related to its physical properties. (a) **Explain** how the properties of water contribute to the following. ● the role of water as a medium for the metabolic processes of cells ● the ability of water to moderate temperature within living organisms and in organisms' environments ● transpiration from the leaves of plants (b) **Describe** the chemical composition of either protein and **explain** how the structure of the polymer impacts the function of the macromolecule giving a specific example.

		OTHER EVIDENCE: *Students will show they have achieved Stage 1 goals by…* ● Unit Assessment ● Verbal Questioning and Discussions (whole class and small group) ● Case Study questions ● Lab Analysis Questions ● Simulations and/or Modeling Activities

Stage 3 – Learning Plan		
Code	***Pre-Assessment*** Entrance/Exit Tickets , discussions with students, kahoots or google form quick questions	
	Summary of Key Learning Events and Instruction *Student success at transfer meaning and acquisition depends on…*	Progress Monitoring
M, A	● take notes from videos and textbook readings on each topic	● Verbal Questioning and Discussions (whole class and small group) ● Questions on worksheets and homeworks ● Lab Analysis Questions ● Simulations and/or Modeling Activities ● Warm Ups and Exit tickets
M, A	● work collaboratively with partners or small groups to complete graphic organizers to summarize major concepts	
T, M, A	● Lab: Investigate the effect of salinity on surface tension and other properties of water	
T, M, A	● model dehydration synthesis and hydrolysis reactions using molecular model kits	
M, A	● POGIL on macromolecules	

Unit 2 - Cell Structure and Function

Stage 1 Desired Results

ESTABLISHED GOALS

SYI-1.D Describe the structure and/ or function of subcellular components and organelles.

SYI-1.E Explain how subcellular components and organelles contribute to the function of the cell.

SYI-1.F Describe the structural features of a cell that allow organisms to capture, store, and use energy

ENE-1.B Explain the effect of surface area-to-volume ratios on the exchange of materials between cells or organisms and the environment.

Explain how specialized structures and strategies are used for the efficient exchange of molecules to the environment.

ENE-2.A Describe the roles of each of the components of the cell membrane in maintaining the internal environment of the cell.

ENE-2.B Describe the Fluid Mosaic Model of cell membranes.

Transfer

Students will be able to independently use their learning to…

Science Practice 1 – Concept Explanation Explain biological concepts, processes, and models presented in written format.

Science Practice 2 – Visual Representations Analyze visual representations of biological concepts and processes.

Science Practice 4 – Representing and Describing Data Represent and describe data.

Science Practice 6 - Argumentation Develop and justify scientific arguments using evidence.

Meaning

UNDERSTANDINGS
Students will understand that…

SYI-1 Living systems are organized in a hierarchy of structural levels that interact.

ENE-1 The highly complex organization of living systems requires constant input of energy and the exchange of macromolecules.

ENE-2 Cells have membranes that allow them to establish and maintain internal environments that are different from their external environments.

EVO-1 Evolution is characterized by a change in the genetic makeup of a population over time and is supported by multiple lines of evidence.

ESSENTIAL QUESTIONS
Students will keep considering…

What are the origins of eukaryotic cells and the evidence to support this theory?

How do the mechanisms for transport across membranes support energy conservation?

What are the advantages and disadvantages of cellular compartmentalization?

How are living systems affected by the presence or absence of subcellular components?

Explain how the structure of biological membranes influences selective permeability ENE-2.E Describe the mechanisms that organisms use to maintain solute and water balance. ENE-2.F Describe the mechanisms that organisms use to transport large molecules across the plasma membrane. ENE-2.G Explain how the structure of a molecule affects its ability to pass through the plasma membrane. ENE-2.H Explain how concentration gradients affect the movement of molecules across membranes ENE-2.I Explain how osmoregulatory mechanisms contribute to the health and survival of organisms. ENE-2.J Describe the processes that allow ions and other molecules to move across membranes. ENE-2.K Describe the membrane bound structures of the eukaryotic cell. ENE-2.L Explain how internal membranes and membrane bound organelles contribute to compartmentalization of eukaryotic cell functions. EVO-1.A Describe similarities and/or	***Acquisition***	
	Students will know…	*Students will be skilled at…*
	SYI-1.D.1 Ribosomes comprise ribosomal RNA (rRNA) and protein. Ribosomes synthesize protein according to mRNA sequence. SYI-1.D.2 Ribosomes are found in all forms of life, reflecting the common ancestry of all known life. SYI-1.D.3 Endoplasmic reticulum (ER) occurs in two forms—smooth and rough. Rough ER is associated with membrane-bound ribosomes SYI-1.D.4 The Golgi complex is a membrane-bound structure that consists of a series of flattened membrane sacs SYI-1.D.5 Mitochondria have a double membrane. The outer membrane is smooth, but the inner membrane is highly convoluted, forming folds. SYI-1.D.6 Lysosomes are membrane-enclosed sacs that contain hydrolytic enzymes. SYI-1.D.7 A vacuole is a membrane-bound sac that plays many and differing roles. In plants, a specialized large vacuole serves multiple functions. SYI-1.D.8 Chloroplasts are specialized organelles that are found in photosynthetic algae and plants. Chloroplasts have a double outer membrane. SYI-1.E.1 Organelles and subcellular structures, and the interactions among them, support cellular function SYI-1.F.1 The folding of the inner membrane increases the surface area, which allows for more ATP to be	Describe the structure and/ or function of subcellular components and organelles. Explain how subcellular components and organelles contribute to the function of the cell. Describe the structural features of a cell that allow organisms to capture, store, and use energy Explain the effect of surface area-to-volume ratios on the exchange of materials between cells or organisms and the environment. Explain how specialized structures and strategies are used for the efficient exchange of molecules to the environment. Describe the roles of each of the components of the cell membrane in maintaining the internal environment of the cell. Describe the Fluid Mosaic Model of cell membranes. Explain how the structure of biological membranes influences selective permeability Describe the mechanisms that organisms use to maintain solute and water balance. Describe the mechanisms that organisms use to transport large molecules across the plasma membrane. Explain how the structure of a molecule affects its ability to pass through the plasma membrane. Explain how concentration gradients affect the movement

differences in compartmentalization between prokaryotic and eukaryotic cells. EVO-1.B Describe the relationship between the functions of endosymbiotic organelles and their free-living ancestral counterparts.	synthesized. SYI-1.F.2 Within the chloroplast are thylakoids and the stroma SYI-1.F.3 The thylakoids are organized in stacks, called grana. SYI-1.F.4 Membranes contain chlorophyll pigments and electron transport proteins that comprise the photosystems. SYI-1.F.5 The light-dependent reactions of photosynthesis occur in the grana. SYI-1.F.6 The stroma is the fluid within the inner chloroplast membrane and outside of the thylakoid. SYI-1.F.7 The carbon fixation (Calvin-Benson cycle) reactions of photosynthesis occur in the stroma. SYI-1.F.8 The Krebs cycle (citric acid cycle) reactions occur in the matrix of the mitochondria. SYI-1.F.9 Electron transport and ATP synthesis occur on the inner mitochondrial membrane. ENE-1.B.1 Surface area-to-volume ratios affect the ability of a biological system to obtain necessary resources, eliminate waste products, acquire or dissipate thermal energy, and otherwise exchange chemicals and energy with the environment. ENE-1.B.2 The surface area of the plasma membrane must be large enough to adequately exchange materials ENE-1.C.1 Organisms have evolved highly efficient strategies to obtain nutrients and eliminate wastes.	of molecules across membranes Explain how osmoregulatory mechanisms contribute to the health and survival of organisms. Describe the processes that allow ions and other molecules to move across membranes. Describe the membrane bound structures of the eukaryotic cell. Explain how internal membranes and membrane bound organelles contribute to compartmentalization of eukaryotic cell functions. Describe similarities and/or differences in compartmentalization between prokaryotic and eukaryotic cells. Describe the relationship between the functions of endosymbiotic organelles and their free-living ancestral counterparts.

	Cells and organisms use specialized exchange surfaces to obtain and release molecules from or into the surrounding environment. ENE-2.A.1 Phospholipids have both hydrophilic and hydrophobic regions. The hydrophilic phosphate regions of the phospholipids are oriented toward the aqueous external or internal environments, while the hydrophobic fatty acid regions face each other within the interior of the membrane. ENE-2.A.2 Embedded proteins can be hydrophilic, with charged and polar side groups, or hydrophobic, with nonpolar side groups. ENE-2.B.1 Cell membranes consist of a structural framework of phospholipid molecules that is embedded with proteins, steroids (such as cholesterol in eukaryotes), glycoproteins, and glycolipids that can flow around the surface of the cell within the membrane. ENE-2.C.1 The structure of cell membranes results in selective permeability. ENE-2.C.2 Cell membranes separate the internal environment of the cell from the external environment. ENE-2.C.3 Selective permeability is a direct consequence of membrane structure, as described by the fluid mosaic model. ENE-2.C.4 Small nonpolar molecules, including N2, O2, and CO2 , freely pass across the membrane. Hydrophilic substances, such as large polar molecules and ions, move across the membrane through embedded channel and transport proteins.	

	ENE-2.C.5 Polar uncharged molecules, including H2O, pass through the membrane in small amounts. ENE-2.D.1 Cell walls provide a structural boundary, as well as a permeability barrier for some substances to the internal environments. ENE-2.D.2 Cell walls of plants, prokaryotes, and fungi are composed of complex carbohydrates. ENE-2.E.1 Passive transport is the net movement of molecules from high concentration to low concentration without the direct input of metabolic energy. ENE-2.E.2 Passive transport plays a primary role in the import of materials and the export of wastes. ENE-2.E.3 Active transport requires the direct input of energy to move molecules from regions of low concentration to regions of high concentration. ENE-2.F.1 The selective permeability of membranes allows for the formation of concentration gradients of solutes across the membrane. ENE-2.F.2 The processes of endocytosis and exocytosis require energy to move large molecules into and out of cells ENE-2.G.1 Membrane proteins are required for facilitated diffusion of charged and large polar molecules through a membrane ENE-2.G.2 Membrane proteins are necessary for active transport. ENE-2.G.3 Metabolic energy (such as from ATP) is required for active transport of molecules and/ or ions across the membrane and to establish and maintain concentration gradients.	

	ENE-2.G.4 The Na+/K+ ATPase contributes to the maintenance of the membrane potential ENE-2.H.1 External environments can be hypotonic, hypertonic or isotonic to internal environments of cells ENE-2.I.1 Growth and homeostasis are maintained by the constant movement of molecules across membranes. ENE-2.I.2 Osmoregulation maintains water balance and allows organisms to control their internal solute composition/water potential. ENE-2.J.1 A variety of processes allow for the movement of ions and other molecules across membranes, including passive and active transport, endocytosis and exocytosis. ENE-2.K.1 Membranes and membrane-bound organelles in eukaryotic cells compartmentalize intracellular metabolic processes and specific enzymatic reactions. ENE-2.L.1 Internal membranes facilitate cellular processes by minimizing competing interactions and by increasing surface areas where reactions can occur. ENE-2.L.1 Internal membranes facilitate cellular processes by minimizing competing interactions and by increasing surface areas where reactions can occur. EVO-1.B.1 Membrane-bound organelles evolved from previously free-living prokaryotic cells via endosymbiosis.	

Stage 2 – Evidence		
Code	**Evaluative Criteria**	**Assessment Evidence**
	Students are assessed on their understanding of core concepts of cellular organelles, membrane structure, and their role in maintaining homeostasis in organisms. Students are required to use their critical thinking skills including data analysis, data interpretation, hypothesizing and justifying conclusions evaluated by the GIZMO rubrics.	PERFORMANCE TASK(S): *Students will show that they really understand evidence of…* Gizmo Case Study - Osmosis - As a veterinarian, students help a young calf, named Clark, who is having seizures. To determine the cause, the students fly into Clark's brain to collect data on sodium and pressure levels in the brain matrix and blood, the neuron firing rate and free water movement between the blood and the brain. They then analyze and interpret the data by comparing it to normal levels. Using their learning , they are then asked to form a diagnosis on whether cerebral edema or epilepsy is the cause of the seizures. - They are then presented with 3 saline treatment options and are asked to hypothesize which will be the most effective. They then return to the brain to administer their treatment and observe how the treatment affects the data.
		OTHER EVIDENCE: *Students will show they have achieved Stage 1 goals by…* ● Unit Assessment ● Verbal Questioning and Discussions (whole class and small group) ● Case Study questions ● Lab Analysis Questions ● Simulations and/or Modeling Activities

Stage 3 – Learning Plan

Code	***Pre-Assessment*** Entrance/Exit Tickets , discussions with students, kahoots or google form quick questions	
	Summary of Key Learning Events and Instruction *Student success at transfer meaning and acquisition depends on…*	Progress Monitoring
M, A	● take notes from videos and textbook readings on each topic	● Verbal Questioning and Discussions (whole class and small group) ● Questions on worksheets and homeworks ● Lab Analysis Questions ● Simulations and/or Modeling Activities ● Warm Ups and Exit tickets
M, A	● work collaboratively with partners or small groups to complete graphic organizers to summarize major concepts	
M, A	● Cell Analogy Activity	
T, M, A	● Case Study: Defective Cell Organelles	
M, A	● Bubble Membrane Activity	
T, M, A	● Lab: Investigate the effect of concentration on membrane transport	
T, M, A	● Case Study: Osmosis and Seizures	

Unit 3 - Cell Energetics

Stage 1 Desired Results

ESTABLISHED GOALS

ENE-1.D Describe the properties of enzymes.

ENE-1.E Explain how enzymes affect the rate of biological reactions.

ENE-1.F Explain how changes to the structure of an enzyme may affect its function.

ENE-1.H Describe the role of energy in living organisms.

ENE-1.I Describe the photosynthetic processes that allow organisms to capture and store energy

ENE-1.J Explain how cells capture energy from light and transfer it to biological molecules for storage and use.

ENE-1.K Describe the processes that allow organisms to use energy stored in biological macromolecules.

ENE-1.L Explain how cells obtain energy from biological macromolecules in order to power cellular functions.

Transfer

Students will be able to independently use their learning to…

Science Practice 1 – Concept Explanation Explain biological concepts, processes, and models presented in written format.
Science Practice 2 – Visual Representations Analyze visual representations of biological concepts and processes.
Science Practice 3 – Questions and Methods Determine scientific questions and methods.
Science Practice 4 – Representing and Describing Data Represent and describe data.
Science Practice 5 – Statistical Tests and Data Analysis Perform statistical tests and mathematical calculations to analyze and interpret data.
Science Practice 6 - Argumentation Develop and justify scientific arguments using evidence.

Meaning

UNDERSTANDINGS
Students will understand that…

ENE-1 The highly complex organization of living systems requires constant input of energy and the exchange of macromolecules.

ESSENTIAL QUESTIONS
Students will keep considering…

How is energy captured and then used by a living system?

How do organisms use energy or conserve energy to respond to environmental stimuli?

Acquisition

Students will know…

ENE-1.D.1 The structure of enzymes includes the active site that specifically interacts with substrate molecules.

ENE-1.D.2 For an enzyme-mediated chemical reaction

Students will be skilled at…

Describing the properties of enzymes.

Explaining how enzymes affect the rate of biological reactions.

	to occur, the shape and charge of the substrate must be compatible with the active site of the enzyme. ENE-1.E.1 The structure and function of enzymes contribute to the regulation of biological processes ENE-1.F.1 Change to the molecular structure of a component in an enzymatic system may result in a change of the function or efficiency of the system ENE-1.F.2 In some cases, enzyme denaturation is reversible, allowing the enzyme to regain activity ENE-1.G.1 Environmental pH can alter the efficiency of enzyme activity, including through disruption of hydrogen bonds that provide enzyme structure. ENE-1.G.2 The relative concentrations of substrates and products determine how efficiently an enzymatic reaction proceeds. ENE-1.G.3 Higher environmental temperatures increase the speed of movement of molecules in a solution, increasing the frequency of collisions between enzymes and substrates and therefore increasing the rate of reaction. ENE-1G.4 Competitive inhibitor molecules can bind reversibly or irreversibly to the active site of the enzyme. Noncompetitive inhibitors can bind allosteric sites, changing the activity of the enzyme. ENE-1.H.1 All living systems require constant input of energy. ENE-1.H.2 Life requires a highly ordered system and does not violate the second law of thermodynamics ENE-1.H.3 Energy-related pathways in biological systems are sequential to allow for a more controlled and efficient transfer of energy. A product of a reaction in a metabolic pathway is generally the reactant for the subsequent step in the pathway.	Explaining how changes to the structure of an enzyme may affect its function. Describing the role of energy in living organisms. Describing the photosynthetic processes that allow organisms to capture and store energy Explaining how cells capture energy from light and transfer it to biological molecules for storage and use. Describing the processes that allow organisms to use energy stored in biological macromolecules. Explaining how cells obtain energy from biological macromolecules in order to power cellular functions.

	ENE-1.I.1 Organisms capture and store energy for use in biological processes ENE-1.I.2 The light-dependent reactions of photosynthesis in eukaryotes involve a series of coordinated reaction pathways that capture energy present in light to yield ATP and NADPH, which power the production of organic molecules. ENE-1.J.1 During photosynthesis, chlorophylls absorb energy from light, boosting electrons to a higher energy level in photosystems I and II. ENE-1.J.2 Photosystems I and II are embedded in the internal membranes of chloroplasts and are connected by the transfer of higher energy electrons through an electron transport chain (ETC). ENE-1.J.3 When electrons are transferred between molecules in a sequence of reactions as they pass through the ETC, an electrochemical gradient of protons (hydrogen ions) is established across the internal membrane. ENE-1.J.4 The formation of the proton gradient is linked to the synthesis of ATP from ADP and inorganic phosphate via ATP synthase. ENE-1.J.5 The energy captured in the light reactions and transferred to ATP and NADPH powers the production of carbohydrates from carbon dioxide in the Calvin cycle, which occurs in the stroma of the chloroplast. ENE-1.K.1 Fermentation and cellular respiration use energy from biological macromolecules to produce ATP. Respiration and fermentation are characteristic of all forms of life. ENE-1.K.2 Cellular respiration in eukaryotes involves a series of coordinated enzyme-catalyzed reactions that capture energy from biological macromolecules. ENE-1.K.3 The electron transport chain transfers energy from electrons in a series of coupled reactions that establish an	

	electrochemical gradient across membranes ENE-1.L.1 Glycolysis is a biochemical pathway that releases energy in glucose to form ATP from ADP and inorganic phosphate, NADH from NAD+, and pyruvate. ENE-1.L.2 Pyruvate is transported from the cytosol to the mitochondrion, where further oxidation occurs. ENE-1.L.3 In the Krebs cycle, carbon dioxide is released from organic intermediates, ATP is synthesized from ADP and inorganic phosphate, and electrons are transferred to the coenzymes NADH and FADH2. ENE-1.L.4 Electrons extracted in glycolysis and Krebs cycle reactions are transferred by NADH and FADH2 to the electron transport chain in the inner mitochondrial membrane. ENE-1.L.5 When electrons are transferred between molecules in a sequence of reactions as they pass through the ETC, an electrochemical gradient of protons (hydrogen ions) across the inner mitochondrial membrane is established. ENE-1.L.6 Fermentation allows glycolysis to proceed in the absence of oxygen and produces organic molecules, including alcohol and lactic acid, as waste products. ENE-1.L.7 The conversion of ATP to ADP releases energy, which is used to power many metabolic processes.	

Stage 2 – Evidence

Code	Evaluative Criteria	Assessment Evidence
T, M, A	Students evaluated based on the College Board lab report rubric:	PERFORMANCE TASK(S): *Students will show that they really understand evidence of…* Students will design and carry out an investigation to determine how various environmental factors affect the reaction rates of enzymes that carry out the process of photosynthesis in leaf disks. They will either write a formal lab report or construct a mini poster including all elements in the rubric to share and explain their findings

TITLE	-Concisely explains the purpose of the investigation (e.g., the effect of additional nitrogen fertilizer on the growth rate of corn)	3 pts
ABSTRACT	-A summary of the lab investigation	3 pts
	-Fewer than 100 words (This should mirror abstracts for articles in scientific journals.)	
INTRODUCTION	-Background information	5 pts
	-Purpose of the investigation; how the investigation answers a specific question; curricular context	5 pts
	-Hypothesis(es) ("if … then")	5 pts
MATERIALS AND PROCEDURES	-Materials/supplies listed	5 pts
	-Procedures clearly stated	5 pts
RESULTS/DATA COLLECTION/ ANALYSIS	-Data recorded in tables (tables titled, calculations completed)	10 pts
	-Graphs (X-Y and histograms) present	10 pts
	-Graphs titled	2 pts
	-Axes labeled correctly	3 pts
	-Statistical analysis	5 pts
CONCLUSIONS AND DISCUSSION	-Results summarized	2 pts
	-Errors identified	2 pts
	-Results compared to hypothesis and primary question	2 pts
	-Conclusions stated/results interpreted	10 pts
	-Suggestions for improvement	4 pts
QUESTIONS	-What are questions for further investigation? What new questions arise from the results of the investigation?	12 pts

		OTHER EVIDENCE: *Students will show they have achieved Stage 1 goals by…* ● Unit Assessment ● Verbal Questioning and Discussions (whole class and small group) ● Case Study questions ● Lab Analysis Questions ● Simulations and/or Modeling Activities

Stage 3 – Learning Plan

Code	***Pre-Assessment*** Entrance/Exit Tickets , discussions with students, kahoots or google form quick questions	
	Summary of Key Learning Events and Instruction *Student success at transfer meaning and acquisition depends on…*	Progress Monitoring
M, A	● take notes from videos and textbook readings on each topic	● Verbal Questioning and Discussions (whole class and small group) ● Questions on worksheets and homeworks ● Lab Analysis Questions ● Simulations and/or Modeling Activities ● Warm Ups and Exit tickets
M, A	● work collaboratively with partners or small groups to complete graphic organizers to summarize major concepts	
T, M, A	● Lab: Investigate Factors Affecting Enzyme Reaction Rates	
T, M, A	● Case Study: Enzymes and Digestion	
M, A	● Modeling Photosynthesis and Cellular Respiration Activities	
T, M, A	● Lab: Factors affecting the Rate of Photosynthesis	

Unit 4 - Cell Division and Communication

Stage 1 Desired Results

ESTABLISHED GOALS

IST-3.A Describe the ways that cells can communicate with one another

IST-3.B Explain how cells communicate with one another over short and long distances.

IST-3.C Describe the components of a signal transduction pathway.

IST-3D Describe the role of components of a signal transduction pathway in producing a cellular response.

IST-3.E Describe the role of the environment in eliciting a cellular response

IST-3.F Describe the different types of cellular responses elicited by a signal transduction pathway

IST-3G Explain how a change in the structure of any signaling molecule affects the activity of the signaling pathway.

ENE-3.A Describe positive and/ or negative feedback mechanisms.

Transfer

Students will be able to independently use their learning to…

Science Practice 1 – Concept Explanation - Explain biological concepts, processes, and models presented in written format.

Science Practice 2 – Visual Representations - Analyze visual representations of biological concepts and processes.

Science Practice 4 – Representing and Describing Data - Represent and describe data

Meaning

UNDERSTANDINGS
Students will understand that…

IST-3 Cells communicate by generating, transmitting, receiving, and responding to chemical signals.

IST-3 Cells communicate by generating, transmitting, receiving, and responding to chemical signals

ENE-3 Timing and coordination of biological mechanisms involved in growth, reproduction, and homeostasis depend on organisms responding to environmental cues.

IST-1 Heritable information provides for continuity of life.

ESSENTIAL QUESTIONS
Students will keep considering…

In what ways do cells use energy to communicate with one another?

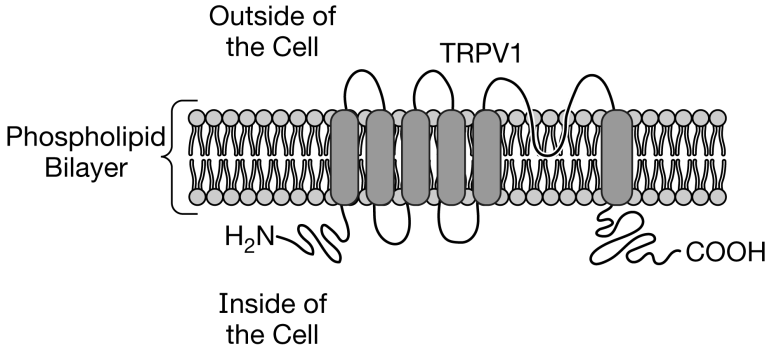
How does the cell cycle aid in the conservation of genetic information?

Why and in what ways do cells communicate with one another?

ENE-3.B Explain how negative feedback helps to maintain homeostasis. ENE-3.C Explain how positive feedback affects homeostasis. IST-1.B Describe the events that occur in the cell cycle. IST-1.C Explain how mitosis results in the transmission of chromosomes from one generation to the next. IST-1.D Describe the role of checkpoints in regulating the cell cycle. IST-1.E Describe the effects of disruptions to the cell cycle on the cell or organism.	***Acquisition***	
	Students will know…	*Students will be skilled at…*
	IST-3.A.1 Cells communicate with one another through direct contact with other cells or from a distance via chemical signaling IST-3.B.1 Cells communicate over short distances by using local regulators that target cells in the vicinity of the signal-emitting cell IST-3.C.1 Signal transduction pathways link signal reception with cellular responses. IST-3.C.2 Many signal transduction pathways include protein modification and phosphorylation cascades. IST-3.D.1 Signaling begins with the recognition of a chemical messenger—a ligand—by a receptor protein in a target cell— IST-3.D.2 Signaling cascades relay signals from receptors to cell targets, often amplifying the incoming signals, resulting in the appropriate responses by the cell, which could include cell growth, secretion of molecules, or gene expression IST-3.E.1 Signal transduction pathways influence how the cell responds to its environment. IST-3.F.1 Signal transduction may result in changes in gene expression and cell function, which may alter phenotype or result in programmed cell death (apoptosis). IST-3.G.1 Changes in signal transduction pathways can alter cellular response— IST-3.G.2 Chemicals that interfere with any component of the signaling pathway may activate or inhibit the	Describing the ways that cells can communicate with one another Explaining how cells communicate with one another over short and long distances. Describing the components of a signal transduction pathway. Describing the role of components of a signal transduction pathway in producing a cellular response. Describing the role of the environment in eliciting a cellular response Describing the different types of cellular responses elicited by a signal transduction pathway Explaining how a change in the structure of any signaling molecule affects the activity of the signaling pathway. Describing positive and/ or negative feedback mechanisms. Explaining how negative feedback helps to maintain homeostasis. Explaining how positive feedback affects homeostasis. Describing the events that occur in the cell cycle. Explaining how mitosis results in the transmission of chromosomes from one generation to the next. Describing the role of checkpoints in regulating the cell cycle.

	pathway. ENE-3.A.1 Organisms use feedback mechanisms to maintain their internal environments and respond to internal and external environmental changes. ENE-3.B.1 Negative feedback mechanisms maintain homeostasis for a particular condition by regulating physiological processes. If a system is perturbed, negative feedback mechanisms return the system back to its target set point. These processes operate at the molecular and cellular levels. ENE-3.C.1 Positive feedback mechanisms amplify responses and processes in biological organisms. The variable initiating the response is moved farther away from the initial set point. Amplification occurs when the stimulus is further activated, which, in turn, initiates an additional response that produces system change. IST-1.B.1 In eukaryotes, cells divide and transmit genetic information via two highly regulated processes. IST-1.B.2 The cell cycle is a highly regulated series of events for the growth and reproduction of cells IST-1.C.1 Mitosis is a process that ensures the transfer of a complete genome from a parent cell to two genetically identical daughter cells IST-1.D.1 A number of internal controls or checkpoints regulate progression through the cycle. IST-1.D.2 Interactions between cyclins and cyclin dependent kinases control the cell cycle. IST-1.E.1 Disruptions to the cell cycle may result in cancer and/or programmed cell death (apoptosis).	Describing the effects of disruptions to the cell cycle on the cell or organism.

Stage 2 – Evidence

Code	Evaluative Criteria	Assessment Evidence
T, M, A	Scoring according the the College Board rubric: Part A An acceptable description. Acceptable descriptions include the following. - The site of TRPV1 that allows H ions to bind will have to be negatively charged and will be part of the extracellular domain - ATF3 is produced on cytoplasmic (free) ribosomes as it is used within the cell and not secreted Part B - The response includes an explanation that (cells are not able to undergo mitosis) because they have not been able to perform DNA replication. Part C - A prediction that apoptosis will not be induced - A justification that if NFAT2 cannot be dephosphorylated, it will be unable to (move to the nucleus and) inhibit ATF3 expression, so ATF3 will inhibit pGoG, which will not induce apoptosis Part D - The response includes support for the claim by stating that a mutation resulting in a nonfunctional pGoG will result in the inability of pGoG to stop cells from dividing/induce apoptosis, and cancer is characterized by excessive cell division.	PERFORMANCE TASK(S): *Students will show that they really understand evidence of…* **Free Response Question -** Students will answer the following **FRQ** to demonstrate their understanding of the process of cell signaling as it relates to cell growth and division. Increased expression and activity of the ligand-gated ion channel TRPV1 has been shown to block cell division and induce apoptosis in human cells. The structure of the TRPV1 protein consists of several transmembrane domains that are embedded in the membrane as well as a carboxy-terminus and an amino-terminus that are located inside the cell (Figure 1).  Figure 1. Structure of the TRPV1 protein channel in the membraneTRPV1 is activated by several stimuli, including the binding of capsaicin, a chemical found in chili peppers. Capsaicin enters the cell by simple diffusion and then binds to one of the transmembrane domains of TRPV1, which opens the ion channel. The opening of the TRPV1 channel allows Ca2+ ions to enter the cell, leading to the activation of the enzyme calcineurin. Calcineurin removes phosphate groups from the phosphorylated form of the transcription factor NFAT2, which is typically found in the cytoplasm. Once dephosphorylated, NFAT2 moves into the nucleus, where it blocks the transcription of another protein, ATF3. ATF3, when active, prevents the cell cycle regulatory protein pGoG from inducing apoptosis and blocking cell division (Figure 2).

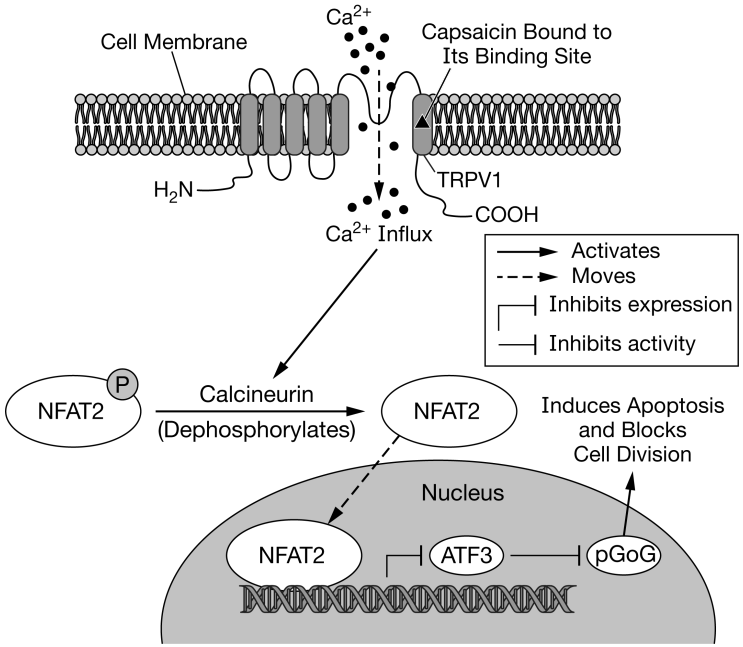


Figure 2. Capsaicin-activated TRPV1 signaling pathway in human cells

(a) Low extracellular pH activates TRPV1 through the binding of H+ ions toTRPV1. **Describe** the properties, including the location, of the site of TRPV1 that allow H+ ions to bind. **Describe** the specific location in the cell where ATF3 protein is produced.

(b) The pGoG protein is known to block the G1 to S transition in the cell cycle. **Explain** why this prevents mitosis from happening in the cell.

(c) Before treating melanoma cells with capsaicin, researchers pretreated the cells with an inhibitor of calcineurin. **Predict** the effect of this pretreatment on the ability of capsaicin to induce apoptosis by the pathway shown in Figure 2. Provide reasoning to **justify** your prediction.

(d) Researchers claim that many cancers include a mutation in the gene encoding pGoG. **Support** the researchers' claim.

		OTHER EVIDENCE: *Students will show they have achieved Stage 1 goals by…* ● Unit Assessment ● Verbal Questioning and Discussions (whole class and small group) ● Case Study questions ● Lab Analysis Questions ● Simulations and/or Modeling Activities

Stage 3 – Learning Plan

Code	***Pre-Assessment*** Entrance/Exit Tickets , discussions with students, kahoots or google form quick questions	
	Summary of Key Learning Events and Instruction *Student success at transfer meaning and acquisition depends on…*	Progress Monitoring ● Verbal Questioning and Discussions (whole class and small group) ● Questions on worksheets and homeworks ● Lab Analysis Questions ● Simulations and/or Modeling Activities ● Warm Ups and Exit tickets
M, A	● take notes from videos and textbook readings on each topic	
M, A	● work collaboratively with partners or small groups to complete graphic organizers to summarize major concepts	
M, A	● model the process of mitosis and meiosis using manipulatives	
T, M, A	● Lab: Onion Root Tip Lab and TIme in the Cell Cycle	
T, M, A	● Case Study: Diabetes and insulin signaling	
M, A	● POGIL - Cell Communication	
T, M, A	● Analyze changes to the following cell signaling pathways: epinephrine, insulin, growth hormone, and endocrine disruptors and predict impact to cells	

Unit 5 - Heredity

Stage 1 Desired Results

ESTABLISHED GOALS

IST-1.F Explain how meiosis results in the transmission of chromosomes from one generation to the next.

IST-1.G Describe similarities and/ or differences between the phases and outcomes of mitosis and meiosis.

IST-1.H Explain how the process of meiosis generates genetic diversity

EVO-2.A Explain how shared, conserved, fundamental processes and features support the concept of common ancestry for all organisms

IST-1.I Explain the inheritance of genes and traits as described by Mendel's laws.

IST-1.J Explain deviations from Mendel's model of the inheritance of traits.

SYI-3.B Explain how the same genotype can result in multiple phenotypes under different environmental conditions.

SYI-3.C Explain how chromosomal inheritance generates genetic variation

Transfer

Students will be able to independently use their learning to…

Science Practice 1 – Concept Explanation Explain biological concepts, processes, and models presented in written format.

Science Practice 2 – Visual Representations Analyze visual representations of biological concepts and processes.

Science Practice 5 – Statistical Tests and Data Analysis Perform statistical tests and mathematical calculations to analyze and interpret data.

Science Practice 6 - Argumentation Develop and justify scientific arguments using evidence.

Meaning

UNDERSTANDINGS
Students will understand that…

IST-1 Heritable information provides for continuity of life.

EVO-2 Organisms are linked by lines of descent from common ancestry.

SYI-3 Naturally occurring diversity among and between components within biological systems affects interactions with the environment

ESSENTIAL QUESTIONS
Students will keep considering…

How is our understanding of evolution influenced by our knowledge of genetics?

Why is it important that not all inherited characteristics get expressed in the next generation?

How would Mendel's laws have been affected if he had studied a different type of plant?

How does the diversity of a species affect inheritance?

in sexual reproduction.	***Acquisition***	
	Students will know…	*Students will be skilled at…*
	IST-1.F.1 Meiosis is a process that ensures the formation of haploid gamete cells in sexually reproducing diploid organisms IST-1.G.1 Mitosis and meiosis are similar in the way chromosomes segregate but differ in the number of cells produced and the genetic content of the daughter cells. IST-1.H.1 Separation of the homologous chromosomes in meiosis I ensures that each gamete receives a haploid (1n) set of chromosomes that comprises both maternal and paternal chromosomes. IST-1.H.2 During meiosis I, homologous chromatids exchange genetic material via a process called "crossing over" (recombination), which increases genetic diversity among the resultant gametes. IST-1.H.3 Sexual reproduction in eukaryotes involving gamete formation—including crossing over, the random assortment of chromosomes during meiosis, and subsequent fertilization of gametes—serves to increase variation. EVO-2.A.1 DNA and RNA are carriers of genetic information. EVO-2.A.2 Ribosomes are found in all forms of life. EVO-2.A.3 Major features of the genetic code are shared by all modern living systems. EVO-2.A.4 Core metabolic pathways are conserved across all currently recognized domains.	Explaining how meiosis results in the transmission of chromosomes from one generation to the next. Describing similarities and/ or differences between the phases and outcomes of mitosis and meiosis. Explaining how the process of meiosis generates genetic diversity Explaining how shared, conserved, fundamental processes and features support the concept of common ancestry for all organisms Explaining the inheritance of genes and traits as described by Mendel's laws. Explaining deviations from Mendel's model of the inheritance of traits. Explaining how the same genotype can result in multiple phenotypes under different environmental conditions. Explaining how chromosomal inheritance generates genetic variation in sexual reproduction.

	IST-1.I.1 Mendel's laws of segregation and independent assortment can be applied to genes that are on different chromosomes. IST-1.I.2 Fertilization involves the fusion of two haploid gametes, restoring the diploid number of chromosomes and increasing genetic variation in populations by creating new combinations of alleles in the zygote IST-1.J.1 Patterns of inheritance of many traits do not follow ratios predicted by Mendel's laws and can be identified by quantitative analysis, where observed phenotypic ratios statistically differ from the predicted ratios IST-1.J.2 Some traits are determined by genes on sex chromosomes and are known as sexlinked traits. The pattern of inheritance of sex-linked traits can often be predicted from data, including pedigree, indicating the parent genotype/phenotype and the offspring genotypes/phenotypes. IST-1.J.3 Many traits are the product of multiple genes and/or physiological processes acting in combination; these traits therefore do not segregate in Mendelian patterns. IST-1.J.4 Some traits result from non-nuclear inheritance— SYI-3.B.1 Environmental factors influence gene expression and can lead to phenotypic plasticity. Phenotypic plasticity occurs when individuals with the same genotype exhibit different phenotypes in different environments. SYI-3.C.1 Segregation, independent assortment of chromosomes, and fertilization result in genetic	

	variation in populations. SYI-3.C.2 The chromosomal basis of inheritance provides an understanding of the pattern of transmission of genes from parent to offspring. SYI-3.C.3 Certain human genetic disorders can be attributed to the inheritance of a single affected or mutated allele or specific chromosomal changes, such as nondisjunction.	

Stage 2 – Evidence

Code	Evaluative Criteria	Assessment Evidence
T, M, A	Scored according to College Board Rubric: **Part A** **Maximum 4 points** 1 pt Genotypes of the parents (words or symbols) X^EY (or X^+Y) and X^eXe 1 pt Discuss/show how these resulted in this F1 (may be annotated Punnett) 1 pt Explain that it is a sex-linked (X-linked) gene (not just the word) 1 pt How you know which type is dominant 1 pt F2 results (may be annotated Punnett square) Part B **Maximum 4 points** 1 pt Correct F2 hypothesis (1:1:1:1; or 25/genotype) 1 pt Show work (components): (o-e)2/e (or correct numbers (4/25 + 36/25 + 1/ 25 + 9/25 = 50/25 = 2; or at least the last term) 1 pt Sum: correct chi-square result ~ 2.0 or 1.85 1 pt degrees of freedom = 3 (critical value is 7.82) 1 pt: correct interpretation of chi-square in terms of p p = probability that the difference between the observed and the expected value is due to chance alone. This p value shows we accept our hypothesis. The null hypothesis is supported in this case	PERFORMANCE TASK(S): *Students will show that they really understand evidence of…* **Free Response Question -** Students will answer the following **FRQs** to demonstrate their understanding of heredity. In fruit flies, the phenotype for eye color is determined by a certain locus. ***E*** indicates the dominant allele and ***e*** indicates the recessive allele. The cross between a male wild-type fruit fly and a female white-eyed fruit fly produced the following offspring. Wild-type Male | Wild-type Female | White-eyed Male | White-eyed Female | Brown-eyed Female F1: 0 | 45 | 55 | 0 | 1 The wild-type and white-eyed individuals from the F1 generation were then crossed to produce the following offspring. F2: 23 | 31 | 22 | 24 | 0 (a) Determine the genotypes of the original parents (P generation) and explain your reasoning. You may use Punnett squares to enhance your description, but the results from the Punnett squares must be discussed in your answer. (b) Use a Chi-squared test on the F2 generation data to analyze your prediction of the parental genotypes. Show all your work and explain the importance of your final answer. (c) The brown-eyed female in the F1 generation resulted from a mutational change. Explain what a mutation is, and discuss two types of mutations that might have produced the brown-eyed female in the F1 generation.

	Part C **Maximum 4 points** 1 pt Explain what a mutation is: (heritable) change in the DNA (code) 1-2 pts Discuss 2 types of mutations May be: Point mutation, frameshift (deletion/duplication), insertion, transposition, break, inversion within gene, base substitution, nonsense/stop, missense) May NOT be: chromosomal aberration, nondisjunction, silent/neutral, transcription or translation or processing error 1 pt Molecular or biochemical elaboration beyond the explanation required	
		OTHER EVIDENCE: *Students will show they have achieved Stage 1 goals by…* ● Unit Assessment ● Verbal Questioning and Discussions (whole class and small group) ● Case Study questions ● Lab Analysis Questions ● Simulations and/or Modeling Activities

Stage 3 – Learning Plan		
Code	***Pre-Assessment*** Entrance/Exit Tickets , discussions with students, kahoots or google form quick questions	
	Summary of Key Learning Events and Instruction *Student success at transfer meaning and acquisition depends on…*	Progress Monitoring
M, A	● take notes from videos and textbook readings on each topic	● Verbal Questioning and Discussions (whole class and small group) ● Questions on worksheets and homeworks ● Lab Analysis Questions ● Simulations and/or Modeling Activities ● Warm Ups and Exit tickets
M, A	● using punnett squares and the rules of probability to predict genotypic and phenotypic outcomes of genetic crosses	
T, M, A	● working collaboratively with partners or small groups to complete genetics practice problems (Mendelian, non-Mendelian, genetic linkage, and pedigrees)	
M, A	● working collaboratively with partners or small groups to use chi square to statistically analyze the results of genetic crosses	
	● creating chromosome maps of linked genes using recombination frequencies	

Unit 6 - Gene Expression and Biotechnology

Stage 1 Desired Results

ESTABLISHED GOALS

IST-1.K Describe the structures involved in passing hereditary information from one generation to the next.

IST-1.L Describe the characteristics of DNA that allow it to be used as the hereditary material.

IST-1.M Describe the mechanisms by which genetic information is copied for transmission between generations.

IST-1.N Describe the mechanisms by which genetic information flows from DNA to RNA to protein.

IST-1.O Explain how the phenotype of an organism is determined by its genotype.

IST-2.A Describe the types of interactions that regulate gene expression.

IST-2.B Explain how the location of regulatory sequences relates to their function

IST-2.C Explain how the binding of transcription factors to promoter

Transfer

Students will be able to independently use their learning to…

Science Practice 1 – Concept Explanation Explain biological concepts, processes, and models presented in written format.

Science Practice 2 – Visual Representations Analyze visual representations of biological concepts and processes.

Science Practice 4 – Representing and Describing Data Represent and describe data.

Science Practice 6 - Argumentation Develop and justify scientific arguments using evidence.

Meaning

UNDERSTANDINGS
Students will understand that…

IST-1 Heritable information provides for continuity of life

IST-2 Differences in the expression of genes account for some of the phenotypic differences between organisms.

IST-4 The processing of genetic information is imperfect and is a source of genetic variation.

ESSENTIAL QUESTIONS
Students will keep considering…

How does gene regulation relate to the continuity of life?

How is a species' genetic information diversified from generation to generation?

Acquisition

Students will know…
IST-1.K.1 DNA, and in some cases RNA, is the primary source of heritable information. IST-1.K.2 Genetic information is transmitted from one generation to the next through DNA or RNA—

Students will be skilled at…

Describing the structures involved in passing hereditary information from one generation to the next.

regions affects gene expression and/or the phenotype of the organism. IST-2.D Explain the connection between the regulation of gene expression and phenotypic differences in cells and organisms. IST-2.E Describe the various types of mutation. IST-4.A Explain how changes in genotype may result in changes in phenotype. IST-4.B Explain how alterations in DNA sequences contribute to variation that can be subject to natural selection IST-1.P Explain the use of genetic engineering techniques in analyzing or manipulating DNA.	IST-1.K.3 Prokaryotes and eukaryotes can contain plasmids, which are small extra-chromosomal, double-stranded, circular DNA molecules. IST-1.L.1 DNA, and sometimes RNA, exhibits specific nucleotide base pairing that is conserved through evolution: adenine pairs with thymine or uracil (A-T or A-U) and cytosine pairs with guanine (C-G) IST-1.M.1 DNA replication ensures continuity of hereditary information IST-1.N.1 The sequence of the RNA bases, together with the structure of the RNA molecule, determines RNA function IST-1.N.2 Genetic information flows from a sequence of nucleotides in DNA to a sequence of bases in an mRNA molecule to a sequence of amino acids in a protein. IST-1.N.3 RNA polymerases use a single template strand of DNA to direct the inclusion of bases in the newly formed RNA molecule. This process is known as transcription. IST-1.N.4 The DNA strand acting as the template strand is also referred to as the noncoding strand, minus strand, or antisense strand. Selection of which DNA strand serves as the template strand depends on the gene being transcribed. IST-1.N.5 The enzyme RNA polymerase synthesizes mRNA molecules in the 5’ to 3’ direction by reading the template DNA strand in the 3’ to 5’ direction. IST-1.N.6 In eukaryotic cells the mRNA transcript undergoes a series of enzyme-regulated modifications IST-1.O.1 Translation of the mRNA to generate a polypeptide occurs on ribosomes that are present in the cytoplasm of both prokaryotic and eukaryotic cells	Describing the characteristics of DNA that allow it to be used as the hereditary material. Describing the mechanisms by which genetic information is copied for transmission between generations. Describing the mechanisms by which genetic information flows from DNA to RNA to protein. Explaining how the phenotype of an organism is determined by its genotype. Describing the types of interactions that regulate gene expression. Explaining how the location of regulatory sequences relates to their function Explaining how the binding of transcription factors to promoter regions affects gene expression and/or the phenotype of the organism. Explaining the connection between the regulation of gene expression and phenotypic differences in cells and organisms. Describing the various types of mutation. Explaining how changes in genotype may result in changes in phenotype. Explaining how alterations in DNA sequences contribute to variation that can be subject to natural selection Explaining the use of genetic engineering techniques in analyzing or manipulating DNA.

	and on the rough endoplasmic reticulum of eukaryotic cells. IST-1.O.2 In prokaryotic organisms, translation of the mRNA molecule occurs while it is being transcribed. IST-1.O.3 Translation involves energy and many sequential steps, including initiation, elongation, and termination. IST-1.O.4 The salient features of translation - codons read as mRNA triplets, every codon codes for a specific amino acid, tRNA carry the amino acids to the codons, the code is universal between organisms IST-1.O.5 Genetic information in retroviruses is a special case and has an alternate flow of information: from RNA to DNA, made possible by reverse transcriptase, an enzyme that copies the viral RNA genome into DNA. This DNA integrates into the host genome and becomes transcribed and translated for the assembly of new viral progeny. IST-2.A.1 Regulatory sequences are stretches of DNA that interact with regulatory proteins to control transcription. IST-2.A.2 Epigenetic changes can affect gene expression through reversible modifications of DNA or histones. IST-2.A.3 The phenotype of a cell or organism is determined by the combination of genes that are expressed and the levels at which they are expressed— IST-2.B.1 Both prokaryotes and eukaryotes have groups of genes that are coordinately regulated— IST-2.C.1 Promoters are DNA sequences upstream of the transcription start site where RNA polymerase and transcription factors bind to initiate transcription. IST-2.C.2 Negative regulatory molecules inhibit gene expression by binding to DNA and blocking transcription.	

	IST-2.D.1 Gene regulation results in differential gene expression and influences cell products and function. IST-2.D.2 Certain small RNA molecules have roles in regulating gene expression. IST-2.E.1 Changes in genotype can result in changes in phenotype— IST-2.E.2 Alterations in a DNA sequence can lead to changes in the type or amount of the protein produced and the consequent phenotype. DNA mutations can be positive, negative, or neutral based on the effect or the lack of effect they have on the resulting nucleic acid or protein and the phenotypes that are conferred by the protein IST-4.A.1 Errors in DNA replication or DNA repair mechanisms, and external factors, including radiation and reactive chemicals, can cause random mutations in the DNA— IST-4.A.2 Errors in mitosis or meiosis can result in changes in phenotype— IST-4.B.1 Changes in genotype may affect phenotypes that are subject to natural selection. Genetic changes that enhance survival and reproduction can be selected for by environmental conditions— ESSENTIAL KNOWLEDGE IST-1.P.1 Genetic engineering techniques can be used to analyze and manipulate DNA and RNA—	

Stage 2 – Evidence		
Code	**Evaluative Criteria**	**Assessment Evidence**
T, M, A	Content Accuracy - includes all required components of the prokaryotic operon (gene, structural gene, promoter, operon, repressor gene, corepressors, inhibitors, and activators) - includes a key for all symbols - demonstrates impact on transcription and translation - explains the impact of a mutation in either gene on the regulatory process Presentation - is neat, colorful, and clearly labeled	PERFORMANCE TASK(S): *Students will show that they really understand evidence of…* the methods of gene expression and regulation **Prokaryotic Gene Expression Modeling Activity** ● students will create a model demonstrating how various environmental conditions impact the expression of the lactase and tryptophan genes and the impact a mutation in either a regulatory or structural gene would have on the process ● each group assigned a different environmental condition ● students can create posters, animations, or skits that are then shared with the class
		OTHER EVIDENCE: *Students will show they have achieved Stage 1 goals by…* ● Unit Assessment ● Verbal Questioning and Discussions (whole class and small group) ● Case Study questions ● Lab Analysis Questions ● Simulations and/or Modeling Activities

Stage 3 – Learning Plan		
Code	***Pre-Assessment*** Entrance/Exit Tickets , discussions with students, kahoots or google form quick questions	
	Summary of Key Learning Events and Instruction *Student success at transfer meaning and acquisition depends on…*	Progress Monitoring ● Verbal Questioning and Discussions (whole class and small group) ● Questions on worksheets and homeworks ● Lab Analysis Questions ● Simulations and/or Modeling Activities ● Warm Ups and Exit tickets
M, A	● take notes from videos and textbook readings on each topic	
M, A	● work collaboratively with partners or small groups to complete graphic organizers to summarize major concepts	
M, A	● modeling the processes of DNA Replication and Protein Synthesis using manipulatives	
M, A	● Mystery Monster Activity - transcribe and translate genetic code to determine the phenotype of monsters	
T, M, A	● CF Mutation Case Study - Analyze the various mutations of cystic fibrosis to determine the impact on cell transport proteins in the cell membrane	
T, M, A	● modeling the lac and trp operons under various environmental conditions using manipulatives	
T, M, A	● Stickleback Activity - model the effect of regulatory switches in gene expression	
M, A	● model the process of cloning a gene in a Paper Plasmid Lab	
M, A	● Article: Crisper as a Tool for Gene editing	

Unit 7 - Evolution

Stage 1 Desired Results

ESTABLISHED GOALS

EVO-1.C Describe the causes of natural selection.

EVO-1.D Explain how natural selection affects populations.

EVO-1.E Describe the importance of phenotypic variation in a population.

EVO-1.F Explain how humans can affect diversity within a population.

EVO-1.G Explain the relationship between changes in the environment and evolutionary changes in the population.

EVO-1.H Explain how random occurrences affect the genetic makeup of a population.

EVO-1.I Describe the role of random processes in the evolution of specific populations.

EVO-1.J Describe the change in the genetic makeup of a population over time.

EVO-1.K Describe the conditions under

Transfer

Students will be able to independently use their learning to…

Science Practice 1 – Concept Explanation Explain biological concepts, processes, and models presented in written format.

Science Practice 2 – Visual Representations Analyze visual representations of biological concepts and processes.

Science Practice 4 – Representing and Describing Data Represent and describe data.

Science Practice 5 – Statistical Tests and Data Analysis Perform statistical tests and mathematical calculations to analyze and interpret data.

Science Practice 6 - Argumentation Develop and justify scientific arguments using evidence.

Meaning

UNDERSTANDINGS
Students will understand that…

EVO-1 Evolution is characterized by a change in the genetic makeup of a population over time and is supported by multiple lines of evidence

EVO-2 Organisms are linked by lines of descent from common ancestry.

EVO-3 Life continues to evolve within a changing environment

SYI-3 Naturally occurring diversity among and between components within biological systems affects interactions with the environment.

ESSENTIAL QUESTIONS
Students will keep considering…

What conditions in a population make it more or less likely to evolve?

Scientifically defend the theory of evolution

How does species interaction encourage or slow changes in species?

which allele and genotype frequencies will change in populations. EVO-1.L Explain the impacts on the population if any of the conditions of HardyWeinberg are not met. EVO-1.M Describe the types of data that provide evidence for evolution. EVO-1.N Explain how morphological, biochemical, and geological data provide evidence that organisms have changed over time. EVO-2.B Describe the fundamental molecular and cellular features shared across all domains of life, which provide evidence of common ancestry. EVO-2.C Describe structural and functional evidence on cellular and molecular levels that provides evidence for the common ancestry of all eukaryotes. EVO-3.A Explain how evolution is an ongoing process in all living organisms. EVO-3.B Describe the types of evidence that can be used to infer an evolutionary relationship. EVO-3.C Explain how a phylogenetic tree and/or cladogram can be used to infer evolutionary relatedness. EVO-3.D Describe the conditions under which new species may arise.	***Acquisition***	
	Students will know…	*Students will be skilled at…*
	EVO-1.C.1 Natural selection is a major mechanism of evolution. EVO-1.C.2 According to Darwin's theory of natural selection, competition for limited resources results in differential survival. Individuals with more favorable phenotypes are more likely to survive and produce more offspring, thus passing traits to subsequent generations. EVO-1.D.1 Evolutionary fitness is measured by reproductive success. EVO-1.D.2 Biotic and abiotic environments can be more or less stable/fluctuating, and this affects the rate and direction of evolution; different genetic variations can be selected in each generation. EVO-1.E.1 Natural selection acts on phenotypic variations in populations. EVO-1.E.2 Environments change and apply selective pressures to populations. EVO-1.E.3 Some phenotypic variations significantly increase or decrease fitness of the organism in particular environments. EVO-1.F.1 Through artificial selection, humans affect variation in other species. EVO-1.G.1 Convergent evolution occurs when similar selective pressures result in similar phenotypic adaptations in different populations or species. EVO-1.H.1 Evolution is also driven by random	Describing the causes of natural selection. Explaining how natural selection affects populations. Describing the importance of phenotypic variation in a population. Explaining how humans can affect diversity within a population. Explaining the relationship between changes in the environment and evolutionary changes in the population. Explaining how random occurrences affect the genetic makeup of a population. Describing the role of random processes in the evolution of specific populations. Describing the change in the genetic makeup of a population over time. Describing the conditions under which allele and genotype frequencies will change in populations. Explaining the impacts on the population if any of the conditions of HardyWeinberg are not met. Describing the types of data that provide evidence for evolution. Explaining how morphological, biochemical, and geological data provide evidence that organisms have changed over time.

EVO-3.E Describe the rate of evolution and speciation under different ecological conditions. EVO-3.F Explain the processes and mechanisms that drive speciation. EVO-3.G Describe factors that lead to the extinction of a population. EVO-3.H Explain how the risk of extinction is affected by changes in the environment. EVO-3.I Explain species diversity in an ecosystem as a function of speciation and extinction rates. EVO-3.J Explain how extinction can make new environments available for adaptive radiation. SYI-3.D Explain how the genetic diversity of a species or population affects its ability to withstand environmental pressures. SYI-3.E Describe the scientific evidence that provides support for models of the origin of life on Earth.	occurrences EVO-1.I.1 Reduction of genetic variation within a given population can increase the differences between populations of the same species. EVO-1.J.1 Mutation results in genetic variation, which provides phenotypes on which natural selection acts. EVO-1.K.1 Hardy-Weinberg is a model for describing and predicting allele frequencies in a non evolving population. Conditions for a population or an allele to be in Hardy-Weinberg equilibrium are—(1) a large population size, (2) absence of migration, (3) no net mutations, (4) random mating, and (5) absence of selection. These conditions are seldom met, but they provide a valuable null hypothesis. EVO-1.K.2 Allele frequencies in a population can be calculated from genotype frequencies. EVO-1.L.1 Changes in allele frequencies provide evidence for the occurrence of evolution in a population. EVO-1.L.2 Small populations are more susceptible to random environmental impact than large populations. EVO-1.M.1 Evolution is supported by scientific evidence from many disciplines (geographical, geological, physical, biochemical, and mathematical data). EVO-1.N.1 Molecular, morphological, and genetic evidence from extant and extinct organisms adds to our understanding of evolution EVO-1.N.2 A comparison of DNA nucleotide sequences and/or protein amino acid sequences provides evidence for evolution and common ancestry	Describing the fundamental molecular and cellular features shared across all domains of life, which provide evidence of common ancestry. Describing structural and functional evidence on cellular and molecular levels that provides evidence for the common ancestry of all eukaryotes. Explaining how evolution is an ongoing process in all living organisms. Describing the types of evidence that can be used to infer an evolutionary relationship. Explaining how a phylogenetic tree and/or cladogram can be used to infer evolutionary relatedness. Describing the conditions under which new species may arise. Describing the rate of evolution and speciation under different ecological conditions. Explaining the processes and mechanisms that drive speciation. Describing factors that lead to the extinction of a population. Explaining how the risk of extinction is affected by changes in the environment. Explaining species diversity in an ecosystem as a function of speciation and extinction rates. Explaining how extinction can make new environments available for adaptive radiation. Explaining how the genetic diversity of a species or

	EVO-2.B.1 Many fundamental molecular and cellular features and processes are conserved across organisms. EVO-2.B.2 Structural and functional evidence supports the relatedness of organisms in all domains. EVO-2.C.1 Structural evidence indicates common ancestry of all eukaryotes EVO-3.A.1 Populations of organisms continue to evolve. EVO-3.A.2 All species have evolved and continue to evolve EVO-3.B.1 Phylogenetic trees and cladograms show evolutionary relationships among lineages EVO-3.C.1 Phylogenetic trees and cladograms can be used to illustrate speciation that has occurred. The nodes on a tree represent the most recent common ancestor of any two groups or lineages. EVO-3.C.2 Phylogenetic trees and cladograms can be constructed from morphological similarities of living or fossil species and from DNA and protein sequence similarities. EVO-3.C.3 Phylogenetic trees and cladograms represent hypotheses and are constantly being revised, based on evidence. EVO-3.D.1 Speciation may occur when two populations become reproductively isolated from each other. EVO-3.D.2 The biological species concept provides a commonly used definition of species for sexually reproducing organisms. It states that species can be defined as a group capable of interbreeding and	population affects its ability to withstand environmental pressures. Describing the scientific evidence that provides support for models of the origin of life on Earth.

	exchanging genetic information to produce viable, fertile offspring. EVO-3.E.1 Punctuated equilibrium is when evolution occurs rapidly after a long period of stasis. Gradualism is when evolution occurs slowly over hundreds of thousands or millions of years. EVO-3.E.2 Divergent evolution occurs when adaptation to new habitats results in phenotypic diversification. Speciation rates can be especially rapid during times of adaptive radiation as new habitats become available. EVO-3.F.1 Speciation results in diversity of life forms. EVO-3.F.2 Speciation may be sympatric or allopatric. EVO-3.F.3 Various prezygotic and postzygotic mechanisms can maintain reproductive isolation and prevent gene flow between populations. EVO-3.G.1 Extinctions have occurred throughout Earth's history. EVO-3.G.2 Extinction rates can be rapid during times of ecological stress. EVO-3.H.1 Human activity can drive changes in ecosystems that cause extinctions. EVO-3.I.1 The amount of diversity in an ecosystem can be determined by the rate of speciation and the rate of extinction. EVO-3.J.1 Extinction provides newly available niches that can then be exploited by different species. SYI-3.D.1 The level of variation in a population affects population dynamics	

	SYI-3.E.1 Several hypotheses about the origin of life on Earth are supported with scientific evidence SYI-3.E.2 The RNA World Hypothesis proposes that RNA could have been the earliest genetic material.	

Stage 2 – Evidence		
Code	**Evaluative Criteria**	**Assessment Evidence**
T, M, A	Students evaluated on ● their ability to accurately describe and interpret phylogenetic trees. ● how detailed their analysis, comparison, and interpretation of data sets is to formulate and support hypotheses about evolutionary mechanisms and processes. ● accurately describing and contrasting macroevolution and microevolution * scoring guidelines and sample responses in the HHMI teacher's guide	PERFORMANCE TASK(S): *Students will show that they really understand evidence of…* using phylogenetic trees/cladograms to determine evolutionary relationships between species and describing the mechanisms for the evolution of the different species **Lizards in an Evolutionary Tree Activity (HHMI)** - view the short film "The Origin of Species: Lizards in an Evolutionary Tree" and complete then analyze the researchers data and hypothesize mechanisms for evolution within this population.
		OTHER EVIDENCE: *Students will show they have achieved Stage 1 goals by…* ● Unit Assessment ● Verbal Questioning and Discussions (whole class and small group) ● Case Study questions ● Lab Analysis Questions ● Simulations and/or Modeling Activities

Stage 3 – Learning Plan		
Code	***M,Pre-Assessment*** Entrance/Exit Tickets , discussions with students, kahoots or google form quick questions	
	Summary of Key Learning Events and Instruction *Student success at transfer meaning and acquisition depends on…*	Progress Monitoring
M, A	● take notes from videos and textbook readings on each topic	● Verbal Questioning and Discussions (whole class and small group) ● Questions on worksheets and homeworks ● Lab Analysis Questions ● Simulations and/or Modeling Activities ● Warm Ups and Exit tickets
T, M, A	● analyze data of the Galapagos FInches and explain the patterns observed in terms of Natural Selection	
T, M, A	● work collaboratively with partners or small groups to evaluate and explain the evidence for evolution (fossils, embryology, molecular sequences, homologous structures, and vestigial structures)	
T, M, A	● Rock Pocket Mice Lab - apply the Hardy-Weinberg principles to the rock pocket mouse population to explain how variation, selection, and time influence evolution	
T, M, A	● Cladogram Activity - construct and analyze cladograms to determine phylogenetic relationships among organisms	

Unit 8 - Ecology

Stage 1 Desired Results

ESTABLISHED GOALS

ENE-3.D Explain how the behavioral and/or physiological response of an organism is related to changes in internal or external environment.

IST-5.A Explain how the behavioral responses of organisms affect their overall fitness and may contribute to the success of the population

ENE-1.M Describe the strategies organisms use to acquire and use energy.

ENE-1.N Explain how changes in energy availability affect populations and ecosystems.

ENE-1.O Explain how the activities of autotrophs and heterotrophs enable the flow of energy within an ecosystem.

SYI-1.G Describe factors that influence growth dynamics of populations.

SYI-1.H Explain how the density of a population affects and is determined by resource availability in the environment.

Transfer

Students will be able to independently use their learning to…

Science Practice 1 – Concept Explanation Explain biological concepts, processes, and models presented in written format.

Science Practice 2 – Visual Representations Analyze visual representations of biological concepts and processes.

Science Practice 3 – Questions and Methods Determine scientific questions and methods.

Science Practice 4 – Representing and Describing Data Represent and describe data.

Science Practice 5 – Statistical Tests and Data Analysis Perform statistical tests and mathematical calculations to analyze and interpret data.

Science Practice 6 - Argumentation Develop and justify scientific arguments using evidence.

Meaning

UNDERSTANDINGS

Students will understand that…

ENE-3 Timing and coordination of biological mechanisms involved in growth, reproduction, and homeostasis depend on organisms responding to environmental cues.

IST-5 Transmission of information results in changes within and between biological systems.

ENE-1 The highly complex organization of living systems requires constant input of energy and the

ESSENTIAL QUESTIONS

Students will keep considering…

How does diversity among and between species in a biological system affect the evolution of species within the system?

How does the acquisition of energy relate to the health of a biological system?

How do communities and ecosystems change, for better or worse, due to biological disruption?

ENE-4.A Describe the structure of a community according to its species composition and diversity ENE-4.B Explain how interactions within and among populations influence community structure. ENE-4.C Explain how community structure is related to energy availability in the environment. SYI-3.F Describe the relationship between ecosystem diversity and its resilience to changes in the environment. SYI-3.G Explain how the addition or removal of any component of an ecosystem will affect its overall short-term and long term structure. EVO-1.O Explain the interaction between the environment and random or preexisting variations in populations. SYI-2.A Explain how invasive species affect ecosystem dynamics. SYI-2.B Describe human activities that lead to changes in ecosystem structure and/ or dynamics. SYI-2.C Explain how geological and meteorological activity leads to changes in ecosystem structure and/or dynamics.	exchange of macromolecules. SYI-1 Living systems are organized in a hierarchy of structural levels that interact. ENE-4 Communities and ecosystems change on the basis of interactions among populations and disruptions to the environment. SYI-3 Naturally occurring diversity among and between components within biological systems affects interactions with the environment. EVO-1 Evolution is characterized by change in the genetic make-up of a population over time and is supported by multiple lines of evidence. SYI-2 Competition and cooperation are important aspects of biological systems.	How does a disruption of a biological system affect genetic information storage and transmission? How do species interactions affect the survival of an ecosystem?
	Acquisition	
	Students will know… ENE-3.D.1 Organisms respond to changes in their environment through behavioral and physiological mechanisms ENE-3.D.2 Organisms exchange information with one another in response to internal changes and external cues, which can change behavior. IST-5.A.1 Individuals can act on information and communicate it to others. IST-5.A.2 Communication occurs through various mechanisms IST-5.A.3 Responses to information and communication of information are vital to natural selection and evolution	*Students will be skilled at…* Explaining how the behavioral and/or physiological response of an organism is related to changes in internal or external environment. Explaining how the behavioral responses of organisms affect their overall fitness and may contribute to the success of the population Describing the strategies organisms use to acquire and use energy. Explaining how changes in energy availability affect populations and ecosystems. Explaining how the activities of autotrophs and

	ENE-1.M.1 Organisms use energy to maintain organization, grow, and reproduce ENE-1.N.1 Changes in energy availability can result in changes in population size. ENE.1.N.2 Changes in energy availability can result in disruptions to an ecosystem ENE-1.O.1 Autotrophs capture energy from physical or chemical sources in the environment ENE-1. O.2 Heterotrophs capture energy present in carbon compounds produced by other organisms. SYI-1.G.1 Populations comprise individual organisms that interact with one another and with the environment in complex ways. SYI-1.G.2 Many adaptations in organisms are related to obtaining and using energy and matter in a particular environment SYI-1.H.1 A population can produce a density of individuals that exceeds the system's resource availability. SYI-1.H.2 As limits to growth due to density-dependent and density-independent factors are imposed, a logistic growth model generally ensues ENE-4.A.1 The structure of a community is measured and described in terms of species composition and species diversity. ENE-4.B.1 Communities change over time depending on interactions between populations. ENE-4.B.2 Interactions among populations determine how they access energy and matter within a community. ENE-4.B.3 Relationships among interacting populations can be characterized by positive and negative effects and can be modeled. Examples	heterotrophs enable the flow of energy within an ecosystem. Describing factors that influence growth dynamics of populations. Explaining how the density of a population affects and is determined by resource availability in the environment. Describing the structure of a community according to its species composition and diversity Explaining how interactions within and among populations influence community structure. Explaining how community structure is related to energy availability in the environment. Describing the relationship between ecosystem diversity and its resilience to changes in the environment. Explaining how the addition or removal of any component of an ecosystem will affect its overall short-term and long term structure. Explaining the interaction between the environment and random or preexisting variations in populations. Explaining how invasive species affect ecosystem dynamics. Describing human activities that lead to changes in ecosystem structure and/ or dynamics. Explaining how geological and meteorological activity leads to changes in ecosystem structure and/or dynamics.

	include predator/prey interactions, trophic cascades, and niche partitioning. ENE-4.B.4 Competition, predation, and symbioses, including parasitism, mutualism, and commensalism, can drive population dynamics. ENE-4.C.1 Cooperation or coordination between organisms, populations, and species can result in enhanced movement of, or access to, matter and energy. SYI-3.F.1 Natural and artificial ecosystems with fewer component parts and with little diversity among the parts are often less resilient to changes in the environment. SYI-3.F.2 Keystone species, producers, and essential abiotic and biotic factors contribute to maintaining the diversity of an ecosystem. SYI-3.G.1 The diversity of species within an ecosystem may influence the organization of the ecosystem. SYI-3.G.2 The effects of keystone species on the ecosystem are disproportionate relative to their abundance in the ecosystem, and when they are removed from the ecosystem, the ecosystem often collapses. EVO-1.O.1 An adaptation is a genetic variation that is favored by selection and is manifested as a trait that provides an advantage to an organism in a particular environment. EVO-1.O.2 Mutations are random and are not directed by specific environmental pressures. SYI-2.A.1 The intentional or unintentional introduction of an invasive species can allow the species to exploit a new niche free of predators or competitors or to outcompete other organisms for resources. SYI-2.A.2 The availability of resources can result in uncontrolled population growth and ecological	

	changes. SYI-2.B.1 The distribution of local and global ecosystems changes over time. SYI-2.B.2 Human impact accelerates change at local and global levels— SYI-2.C.1 Geological and meteorological events affect habitat change and ecosystem distribution. Biogeographical studies illustrate these changes.	

Stage 2 – Evidence		
Code	**Evaluative Criteria**	**Assessment Evidence**
T, M, A	Students evaluated on ● accurately classifying organisms based on their roles in the transfer of energy in an ecosystem. ● Creating clear and accurate models (e.g., a food webs and trophic pyramids) showing feeding relationships among organisms. ● Evaluating the effectiveness of different models that depict relationships among organisms in a community. ● Correctly predicting how ecological forces or disturbances may impact their models and * scoring guidelines and sample responses in the HHMI teacher's guide	PERFORMANCE TASK(S): *Students will show that they really understand evidence of…* how energy and matter flow through ecosystems and how ecological disturbances interfere with the relationships between species in a community and can disrupt the flow of energy and matter **Gorongosa Food Web Activity (HHMI)** - construct food webs of the African Savanna to model ecological relationships within the community then evaluate the impact of both natural and man-made ecological disturbances on each trophic level of the community
		OTHER EVIDENCE: *Students will show they have achieved Stage 1 goals by…* ● Unit Assessment ● Verbal Questioning and Discussions (whole class and small group) ● Case Study questions ● Lab Analysis Questions ● Simulations and/or Modeling Activities

Stage 3 – Learning Plan		
Code	***Pre-Assessment*** Entrance/Exit Tickets , discussions with students, kahoots or google form quick questions	
	Summary of Key Learning Events and Instruction *Student success at transfer meaning and acquisition depends on…*	Progress Monitoring
M, A	● take notes from videos and textbook readings on each topic	● Verbal Questioning and Discussions (whole class and small group) ● Questions on worksheets and homeworks ● Lab Analysis Questions ● Simulations and/or Modeling Activities ● Warm Ups and Exit tickets
M, A	● work collaboratively with partners or small groups to complete graphic organizers to summarize the types of symbiotic relationships within communities	
T, M, A	● Gorongosa Food Web Activity - construct food webs of the African Savanna to model ecological relationships within the community then predict the impact of both natural and man-made ecological disturbances on each trophic level of the community	
T, M, A	● analyze population growth models and describe the impact of both density dependent and density independent factors on the population	
T, M, A	● practice population demographic problems (growth rate, carrying capacity, logistic and exponential growth)	
T, M, A	● Lab: Animal Behavior - design and conduct an investigation to determine organisms respond to their environment, share findings with class during poster symposium	