Unit 1: Introduction to Laboratory Skills and Content September

Standards	Laboratory skills and content are integrated within each of the NYS science topics and are not specifically stated in a standard. The nature of science is included in the *Next Generation Science Standards*. The complete grid can be found in ***APPENDIX H – Understanding the Scientific Enterprise: The Nature of Science in the Next Generation Science Standards.*** The basic understandings about the nature of science are: Scientific Investigations Use a Variety of Methods Scientific Knowledge is Based on Empirical Evidence Scientific Knowledge is Open to Revision in Light of New Evidence Scientific Models, Laws, Mechanisms, and Theories Explain Natural Phenomena Science is a Way of Knowing Scientific Knowledge Assumes an Order and Consistency in Natural Systems Science is a Human Endeavor Science Addresses Questions About the Natural and Material World
Topics, Skills and Knowledge	**Topics/Vocabulary**: **Scientific Inquiry**: Hypothesis, theory, independent variable, dependent variable, validity, control group, experimental group, controlled variables, recording data as evidence, graphing and interpreting data, drawing conclusions from evidence **Laboratory and Classroom Safety**: safety rules and guidelines, placement and use of safety equipment, fire drill and accident protocols Use of measuring instruments, parts, functions and use of compound light microscopes **NYS Science and Engineering Practices** **Asking Questions and Defining Problems** -Ask questions that arise from examining models or a theory to clarify relationships. **Developing and Using Models** -Use a model based on evidence to illustrate the relationships between systems or between components of a system. **Planning and Carrying out Investigations** -Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated. -Select appropriate tools to collect, record, analyze, and evaluate data. **Analyzing and Interpreting Data** -Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. **Using Mathematics and Computational Thinking:** -Use mathematical and/or computational representations of phenomena or design solutions to support explanations. -Use mathematical representations of phenomena or design solutions to support and revise explanations. -Create or revise a simulation of a phenomenon, designed device, process, or system. **Constructing Explanations and Designing Solutions** -Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. **Engaging in Argument from Evidence** -Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence.

	-Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. – -Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. **NYS Disciplinary Core Ideas** **The disciplinary core idea will vary based on the investigation lab chosen by the instructor**
Overarching Concepts	**Scientific inquiry allows us to develop explanations of the living world on a continuing creative process in order to pose questions, seek answers in a safe way, and develop solutions.** **NYS Crosscutting Concepts** **Cause and Effect**: Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. **Scale, Proportion, and Quality:** Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another. **Connections to Nature of Science** **Scientific Investigations Use a Variety of Methods** Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. **Scientific Knowledge Assumes an Order and Consistency in Natural Systems:** Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.
Resources	Textbook, notes, science news articles and readings Lab Safety lab packet, Graphing lab packet Materials for Labs- may include: oil, water, food coloring (4 colors), small clear plastic cups, wooden/plastic stirrers meter sticks & small metric rulers, 10mL & 25mL graduated cylinders, small and large test tubes and/or containers to measure volume small objects (pennies, keys, paper clips, etc.) to measure mass, triple beam balance, compound light microscopes, glass slides & cover slips, newspaper (for small "e"), water, eye dropper, beakers (for water)
Assessments	**Formative**: Quizzes, Selected worksheets, notebook/journal checks and teacher observation **Summative**: Unit Tests and Labs **Suggested Labs:** Lab Safety, Scientific Method, Metric Measurement, Graphing and Analyzing Data, Compound Light Microscopy

Unit 2: Living Cells and Cellular Processes October/November

Standards	**MS-LS1-1. Conduct an investigation to provide evidence that living things are made of cells, either one cell or many different numbers and types of cells.** **Clarification Statement:** Emphasis is on developing evidence that living things are made of cells, distinguishing between living and non-living cells, and understanding that living things may be made of one cell or many and varied cells. **MS-LS1-2. Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.** **Clarification Statement**: Emphasis is on the cell functioning as a whole system and the primary role of identified parts of the cell, specifically the nucleus, chloroplasts, mitochondria, cell membrane, and cell wall. **Assessment Boundary**: Assessment of organelle structure/function relationships is limited to the cell wall and cell membrane. Assessment of the function of the other organelles is limited to their relationship to the whole cell. Assessment does not include the biochemical function of cells or cell parts. **HS-LS1-5. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.** **Clarification Statement**: Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. Examples of models could include diagrams, chemical equations, and conceptual models. **Assessment Boundary**: Assessment does not include specific biochemical steps.] **HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements such as nitrogen, sulfur, and phosphorus to form amino acids and other carbon-based molecules.** **Clarification Statement:** Emphasis is on using evidence from models and simulations to support explanations for the synthesis of lipids, starches, proteins, and nucleic acids. **Assessment Boundary:** Assessment does not include the details of the specific chemical reactions or identification of structural and molecular formulas for macromolecules. **HS-LS1-7. Use a model to illustrate that aerobic cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.** **Clarification Statement**: Emphasis is on the conceptual understanding of the inputs and outputs of the process of aerobic cellular respiration. **Assessment Boundary**: Assessment should not include identification of the steps or specific processes involved in aerobic cellular respiration **HS-LS2-3. Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in ecosystems.** **Clarification Statement**: Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration and photosynthesis within ecosystems. **Assessment Boundary**: Assessment does not include the specific chemical processes of aerobic respiration, anaerobic respiration, and photosynthesis. **HS-LS2-5. Develop a model to illustrate the role of various processes in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.** **Clarification Statement**: Examples of models could include simulations, diagrams, and mathematical models of the carbon cycle (photosynthesis, respiration, decomposition, and combustion). **Assessment Boundary**: Assessment does not include the specific chemical steps of photosynthesis and respiration.
Topics, Skills and Knowledge	**Topics/Vocabulary:** **Living vs nonliving**, Unicellular vs multicellular, life processes, metabolism, homeostasis **Life activities** Ingestion and Digestion, mechanical vs chemical digestion, nutrient absorption, respiration, gas exchange, transport, indicators **Molecular basis of life**, pH, water chemistry, organic molecules, enzymes, enzyme-substrate relationships, organic compounds

	Cell theory, prokaryotic vs eukaryotic cells, plant vs animal organelles-structure and function, cellular transport, osmosis, diffusion, active and passive transport, facilitated diffusion, (hypo-, hyper-, iso-)tonic, bulk transport **Photosynthesis,** equation in words and symbols; pigments, chloroplasts, light dependent, light independent, carbon cycle, ATP, chlorophyll **Cellular respiration,** equation in words and symbols, aerobic vs. anaerobic, formation of ATP, glycolysis, Krebs cycle, electron transport chain **NYS Science and Engineering Practices** **Developing and Using Models** -Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HSLS1- 5),(HS-LS1-7) -Develop a model based on evidence to illustrate the relationships between systems or components of a system. (HS-LS2-5) **Using Mathematics and Computational Thinking** -Use mathematical representations of phenomena or design solutions to support claims. (HS-LS2-4) **Constructing Explanations and Designing Solutions** -Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS1-6),(HSLS2-3) **NYS Disciplinary Core Ideas** **LS1.A: Structure and Function** -Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1) -All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS-LS1-1) (Note: This Disciplinary Core Idea is also addressed by HS-LS3-1.) -All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular).(MS-LS1-1) -Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell.(MS-LS1-2) -In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. **LS1.C: Organization for Matter and Energy Flow in Organisms** The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HS-LS1-5) As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. (HS LS1-6),(HS-LS1-7) -(NYSED) Sugar molecules contain carbon, hydrogen, and oxygen. Their hydrocarbon backbones combine with other elements to make amino acids and other carbon-based molecules that can be assembled into larger molecules, such as proteins or DNA. (HS-LS1-6) -(NYSED) Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed. In this process ATP is produced, which is used to carry out life processes. (HS-LS1-7) **LS2.B:** Cycles of Matter and Energy Transfer in Ecosystems Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (HSLS2-3)

	-(NYSED) When matter is cycled through organisms and ecosystems, some of the matter reacts to release energy for life functions, some is stored in newly made structures, and some is eliminated as waste. (HS-LS2-4) -(NYSED) Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, hydrosphere, and geosphere through chemical, physical, geological, and biological processes. (HS-LS2-5) **PS3.D: Energy in Chemical Processes** The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. (secondary to HS-LS2-5)
Overarching Concepts	Living things contain cells that have organelles which perform essential life processes thereby contributing to the survival of the organism. **NYS Crosscutting Concepts** **Systems and System Models** -Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions— including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-2) - Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. (MS-LS1-3) **Structure and Function** -Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-LS1-1) -Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the relationships among its parts, therefore complex natural and designed structures/systems can be analyzed to determine how they function. (MS-LS1-2) **Energy and Matter** -Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-LS1-5), (HS-LS1-6) -Energy can be transferred between one place and another place, between objects and/or fields, or between systems.(HS-LS1-7),(HS-LS2-4) -Energy drives the cycling of matter within and between systems. (HS-LS2-3) **Scale, Proportion, and Quantity** -Phenomena that can be observed at one scale may not be observable at another scale. (MS-LS1-1) **Connections to Engineering, Technology and Applications of Science** **Interdependence of Science, Engineering, and Technology:** Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems. (MS-LS1-1) **Connections to Nature of Science** **Scientific Knowledge is Open to Revision in Light of New Evidence:** Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-3)
Resources	Miller and Levine and/or Campbell textbook Materials and equipment need for labs Dialysis tubing, beakers, test tubes, glucose, starch, benedicts solution, iodine, salt solution, microscope, slides, red onion or elodea, heat source, student lab packet (NYS Lab)
Assessments	**Formative**: Quizzes, Selected worksheets, notebook/journal checks and teacher observation **Summative**: Unit Tests and Labs **Required Lab:** NY STATE LAB- Diffusion Through a Membrane **Suggested Labs:** Cell Model Lab, Chromatography Lab, Nutrient Identification Lab, Enzymes Lab, Animal vs. Plant Cells Lab, Molecular Models, Carbohydrate Structure Lab, Leaf Structure Lab, Stomate Lab, Elodea Plasmolysis, Yeast Respiration

Unit 3: Human Body Systems and Homeostasis November/December

Standards	**HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.** **Clarification Statement:** Emphasis is on functions at the organism's system level such as nutrient uptake, water delivery, immune response, and organism response to stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system. **Assessment Boundary:** Assessment does not include interactions and functions at the molecular or chemical reaction level. **MS-LS1-3. Construct an explanation supported by evidence for how the body is composed of interacting systems consisting of cells, tissues, and organs working together to maintain homeostasis.** **Clarification Statement:** Emphasis should be on the function and interactions of the major body systems (e.g. circulatory, respiratory, nervous, and musculoskeletal. **Assessment Boundary:** Assessment is focused on the interactions between systems not on the functions of individual systems. **MS-LS1-8. Gather and synthesize information that sensory receptors respond to stimuli, resulting in immediate behavior and/or storage as memories.** **Assessment Boundary:** Assessment does not include mechanisms for the transmission of this information**.** **HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis** **Clarification Statement**: Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, and root development in response to water levels. **Assessment Boundary**: Assessment does not include the cellular processes involved in the feedback mechanism.
Topics, Skills and Knowledge	**Topics/Vocabulary:** **Unicellular vs. Multicellular organization**, dynamic equilibrium, homeostasis, feedback mechanisms, tissues, organs **Nutrition**: heterotroph vs. autotroph, structures and functions of the digestive system, , mechanical vs chemical digestion, absorption **Respiration**: structures and functions of the respiratory system (lungs, bronchi, bronchioles, alveoli, capillaries, etc...), gas exchange **Circulatory**: transport, structures and functions of the circulatory system(heart, arteries, veins, capillaries) blood components **Immune**: pathogen, allergy, vaccine, passive vs. active immunity, virus, **Regulation**: feedback mechanisms, nervous system structures and functions, endocrine system structures and functions, impulses, hormones **Excretion**: structures and functions of the excretory & urinary system **Integumentary**: structure and functions of the skin **NYS Science and Engineering Practices** **Developing and Using Models** -Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-2) **Planning and Carrying Out Investigations** -Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-LS1-3) **Connections to Nature of Science** **Scientific Investigations Use a Variety of Methods** -Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. (HS-LS1-3)

	NYS Disciplinary Core Ideas **LS1.A: Structure and Function** -Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1) -All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS-LS1-1) (Note: This Disciplinary Core Idea is also addressed by HS-LS3-1.) -Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2) - In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. (MS-LS1-3) -Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3) - (NYSED) Disease is a failure of homeostasis. Organisms have a variety of mechanisms to prevent and combat disease. -Technological advances including vaccinations and antibiotics have contributed to the prevention and treatment of disease. (HS-LS1-2, HS-LS1-3) **LS1.D:** Information Processing -Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. (MS-LS1-8)
Overarching Concepts	**Organisms maintain a dynamic equilibrium that sustains life.** **NYS Crosscutting Concepts** **Systems and System Models** Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-2) **Structure and Function** Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-LS1-1) **Stability and Change** Feedback (negative or positive) can stabilize or destabilize a system. (HSLS1-3)
Resources	Miller and Levine and/or Campbell textbook, access to computer for typing a formal lab report (NYS Lab) Lab Materials as needed: standard wooden clothespins, clock or stop watches (NYS Lab) Large round balloons (1 per student), 30cm long metric rulers, sheep hearts (1 per 2 or 3 students), dissecting trays, scalpels, probes, dissecting scissors, latex and non-latex dissecting gloves, safety goggles, aprons (optional)
Assessments	**Formative**: Quizzes, Selected worksheets, notebook/journal checks and teacher observation **Summative**: Unit Tests and Labs **Required Lab:** NY State Lab Activity - Making Connections **Suggested Labs:** Measuring Lung Capacity, Dissecting a Sheep Heart, Measuring Human Reflexes, Dissecting a Fetal Pig, Systems Brochure, Taste Receptors, Locating Touch Receptors, Sports Injuries, Comparing Digestive Tracts, HIV Simulation (Spread of Disease) Lab,

Unit 4: Reproduction and Genetics January/February

Standards	**HS-LS1-4. Use a model to illustrate cellular division (mitosis) and differentiation**. **Clarification Statement**: Emphasis should be on the outcomes of mitotic division and cell differentiation on growth and development of complex organisms and possible implications for abnormal cell division (cancer) and stem cell research. **Assessment Boundary**: Assessment does not include specific gene control mechanisms or recalling the specific steps of mitosis. **HS-LS1-1. Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.** **Clarification Statement**: Emphasis should be on how the DNA code is transcribed and translated in the synthesis of proteins. Types of proteins involved in performing life functions include enzymes, structural proteins, cell receptors, hormones, and antibodies. **Assessment Boundary**: Assessment does not include identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the detailed biochemistry of protein synthesis. **HS-LS3-1. Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.** **Clarification Statement**: Emphasis should be on the distinction between coding and non-coding regions of DNA. **MS-LS3-1. Develop and use a model to explain why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.** **Clarification Statement**: Mutations in body cells are not inherited. Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins. **Assessment Boundary**: Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations. **MS-LS3-2. Develop and use a model to describe how asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.** **Clarification Statement**: Emphasis is on using models such as diagrams and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring. **MS-LS4-5. Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.** **Clarification Statement:** Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, selective breeding, gene therapy); and, on the impacts these technologies have on society. **HS-LS3-2. Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, (3) mutations caused by environmental factors and/or (4) genetic engineering.** **Clarification Statement**: Emphasis is on using data to support arguments for the way variation occurs including the relevant processes in meiosis and advances in biotechnology. **Assessment Boundary**: Assessment does not include recalling the specific details of the phases of meiosis or the biochemical mechanisms of the specific phases in the process. **HS-LS3-3. Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.** **Clarification Statement**: Emphasis is on the use of mathematics to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits. **Assessment Boundary**: Assessment does not include Hardy-Weinberg calculations.

	HS-LS1-8. Use models to illustrate how human reproduction and development maintains continuity of life. **Clarification Statement**: Emphasis is on structures and function of human reproductive systems, interactions with other human body systems, embryonic development, and influences of environmental factors on development. **Assessment Boundary:** Assessment does not include the details of hormonal regulation or stages of embryonic development.
Topics, Skills and Knowledge	**Topics/Vocabulary:** **Reproduction**: asexual reproduction, mitosis, sexual reproduction, meiosis, gamete, **Human reproductive system**: structures and functions of male and female systems, menstrual cycle, fertilization, embryonic development, factors affecting development, **Genetics**: variation of traits, DNA/RNA structure, nucleotide, chromosome, gene, nitrogenous bases (A T G C), protein synthesis, transcription, translation, mutation, genetic disorders, **Genetic engineering**: gene therapy, recombinant DNA, cloning, GMO, restriction enzyme, gel electrophoresis, impact on medicine and agriculture **NYS Science and Engineering Practices** **Asking Questions and Defining Problems** -Ask questions that arise from examining models or a theory to clarify relationships. (HS-LS3-1) **Developing and Using Models** -Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS14),(HS-LS1-8) **Analyzing and Interpreting Data** -Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (HS-LS3-3) **Engaging in Argument from Evidence** -Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence. (HS-LS3-2) **NYS Disciplinary Core Ideas** **LS1.A: Structure and Function** -Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1) -All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins. (secondary to HS-LS3-1) (Note: This Disciplinary Core Idea is also addressed by HS-LS1-1.) -(NYSED) The structures and functions of the human female reproductive system produce gametes in ovaries, allow for internal fertilization, support the internal development of the embryo and fetus in the uterus, and provide essential materials through the placenta, and nutrition through milk for the newborn. The structures and functions of the human male reproductive system produce gametes in testes and make possible the delivery of these gametes for fertilization. (HS-LS1-8) **LS1.B: Growth and Development of Organisms** In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. (HS-LS1-4)

	- (NYSED) The continuity of life is sustained through reproduction and development. Human development, birth, and aging should be viewed as a predictable pattern of events influenced by factors such as gene expression, hormones, and the environment. (HS-LS18) **LS3.A: Inheritance of Traits** -Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function. (HS-LS3-1) - Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. (MS-LS3-1) - Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. (MS-LS3-2) **LS3.B: Variation of Traits** -In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. (HS-LS3-2) -In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other. (MS-LS3-2) - In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Some changes are beneficial, others harmful, and some neutral to the organism. (MS-LS3-1) - (NYSED) Mutations may result in changes to the structure and function of proteins. (MS-LS3-1) - (NYSED) Environmental factors can cause mutations in genes. Only mutations in sex cells can be inherited. (HS-LS3-2) - (NYSED) Advances in biotechnology have allowed organisms to be modified genetically. (HS-LS3-2) - Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. (HS-LS3-2),(HS-LS3-3)
Overarching Concepts	**The genetic information (DNA) that living things contain act as a map that enable species to survive by determining the structure and function of each cell. Parent organisms pass their genetic information down to their offspring via reproduction.** **NYS Crosscutting Concepts** **Cause and Effect**: Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS3-1),(HS-LS3-2) **Systems and System Models:** Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows— within and between systems at different scales. (HS-LS1-4),(HS-LS1-8) **Structure and Function** -Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function. (MS-LS3-1)

	Connections to Nature of Science **Science is a Human Endeavor** -Technological advances have influenced the progress of science and science has influenced advances in technology. (HSLS3-2),(HS-LS3-3), (New NYSED PE) -Science and engineering are influenced by society and society is influenced by science and engineering. (HS-LS3-2), (HS-LS33),(HS-LS1-8)
Resources	Miller and Levine and/or Campbell textbook, access to computer for typing a formal lab report Lab equipment and supplies for selected activities
Assessments	**Formative**: Quizzes, Selected worksheets, notebook/journal checks and teacher observation **Summative**: Unit Tests and Labs **Suggested Labs:** Menstrual Cycle Lab, Fetal Development Lab, DNA Structure Lab, Protein Synthesis Lab (Twizzlers), Mutations Lab, Karyotyping Lab, Onion Root Tip Lab, Marshmallow Meiosis Lab, Blood Typing Lab, Protein Synthesis Lab (Insulin), DNA Extraction Lab, Modelling Restriction Enzymes

Unit 5: Natural Selection and Evolution February/March

Standards	**HS-LS4-1. Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.** **Clarification Statement**: Emphasis is on a conceptual understanding of the role each line of evidence has relating to common ancestry and biological evolution. Examples of evidence could include similarities in DNA sequences, anatomical structures, and order of appearance of structures in embryological development. **HS-LS4-2. Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.** **Clarification Statement**: Emphasis is on using evidence to explain the influence each of the four factors has on number of organisms, behaviors, morphology, or physiology in terms of ability to compete for limited resources and subsequent survival of individuals and adaptation of species. Examples of evidence could include mathematical models such as simple distribution graphs and proportional reasoning. **Assessment Boundary**: Assessment does not include other mechanisms of evolution, such as genetic drift, gene flow through migration, and co-evolution. **HS-LS4-3. Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.** **Clarification Statement**: Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations. **Assessment Boundary**: Assessment is limited to basic statistical and graphical analysis. Assessment does not include allele frequency calculations. **HS-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations.** **Clarification Statement:** Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations. **HS-LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.** **Clarification Statement:** Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, fishing, introduction of invasive species, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.
Topics, Skills and Knowledge	**Topics/Vocabulary:** **Diversity of life**: taxonomy, classification systems, , binomial nomenclature, biodiversity, phylogenetic tree, cladogram, species **Evidence of evolution**: fossil record, radioactive decay dating, embryology, anatomical structures, analogous, homologous **Selection**: natural variations, sources of genetic variations, natural vs. artificial selection, Darwin's theory, natural selection, selecting agent, roles of competition; overproduction and struggle for survival in evolution, survival of the fittest, antibiotic/insecticide/pesticide resistance, **Patterns of evolution**: adaptive radiation, gradualism vs punctuated equilibrium, **Speciation**: geographic vs reproductive isolation, speciation, causes of extinction

	NYS Science and Engineering Practices **Analyzing and Interpreting Data** -Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (HS-LS4-3) **Constructing Explanations and Designing Solutions** -Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS4-2),(HS-LS4-4) **Engaging in Argument from Evidence** -Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS4-5) **Obtaining, Evaluating, and Communicating Information** -Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-LS4-1) **Connections to Nature of Science** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena.** A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HS-LS4-1) **NYS Disciplinary Core Ideas** **LS4.A: Evidence of Common Ancestry and Diversity** -Genetic information provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence. (HS-LS4-1) **LS4.B: Natural Selection** -Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. (HS-LS4-2),(HS-LS4-3) -The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (HS-LS4-3) **LS4.C: Adaptation** -Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. (HS-LS4-2) -Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. (HS-LS4-3),(HS-LS4-4) -Adaptation also means that the distribution of traits in a population can change when conditions change. (HS-LS4-3)

	-Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometimes the extinction–of some species. (HS-LS4-5) -Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5)
Overarching Concepts	**Varying species of organisms are related through a common ancestor. Similarities in characteristics, both structural and molecular, are often due to ancestry. Evolution is responsible for the changes in specific characteristics of an ancestral organism.** **During periods of environmental change, species that fail to adapt are more likely to become extinct then those species that do adapt.** **NYS Crosscutting Concepts** **Patterns** -Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HSLS4-1),(HS-LS4-3) **Cause and Effect** -Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HSLS4-2),(HS-LS4-4),(HS-LS4-5) **Connections to Nature of Science** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. (HS-LS4-1),(HSLS4-4)
Resources	Miller and Levine and/or Campbell textbook
Assessments	**Formative**: Quizzes, Selected worksheets, notebook/journal checks and teacher observation **Summative**: Unit Tests and Labs **Required Lab: NY State LAB -** Beaks of Finches **Suggested Labs:** Dichotomous Key Lab (Identify Shark Families), Classification Lab, Phylogeny Lab, Evidence of Evolution Lab – Homologous Structures, Amino Acid Sequence Comparison

Unit 6: Ecology March/April/May

Standards	**HS-LS2-1. Use mathematical and/or computational representations to support explanations of biotic and abiotic factors that affect carrying capacity of ecosystems at different scales.** **Clarification Statement:** Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate and competition. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets. **Assessment Boundary**: Assessment does not include deriving mathematical equations to make comparisons. **HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.** **Clarification Statement:** Examples of mathematical representations could include finding the average, determining trends, and using graphical comparisons of multiple sets of data. **Assessment Boundary:** Assessment is limited to provided data. **HS-LS2-4. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.** **Clarification Statement:** Emphasis is on using a mathematical model such as a pyramid of biomass/energy to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem. **Assessment Boundary**: Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy. **HS-LS2-5. Develop a model to illustrate the role of various processes in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.** **Clarification Statement**: Examples of models could include simulations, diagrams, and mathematical models of the carbon cycle (photosynthesis, respiration, decomposition, and combustion). **Assessment Boundary**: Assessment does not include the specific chemical steps of photosynthesis and respiration. **HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.** **Clarification Statement:** Examples of changes in ecosystem conditions could include ecological succession, modest biological or physical changes, such as moderate hunting or seasonal floods; and extreme changes, such as volcanic eruption or sea level rise. **HS-LS2-8. Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.** **Clarification Statement:** Emphasis is on: (1) distinguishing between group and individual behavior, (2) identifying evidence supporting the outcomes of group behavior, and (3) developing logical and reasonable arguments based on evidence. Examples of group behaviors could include flocking, schooling, herding, and cooperative behaviors such as hunting, migrating, and swarming.
Topics, Skills and Knowledge	**Topics/Vocabulary:** Ecology, ecosystems, abiotic, biotic factors, organization, populations, carrying capacity, communities, limiting factors, biosphere, nutritional relationships, predator/prey, competition, symbiotic relationships, niche, habitat , biomes Energy Flows: Trophic levels, Food Chain, Food Web, Energy Pyramid, biomass pyramid, decomposers Formation, change and disruptions: ecological succession, material cycles: Carbon, nitrogen, water **NYS Science and Engineering Practices** **Using Mathematics and Computational Thinking** -Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (HSLS2-1) -Use mathematical representations of phenomena or design solutions to support and revise explanations. (HS-LS2-2)

	-Create or revise a simulation of a phenomenon, designed device, process, or system. (HS-LS2-7) **Constructing Explanations and Designing Solutions** -Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-LS2-7) **Engaging in Argument from Evidence** -Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-6) -Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-8) **Connections to Nature of Science** **Scientific Knowledge is Open to Revision in Light of New Evidence** - Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-2) - Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation. (HSLS2-6),(HS-LS2-8**)** **NYS Disciplinary Core Ideas** **PS3.D: Energy in Chemical Processes** The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. (secondary to HS-LS2-5) **LS1.C: Organization for Matter and Energy Flow in Organisms** The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HS-LS1-5) As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. (HS-LS1-6),(HS-LS1-7) **LS2.A: Interdependent Relationships in Ecosystems** Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (HS-LS21),(HS-LS2-2) -NYSED Carrying capacity results from the availability of biotic and abiotic factors and from challenges such as predation, competition, and disease. (HS-LS2-1),(HSLS2-2) **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (HSLS2-3) Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (HS-LS2-4) -(NYSED) When matter is cycled through organisms and ecosystems, some of the matter reacts to release energy for life functions, some is stored in newly made structures, and some is eliminated as waste. (HS-LS2-4) -(NYSED) Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged

	among the biosphere, atmosphere, hydrosphere, and geosphere through chemical, physical, geological, and biological processes. (HS-LS2-5) **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2),(HS-LS2-6) -Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7) **LS4.D: Biodiversity and Humans** Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (secondary to HS-LS2-7) -Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (secondary to HS-LS2-7) **LS2.D: Social Interactions and Group Behavior** Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HS-LS2-8) **ETS1.B: Developing Possible Solutions** When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (secondary to HSLS2-7)
Overarching Concepts	**Living and non-living things are interdependent and any changes, big or small, can cause an effect (change) on other things.** **NYS Crosscutting Concepts** **Scale, Proportion, and Quantity** -The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-LS2-1) -Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (HS-LS2-2) **Stability and Change** -Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6),(HSLS2-7) -Living and non-living things are interdependent and any changes, big or small, can cause an effect (change) on other things. **Cause and Effect** -Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS27), (HS-LS2-8) **Connections to Nature of Science** **Scientific Knowledge is Open to Revision in Light of New Evidence** -Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-2) -Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation. (HSLS2-6),(HS-LS2-8)
Resources	Miller and Levine and/or Campbell textbook, access to computer for typing a formal lab report
Assessments	**Formative**: Quizzes, Selected worksheets, notebook/journal checks and teacher observation **Summative**: Unit Tests and Labs **Suggested Labs:** Owl Pellet Dissection lab, Construct Food Chains and Food Webs lab, Analysis of the Kaibab Deer Population lab, Flower Dissection lab, Recycling lab,

Unit 7: Human Impact and Homeostasis of Living Organisms May/June

Standards	**HS-LS2-1. Use mathematical and/or computational representations to support explanations of biotic and abiotic factors that affect carrying capacity of ecosystems at different scales.** **Clarification Statement:** Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate and competition. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets. **Assessment Boundary**: Assessment does not include deriving mathematical equations to make comparisons. **HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.** **Clarification Statement**: Examples of mathematical representations could include finding the average, determining trends, and using graphical comparisons of multiple sets of data. **Assessment Boundary**: Assessment is limited to provided data. **HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.** Clarification Statement: Examples of changes in ecosystem conditions could include ecological succession, modest biological or physical changes, such as moderate hunting or seasonal floods; and extreme changes, such as volcanic eruption or sea level rise. **HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*** Clarification Statement: Examples of human activities could include urbanization, building dams, and dissemination of invasive species. Examples of solutions could include simulations, product development, technological innovations, and/or legislation. **HS-LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.** **Clarification Statement:** Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, fishing, introduction of invasive species, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits in species. **HS-ESS3-3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.** **Clarification Statement**: Examples of factors that affect the management of natural resources could include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability could include agricultural efficiency, levels of conservation, and urban planning. **Assessment Boundary**: Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations. **HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.** **Clarification Statement**: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could include practices ranging from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).] **HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity**

	Clarification Statement: Examples of Earth systems to be considered could include the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. An example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations. **Assessment Boundary:** Assessment does not include running computational representations but is limited to using the published results of scientific computational models. **HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.** **HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.** **HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.** **HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.**
Topics, Skills and Knowledge	**Topics/Vocabulary:** **Human population growth**: carrying capacity, limiting factors **Human Impact**: Human activities, agriculture, overhunting, invasive species, land-use, exploitation, urbanization, building dams, deforestation, biodiversity loss, acid rain, climate change, ozone shield, bio-accumulation, waste management pollution **Conservation**: population control, recycling, natural resources, pollution control, species preservation, environmental legislation, renewable resources, nonrenewable resources, biodiversity – value to medicine/ecosystem stability/quality of life, Gel electrophoresis, recycling, composting **NYS Science and Engineering Practices** **Using Mathematics and Computational Thinking** -Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (HSLS2-1) -Use mathematical representations of phenomena or design solutions to support and revise explanations. (HS-LS2-2) -Create or revise a simulation of a phenomenon, designed device, process, or system. (HS-LS2-7) -Create a computational model or simulation of a phenomenon, designed device, process, or system. (HSESS3-3) -Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-ESS3-6) **Constructing Explanations and Designing Solutions** -Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-LS2-7) -Design or refine a solution to a complex real-world problem, based on scientific knowledge, student generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ESS3-4) **Engaging in Argument from Evidence** -Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-6) -Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-8) -Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations). (HS-ESS3-2)

	NYS Disciplinary Core Ideas **LS2.A: Interdependent Relationships in Ecosystems** Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (HS-LS21),(HS-LS2-2) -NYSED Carrying capacity results from the availability of biotic and abiotic factors and from challenges such as predation, competition, and disease. (HS-LS2-1),(HSLS2-2) **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2),(HS-LS2-6) -Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7) **LS4.C: Adaptation** Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometimes the extinction–of some species. (HS-LS4-5) **LS4.D: Biodiversity and Humans** Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (secondary to HS-LS2-7) -Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (secondary to HS-LS2-7) **ESS2.D: Weather and Climate** -Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. (secondary to HS-ESS3-6) **ESS3.C: Human Impacts on Earth Systems** -The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3) -Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4) **ESS3.D: Global Climate Change** -Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities. (HS-ESS3-6) **ETS1.A: Defining and Delimiting Engineering Problems** -Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS-ETS1-1) -Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HS-ETS1-1)

	ETS1.B: Developing Possible Solutions -When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3) -Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (HS-ETS1-4) **ETS1.C: Optimizing the Design Solution** -Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (HSETS1-2)
Overarching Concepts	**NYS Crosscutting Concepts** **Scale, Proportion, and Quantity** The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-LS2-1) Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (HS-LS2-2) **Stability and Change** Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6),(HSLS2-7) Living and non-living things are interdependent and any changes, big or small, can cause an effect (change) on other things. **Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS2-7), (HS-LS2-8) **Systems and System Models** -Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows— within and between systems at different scales. (HS-ETS1-4) **Connections to Nature of Science** **Scientific Knowledge is Open to Revision in Light of New Evidence** -Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-2) -Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation. (HSLS2-6),(HS-LS2-8) **Connections to Engineering, Technology, and Applications of Science** **Influence of Science, Engineering, and Technology on Society and the Natural World** -New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ETS1-1) (HSETS1-3)
Resources	Miller and Levine and/or Campbell textbook, NYS Biodiversity lab supplies, other lab supplies and equipment for selected activities,
Assessments	**Formative**: Quizzes, Selected worksheets, notebook/journal checks and teacher observation **Summative**: Unit Tests and Labs **Required Lab**: NY State Lab: Biodiversity **Suggested Labs:** Terrarium Lab, Composting Lab, Research project on human impact affecting the environment. Examples: Global Warming, nuclear/chemical pollution, Design challenge for a solution to a human impact problem.