TRUMBULL PUBLIC SCHOOLS

Trumbull, Connecticut

GRADE 10 BIOLOGY
Science Department

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Grade 10 Biology
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CORE VALUES AND BELIEFS

The Trumbull School Community engages in an environment conducive to learning which believes that all students will **read** and **write effectively**, therefore communicating in an articulate and coherent manner. All students will participate in activities **that present problem- solving through critical thinking**. Students will use technology as a tool applying it to decision making. We believe that by fostering self-confidence, self-directed and student-centered activities, we will promote **independent thinkers and learners**. We believe **ethical conduct** to be paramount in sustaining the welcoming school climate that we presently enjoy.

Approved 8/26/2011

INTRODUCTION & PHILOSOPHY

Grade 10 Biology is consistent in the continued development of scientifically literate students. Authentic scientific and engineering experiences build on one another and increase in complexity throughout students' K-12 education. In 2015, the Connecticut State Board of Education adopted the Next-Generation Science Standards (NGSS), which embody the National Research Council's *Framework for K-12 Science Education* (2012). Both the *Framework* and the NGSS stress the importance of teaching classroom scientific inquiry as practiced by scientists and engineers. The *Framework* provides a vision for American science education in the 21st century, while the NGSS provides grade-level student performance expectations, disciplinary core ideas, and crosscutting concepts. The *Framework* and NGSS indicated a paradigm shift in science education, one in which teachers are to incorporate authentic learning experiences for students that reflect the nature of doing science and engineering.

The *Framework* and NGSS provide clarity to classroom scientific inquiry by stressing the importance of the eight practices of science and engineering. The practices were designed to help students understand how scientific knowledge develops, and to stimulate students' interest in and continued study of science. Three-dimensional learning facilitates student engagement with Science and Engineering Practices and Crosscutting Concepts to deepen their understanding of Disciplinary Core Ideas in order to explain phenomena and solve problems. Three-dimensional learning promotes development of student skills in the following areas:

- Knowing, using, and interpreting scientific explanations of the natural world (Disciplinary Core Ideas, and Crosscutting Concepts)
- Generating and evaluating scientific evidence and explanations (Science and Engineering Practices)
- Participating productively in scientific practices and discourse (Science and Engineering Practices)
- Understanding the nature and development of scientific knowledge (Science and Engineering Practices, and Crosscutting Concepts)

The shift of science education reflects the interconnected nature of science as it is practiced in the real world and builds coherently across grades K-12. The NGSS focus on deeper understanding of content as well as application of content with an alignment to the Connecticut

Core Standards. A deeper understanding and application of science and engineering practices prepare students for postsecondary success and citizenship in a world fueled by innovations in science and technology.

Most systems or processes depend at some level on physical and chemical subprocesses that occur within, whether the system in question is a star, Earth's atmosphere, a river, a bicycle, the human brain, or a living cell. Large-scale systems often have emergent properties that cannot be explained on the basis of atomic-scale processes; nevertheless, to understand the physical and chemical basis of a system, one must ultimately consider the structure of matter at the atomic and subatomic scales to discover how it influences the system's larger-scale structures, properties, and functions. Similarly, understanding a process at any scale requires awareness of the interactions occurring – in terms of the forces between objects, the related energy transfers, and their consequences. Biology has much in common with the other branches of science, but it also includes a unique set of scientific pursuits. Inquiries into biology (e.g., macromolecules, genetics, evolution, and ecology) have been pursued in part as a means of understanding the unity and diversity among organisms and how organisms interact with each other and with the nonliving components of the environment.

Grade 10 Biology is offered at three separate course levels: Honors, Advanced College Preparatory (ACP), and College Preparatory (CP). All levels will explore each unit of study. The courses are differentiated by pacing of curriculum, rigor of exploration, depth of content knowledge, and the application of quantitative reasoning. The honors course will explore topics with the greatest depth, most rigorous exploration, deepest study of content, and furthest application of quantitative reasoning. More support will be offered at the ACP course level, with the most support offered at the CP course level.

COURSE GOALS

The course goals derive from the 2013 Next-Generation Science Standards, the 2010 Connecticut Core Standards, and the ISTE (International Society for Technology in Education) Technology Standards. Goals are listed specific to each unit in this curriculum guide, and developed through unit lessons using the 5-E learning model (engage, explore, explain, elaborate, evaluate) in order to encourage student engagement and foster metacognitive learning strategies through a reflective process. An important role of science education is not to teach "all the facts," but rather to prepare students with sufficient core knowledge so that they can later acquire additional information on their own.

COURSE ENDURING UNDERSTANDINGS

Students will understand that . . .

- The process of science helps biologists investigate how nature works at all levels, from the molecules in cells to the biosphere.
- Cells are the basic unit of life; the processes that occur at the cellular level provide the energy and basic structure organisms need to survive.
- DNA is the universal code for life; it enables an organism to transmit hereditary information and, along with the environment, determines an organism's characteristics.

- The human body is a complex system. The coordinated functions of its many structures support life processes and maintain homeostasis.

- The diversity of life is the result of ongoing evolutionary change. Species alive today have evolved from ancient common ancestors.

- The existence of life on earth depends on interactions among organisms and between organisms and their environment.

COURSE ESSENTIAL QUESTIONS

- What are the basic chemical principles that affect living things?
- How do plants and other organisms capture, obtain, and store energy?
- How does a cell produce a new cell?
- How does a single undifferentiated cell lead to a complex multicellular organism?
- What is the structure of DNA, and how does it function in genetic inheritance?
- How do cells make proteins?
- How can we use genetics to study human inheritance?
- How do various body systems interact with each other and with the environment to maintain homeostasis?
- What are the four factors upon which the process of evolution is based?
- How does natural selection lead to evolution?
- How do biotic and abiotic factors shape ecosystems?
- How have human activities shaped local and global ecology?
- How does evolution lead to unity within diversity?

COURSE KNOWLEDGE & SKILLS

Students will understand:

- Patterns. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

- Cause and effect: Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

- Scale, proportion, and quantity. In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

- Systems and system models. Defining the system under study – specifying its boundaries and making explicit a model of that system – provides tools for understanding and testing ideas that are applicable throughout science and engineering.
- Energy and matter: Flows, cycles, and conservation. Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.
- Structure and function. The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.
- Stability and change. For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

Students will be able to . . .

- ask questions (for science) and define problems (for engineering).
- develop and use models.
- plan and carry out investigations.
- analyze and interpret data.
- use mathematics and computational thinking.
- construct explanations (for science) and design solutions (for engineering).
- engage in arguments from evidence.
- obtain, evaluate, and communicate information

COURSE SYLLABUS

Course Name

Grade 10 Biology

Level

College-Preparatory, Advanced College-Preparatory, & Honors

Prerequisites

Successful completion of Grade 9 Integrated Physical Science

Materials Required

None

General Description of the Course

This course is aligned to the Next Generation Science Standards (NGSS) Disciplinary Core Ideas for Grade 10. Through the implementation of the Three Dimensions of NGSS (Disciplinary Core Ideas, Science and Engineering Practices and Cross Cutting Concepts), students will explore topics in life sciences. Students will engage in the Science and Engineering Practices throughout their studies in order to develop their ability to think critically, engage in analysis, effectively communicate and defend their understandings like a scientist or engineer. At the Honors level, algebraic reasoning and independent discovery are expected; the CP level mirrors the ACP level with additional guided inquiry.

Assured Assessments

Formative Assessments:

Formative assessments can include, but are not limited to:

- Questioning, discussion, and in-class activities

Summative Assessments:

- End-of-unit assessment with multiple-choice questions
- End-of-unit assessment with multiple-choice questions and interpreting and analyzing data
- Research and presentation on humans and Earth's ecosystems
- Midyear examination
- End-of-year examination

Core Texts

- Miller, Kenneth R., and Joseph S. Levine. *Biology*. New York: Pearson, 2014. Print.
- *Campbell Biology: Concepts & Connections*. 8th ed. New York: Pearson, 2015. Print.

UNIT 0
Introduction to Biology

Unit Goals
At the completion of this unit, students will:

- Be able to safely perform laboratory experiments in accordance with OSHA Lab Safety and National Fire Code Standards.
- Identify the characteristics required for determining if something is a living organism.
- Design and conduct scientific experiments

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models: ● Planning and Carrying Out Investigations Planning and carrying out in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. 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 . ● Use a model based on evidence to illustrate the relationships between systems or between components of a system. 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.	LS1.A : Structure and Function: ● Systems of specialized cells within organisms help them perform the essential functions of life.	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. ● Energy cannot be created or destroyed – it only moves between one place and another place, between objects and/or fields, or between systems. ● 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. ● Cause and Effect Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (

Unit Essential Questions

- What is the nature of science?
- What is the language of science?
- What is biology?
- How do we safely perform experiments in the science laboratory?
- How is life organized?

Unit Essential Vocabulary

Periodic Table Of Elements
Atomic Number
Subatomic Particles
Proton
Neutron
Electron
Nucleus
Atom
Element
Molecule
Ion
Ionic Bond
Covalent Bond
Hierarchy
Homeostasis
Pseudoscience
Experimental Design
Hypothesis
Observation
Claim/Evidence/Reasoning

Scope and Sequence

- Safety & Equipment
    - Lab Introduction – Identify Equipment and Uses (Icebreaker) - Biology Corner
    - Introductory Activity on Using Science Equipment - Biology Corner
    - Flinn Safety Contract for Life Science
- Language of Science
- Characteristics of living things
    - Anchor: Worm vs rock
        - Students compare and suggest characteristics of life
        - Scavenger hunt outside - students from each table find an example that represents one characteristic of life (assigned).
- Hierarchy of life
    - Jigsaw with cards
    - Atomic Structure and Bonding
- Nature of Science & Experimentation
    - Science vs. Pseudoscience
    - Observation lab
    - Pill bugs lab
    - Flowchart - how can causal questions be answered
    - Assess- design experiment to answer a scientific question

Assured Assessments

Formative Assessments:

- Science Safety Assessment
- Hierarchy Jigsaw activity
- Design an experiment

Summative Assessment

- Students will participate in an assessment consisting of multiple-choice questions, and interpreting and analyzing data, related to introductory topics.

Resources

- Lab Introduction – Identify Equipment and Uses (Icebreaker) - Biology Corner
- Introductory Activity on Using Science Equipment - Biology Corner
- Flinn Safety Contract for Life Science
- Academic Integrity Activity (Biology Corner)
- Characteristics of Life
- Hierarchy of Life
- Atomic structure and bonding - PBS Learning Media: Chemthink interactives
    - atomic structure https://simbucket.com/chemthinkserver/chemthink/index.html?as
    - ionic bonding https://simbucket.com/chemthinkserver/chemthink/index.html?ib
    - covalent bonding https://simbucket.com/chemthinkserver/chemthink/index.html?cb
- Nature of Science - flowchart and sample scientific questions in Biology Corner
    - https://drive.google.com/file/d/0Bx72aSXCBO09bFpYU3RxTDBvS3M/view?resourcekey=0-VIQmD9xJNpRqAfc7Yxvd8Q
    - https://www.biologycorner.com/worksheets/sci_method_scenarios.html

Supplemental

Lab Template

Golden Rules of Experimentation

Academic Integrity - Biology Corner

Time Allotment

- Approximately 2 weeks

UNIT 1

What is a Cell: Structure & Function

Unit Goals

At the completion of this unit, students will:

NGSS.HS-LS1-2	Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
NGSS.HS-LS1-5	Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
NGSS.HS-LS1-6	Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.
NGSS.HS-LS1-7	Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed, resulting in a net transfer of energy.
NGSS.HS-LS2-3	Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
CCS.ELA-Literacy.RST.9-10.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
CCS.5.MD.B	Represent and interpret data.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models: ● Use a model based on evidence to illustrate the relationships between systems or between components of a system. (NGSS.HS-LS1-5, NGSS.HS-LS1-7) 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. (NGSS.HS-LS1-6)	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. (NGSS.HS-LS1-5) ● The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins and DNA), used for example to form new cells. (NGGS.HS-LS1-6) ● As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (NGSS.HS-LS1-6, NGSS.HS-LS1-7) ● As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. (NGSS.HS-LS1-7)	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. (NGSS.HS- LS1-5, NGSS.HS-LS1-6) ● Energy cannot be created or destroyed – it only moves between one place and another place, between objects and/or fields, or between systems. (NGSS.HS-LS1-7)

Unit Essential Questions

- What is the basic unit of life?
- What are the major differences between prokaryotic and eukaryotic cells?
- What are the general patterns that are similar and different between plants and animals?
- Why are cells so small?
- How are cell structures adapted to their functions?
- How do specialized cells and tissues contribute to the overall function and organization of multicellular organisms? (honors)
- How do materials move into and out of a cell and what are the components of the cell membrane?
- What is an organelle?
- What are the functions of different organelles within a eukaryotic cell, and how do they work together to support cellular processes? How does each contribute to cellular homeostasis?
- How do cells harness & utilize energy?
    - What are the processes of cellular respiration and photosynthesis, and how do they relate to energy flow within cells and ecosystems?

Unit Essential Vocabulary

Cytoskeleton
Nucleus
Nuclear Pore
Active Transport
Carrier Protein
Concentration Gradient
Diffusion
Endocytosis
Exocytosis
Facilitated Diffusion
Fluid Mosaic Model
Isotonic
Homeostasis
Hypertonic
Hypotonic
Osmosis
Passive Transport
Selective Permeability
Vesicle
Carbohydrates
Proteins
Lipids
Nucleic Acids
Monosaccharides
Disaccharides
Polysaccharides
Amino Acids
Fatty Acids
Glycerol
Stomata
Guard Cells
ATP
ADP
Adenosine
Phosphate Group
Photosynthesis
Glycolysis
Lactic Acid Fermentation
Alcoholic Fermentation
Aerobic
Anaerobic

Scope and Sequence

- Light microscope
    - Microscope lab - letter “e”, colored thread
- Anchoring Phenomenon- Red Blood Cells and Sickle Cells
- Modeling red blood cells and sickle cells - clay
- Sickle Cell Case Study
- What is a cell?
    - Microscope lab- plant and animal cells
- Prokaryote vs. eukaryote cells
- Plant and animal cell similarities and differences
- Cell Model Project
    - Stage 1- Choose a cell type
    - Stage 2- Build a cell membrane
    - Stage 3- Adding in organelles
    - Stage 4- Adding in nuclear membrane

- Cell Membrane
  - Cell Size Lab
  - Tonicity lab
  - Dialysis tubing lab
  - Onion cell/elodea plasmolysis
- Organelles
- Mitochondria and chloroplasts
  - Yeast balloon lab
  - Elodea and snails lab
  - Plant in a bag lab
  - Cellular Respiration & Photosynthesis
  - Atomic bonding
- Nucleus and Nuclear membrane

Assured Assessments

Formative Assessments:

- Questioning, group discussion, and in-class activities
- Students will construct a complete model of either a plant or animal cell, and be able to discuss the structure and function of each component added.

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions and open-ended questions regarding the structures and functions of a cell.
- Completed cell model project (Rubric)

Resources

Core

- Miller and Levine, "Biology." Textbook
- Light Microscope Intro Lab
- Red Blood Cell and Sickle Cell Lab
- Sickle Cell Modeling
- Sickle Cell Case Study
- Cell Model Project
- Tonicity Lab
- Dialysis tubing lab
- Cell Size Lab
- Yeast Lab
- Elodea and Snail Lab
- Plant in a bag lab

Supplemental

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Time Allotment

- Approximately 6 Weeks

UNIT 2

Cell Processes

Unit Goals

At the completion of this unit, students will:

NGSS.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.
NGSS.HS-LS1-4	Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.
NGSS.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.
CCS.ELA-Literacy.RST.9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
CCS.5.MD.B	Represent and interpret data.
ISTE Computational Thinker (Standard 5b)	Collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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. (NGSS.HS-LS1-1) Developing and Using Models: ● Use a model based on evidence to illustrate the relationships between systems or between components of a system. (NGSS.HS-LS1-4	LS1.A: Structure and Function: ● Systems of specialized cells within organisms help them perform the essential functions of life. (NGSS.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. (NGGS.HS-LS1-1) 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. (NGSS.HS-LS1-4) 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. (NGSS.HS-LS3-)	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. (NGSS.HS-LS1- 1) Cause and Effect: ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (NGSS.HS-LS3-1) 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. (NGSS.HS-LS1-4)

Unit Essential Questions

- What is the structure and function of DNA?
- How does DNA replication occur?
- How does cell reproduction differ in prokaryotic versus eukaryotic cells?
- What are the stages of the cell cycle?
- How does a complex, multicellular organism develop from a single cell?
- What happens during mitotic cell division?
- How does the structure of DNA determine the structure of proteins?

Unit Essential Vocabulary

Cell Cycle	Cytokinesis	Anticodon
Binary Fission	Purine	Protein Synthesis
Mitosis	Pyrimidine	Start Codon
Chromosomes	Helicase	Stop Codon
Chromatid	Polymerase	Adenine
Spindle Fiber	Transcription	Guanine
Centriole	Translation	Cytosine
Prophase	mRNA	Thymine
Metaphase	tRNA	Uracil
Anaphase	rRNA	Gene
Telophase	Codon	

Scope and Sequence

- Anchoring Phenomenon: Onion Root Tip
- Cell cycle / Mitosis
  - Model stages of mitosis
  - Cell cycle checkpoints and cancer [for Honors]
- DNA structure/replication
  - Creating a model of DNA
  - The structures and functions of the following enzymes: DNA polymerase, DNA helicase, Primase, RNase H, SSBPs, Gyrase [for Honors]
- Protein synthesis
  - transcription and translation model using their cell model from Unit 1

Assured Assessments

Formative Assessments:

- Modeling activities for students to demonstrate their understanding of the structure and replication of DNA
- Modeling stages of mitosis (chalk drawings)
- Modeling transcription and translation using cell model from unit 1

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, and interpreting and analyzing data, related to DNA structure, replication, cell cycle, and protein synthesis.

Resources

Core

- Miller, Kenneth R., and Joseph S. Levine. *Biology*. New York: Pearson, 2014. Print.
- Amoeba Sisters. "Specialized Cells: Significance and Examples." https://www.youtube.com/watch?v=wNe6RuK0FfA.
- "Modeling DNA Using Pop Beads."
- "Paper Model of DNA Replication."
- "Modeling Mitosis With Chalk and Pop-It Beads"
- "Modeling Transcription and Translation With Cell Model"

Supplemental

- Amoeba Sisters. "Introduction to Cells: The Grand Cell Tour.
- "DNA Extraction – Strawberry. https://www.biologycorner.com/worksheets/DNA_extraction.html.
- "Mitosis Flip Book." Trumbull High School.
- "Modeling Cell Cycle Petri Activity."
- "Pasta Mitosis."

Time Allotment

- Approximately 4 weeks

UNIT 3

Genetics

Unit Goals
At the completion of this unit, students will:

NGSS.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, and/or (3) mutations caused by environmental factors.
NGSS.HS-LS3-3	Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.
CCS.ELA-Literacy.RST.9-10.1	Cite specific textual evidence to support analysis of science and technical texts, attending to the precise detail of explanations or descriptions.
CCS.ELA-Literacy.RST.9-10.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
CCS.ELA-Literacy.RST.9-10.7	Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
CCS.MP.5	Use appropriate tools strategically.
CCS.5.MD.B	Represent and interpret data.
CCS.HSS-CP.B.9	Use permutations and combinations to compute probabilities of compound events and solve problems.
ISTE Computational Thinker (Standard 5b)	Collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.
ISTE Creative Communicator (Standard 6b)	Create original works or responsibly repurpose or remix digital resources into new creations.
ISTE Creative Communicator (Standard 6d)	Publish or present content that customizes the message and medium for their intended audiences.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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. (NGSS.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. (NGSS.HS-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. Environmental factors can also cause mutations in genes, and viable mutations are inherited. (NGSS.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. (NGGS.HS-LS3- 2, NHSS.HS-LS3-3)	Cause and Effect: ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (NGSS.HS-LS3-2) Scale, Proportion, and Quantity: ● Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). (NGSS.HS-LS3-3) Science Is a Human Endeavor: ● Technological advances have influenced the progress of science and science has influenced advances in technology. (NGSS.HS-LS3-3) ● Science and engineering are influenced by society and society is influenced by science and engineering. (NGSS.HS-LS3-3)

Unit Essential Questions

- How are gametes produced?
- Where does an organism get its unique characteristics?
- How do crossing-over, independent assortment, mutations and random mating lead to genetic variation?
- How can we use statistics and probability to predict traits?
- What are the other modes of inheritance
- How is sex determined in humans?
- What patterns of inheritance are seen in human blood types?
- What are some of the major genetic disorders?

Unit Essential Vocabulary

Genetics
Gene
Trait
Allele
Hybrid
P- Parental Generation
F_1- First Filial
F_2- Second Filial
Homozygous
Heterozygous
Dominant
Codominance
Incomplete Dominance
Pleiotropy
Recessive
Genotype
Phenotype
Punnett Square
Monohybrid
Dihybrid
Law of Segregation
Law of Independent Assortment
Polygenic
Autosomes
X-Linked
Pedigree
Karyotype

Scope and Sequence

- Anchoring Phenomenon: Observable Human Traits & Pedigree
- Meiosis
- Mendelian genetics
- Non-Mendelian genetics (codominance, incomplete dominance, multiple alleles, sex- linked)
- Karyotype
- Pedigree
- Genetic disorders

Assured Assessments

Formative Assessments:

- Modeling activities for students to demonstrate their understanding of meiosis and non-Mendelian genetics

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, and interpreting and analyzing data, related to meiosis, genetics, genetic disorders, and pedigrees.

Resources

Core

- Miller, Kenneth R., and Joseph S. Levine. *Biology*. New York: Pearson, 2014. Print.
- "Baby Blood Typing Mystery." Trumbull High School.
- "Introduction to Non-Mendelian Genetics."

- “Karyotyping Analysis.”
- “Meiosis Modeling.”
- “Human Pedigree Analysis: Case Studies.”
- “Snurfle Meiosis and Genetics.” https://biomanbio.com/HTML5GamesandLabs/Genegames/snurflemeiosishtml5page.htm

Supplemental

- Amoeba Sisters. “Punnett Squares and Sex-Linked Traits.” https://www.youtube.com/watch?v=h2xufrHWG3E.
- “Genetic Disorder Project.”
- “Mendel’s Peas Genetics: Experiments That Changed the World.” https://www.youtube.com/watch?v=6NvESo3mG90.

Time Allotment

- Approximately 5 weeks

UNIT 4

Evolution

Unit Goals

At the completion of this unit, students will:

NGSS.HS-ESS2-7	Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.
NGSS.HS-LS4-1	Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
NGSS.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.
NGSS.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.
NGSS.HS-LS4-4	Construct an explanation based on evidence for how natural selection leads to adaptation of populations.
NGSS.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.
ISTE Computational Thinker (Standard 5b)	Collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence: ● Construct an oral and written argument or counter-arguments based on data and evidence. (NGSS.HS-ESS2-7) Applying 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. (NGSS.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. (NGSS.HS-LS-4-2, NGSS.HS-LS4-4) Engaging in Argument from Evidence: ● Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (NGSS.HS- LS4-5) Obtaining, Evaluating, and Communicating Information:	ESS2.E: Biogeology ● The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it. (NGGS.HS-ESS2-7) 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. (NGSS.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. (NGSS.HS-LS4-2, NGSS.HS-LS4-3) ● The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (NGSS.HS-LS4-3)	Stability and Change: ● Much of science deals with constructing explanations of how things change and how they remain stable. (NGSS.HS-ESS2-7) 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. (NGSS.HS- LS4-1, NGSS.HS-LS4-3) Cause and Effect: ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (NGSS.HS-LS4-2, NGSS.HS-LS4-4, NGSS.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. (NGSS.HS-LS4-1, NGSS.HS-LS4-4) 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. (NGSS.HS-LS4-3, NGSS.HS-LS4-4)

● 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). (NGSS.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. (NGSS.HS-LS4-1)	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. (NGSS.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	● Adaptation also means that the distribution of traits in a population can change when conditions change. (NGSS.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. (NGSS.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. (NGSS.HS-LS4-5)

Unit Essential Questions

- How has the evolution of Earth itself affected or influenced the evolution of living things on planet Earth?
- What is the importance of variation among organisms? How does this variation contribute to the survival and success of a species?
- What scientific information supports common ancestry and biological evolution?
- What are the four factors upon which the process of evolution is based?
- How does natural selection lead to adaptations of populations?
- How are new species formed?

Unit Essential Vocabulary

Species	Jean-Baptiste Lamarck	Speciation
Variations	Charles Darwin	Adaptive radiation
Evolution	Galapagos Islands	Punctuated equilibrium
Fossil	Natural selection	Divergent evolution
Homologous structures	Adaptations	Parallel evolution
Analogous structures	Gene pool	Convergent evolution
Vestigial structures	Gene flow	
	Genetic drift	

Scope and Sequence

- Introduction of evolution
- Evidence for evolution: Fossil record, homologous, analogous, vestigial structures, DNA analysis, biochemistry, etc.
- Charles Darwin and Jean-Baptiste Lamarck: Contributions to evolution
- Four factors that drive evolution (Darwin's postulates)
- Natural selection vs. artificial selection
- Adaptation (behavioral and physical)
- Types of evolution (divergent, convergent, parallel, coevolution)
- Phylogenetic trees and cladograms
- Coevolution of Earth's systems and life on Earth
- Hardy-Weinberg equilibrium [Honors]

Assured Assessments

Formative Assessments:

-

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, and interpreting and analyzing data, related to evolution.

Resources

Core

- Miller, Kenneth R., and Joseph S. Levine. *Biology*. New York: Pearson, 2014. Print.
- National Geographic. *One Strange Rock*. https://onestrangerock.com/.
- "Peppered Moths."

Supplemental

- "Evolution Mind Map."

- “Human Change through Time Lab Activity.” Trumbull High School.
- “What Is the Evidence for Evolution?” https://www.youtube.com/watch?v=lIEoO5KdPvg.

Time Allotment

- Approximately 4 weeks

UNIT 5

Comparative Anatomy & Homeostasis

Unit Goals

At the completion of this unit, students will:

NGSS.HS-LS1-2	Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
NGSS.HS-LS1-3	Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
ISTE Computational Thinker (Standard 5b)	Collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models: ● Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (NGSS.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. (NGSS.HS- LS1-3) 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. (NGSS.HS-LS-1-3)	LS1.A: Structure and Function: ● 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. (NGSS.HS-LS1-2) ● 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. (NGGS.HS-LS1- 3)	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. (NGSS.HS-LS1-2) Stability and Change: ● Feedback (negative or positive) can stabilize or destabilize a system. (NGSS.HS-LS1-3)

Sub Unit 5a: Reproduction

Unit Essential Questions:

- How is maintaining homeostasis essential for maintaining life?
- How do negative and positive feedback systems work to maintain homeostasis within the human body?
- What are the different ways by which single and multicellular organisms pass on their DNA?
- How do human reproductive systems interact with other systems in the body to maintain homeostasis?
- How do organ systems depend on each other to complete essential functions within the body?
    - What is the endocrine system, and why is it essential for homeostasis?

Essential Vocabulary:

Homeostasis	Estrogen	Oviduct
Target Cell	Testosterone	Ovulation
Negative Feedback	Growth Hormone	Ovule
Positive Feedback	Progesterone	Petal
Hormone	Hyper	Pistil
Receptor	Hypo	Pollen
Gland	Anther	Pollination
Binary Fission	Filament	Regeneration
Budding	Flower	Sepal
Vegetative Propagation	Follicle	Stamen
Endocrine Cascade	Menstrual cycle	Stigma
LH	Menstruation	Style
TSH	Ovary	

Scope and Sequence:

Homeostasis and positive/negative feedback mechanisms

Asexual/ Sexual Reproduction Comparison

- Binary Fission
- Budding
- Regeneration
- Vegetative Propagation

Reproductive System Structure & Function:

- Adaptations for Internal & External Fertilization & Development
- System Structure
- Menstrual Cycle- hormones involved; Stabilizing or Destabilizing a system

Resources:

Core

- “Introduction to Body Systems.”
- “Homeostasis of the Eye Lab.”
- “Homeostasis Lab.” Trumbull High School. [response to exercise]
- Lab: Flower Anatomy
- Lab: Stages of the Menstrual Cycle

Supplemental

- Amoeba Sisters. “Homeostasis and Negative/Positive Feedback.” https://www.youtube.com/watch?v=Iz0Q9nTZCw4.
- Lab: Regeneration (Planaria)

Assured Assessments:

Formative Assessments:

- Analyzing and interpreting data regarding menstrual cycle
- Develop a model (constructing a graph) illustrating the impact of hormone levels on strength of contractions.

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, and interpreting and analyzing data, related to human body systems.

Time Allotment:

- Approximately 2 weeks

UNIT 5

Sub Unit 5b: Digestion

Unit Essential Questions:

- How have different organisms evolved to take in nutrients, as we as digest and utilize those nutrients?
- How do specific nutrients impact the body's ability to maintain homeostasis and essential life functions?

Essential Vocabulary

Bile	Enzyme	Base
Chemical Digestion	Mechanical Digestion	Gizzard
Chyme	Substrate	Internal Digestion
Colon	Active Site	External Digestion
Stomach	pH	Nutrient
Crop	Acid	

Scope and Sequence

- Evolution of different adaptations to obtain food sources
- Macronutrients to functions within the body
    - Proteins & enzymes
    - Digestion/Absorption of nutrients within different structures

Activities:

LAB: Ingestion and Digestion in Protists

LAB: What can teeth tell you about Diet?

LAB: Potato or Liver Catalase

Comparative anatomy models of human, frog, earthworm, squid

LAB: Frog Dissection

Assured Assessments:

Formative:

- Analyzing and interpreting a model of the digestive system

Summative:

- Students will participate in an assessment consisting of multiple-choice questions, and interpreting and analyzing data, related to human body systems.

Resources:

Core

- Miller, Kenneth R., and Joseph S. Levine. *Biology*. New York: Pearson, 2014. Print.
- "Earthworm Dissection."
- "Frog Dissection."

Supplemental

- LAB: Protein Digestion
- Virtual Lab https://gizmos.explorelearning.com/find-gizmos/lesson-info?resourceId=1050

Time Allotment:

- Approximately 3 weeks

UNIT 6

Body Systems: Transport & Gas Exchange

Unit Essential Questions:

- How does the movement of materials and gas exchange differ between organisms?
- How do the structures of the human circulatory system work to maintain homeostasis?
- How does the circulatory system of animals work with other body systems?
- How and why is gas exchange important in maintaining homeostasis?

Scope and Sequence:

- Evolution of different adaptations to exchange gasses and transport materials
- Mechanisms of transport and gas exchange maintain homeostasis within the body

Essential Vocabulary

Aorta	Platelet	Bronchus
Artery	Red Blood Cell	Diaphragm
Atrium	Valve	Gill
Capillary	Vein	Lung
Guard Cell	Ventricle	Respiration
Stomata	Vessel	Trachea
Phloem	White Blood Cell	
Xylem	Alveolus	

Activities:

LAB: Effect of Exercise on CO_2 Release

LAB: Celery (Xylem and Phloem)

Graphing Activity: Elodea- How temperature, amount of light affect the transpiration rate?
https://iwant2study.org/ospsg/index.php/interactive-resources/biology/1061-transpiration

Assured Assessments:

Formative:

- Analyzing and interpreting a model of transport and gas exchange in different organisms.

Summative:

- Students will participate in an assessment consisting of multiple-choice questions, and interpreting and analyzing data, related to human body systems.

Resources:

Core

- Miller, Kenneth R., and Joseph S. Levine. *Biology*. New York: Pearson, 2014. Print.

Supplemental:

- LAB: Comparing causes of decreased function in the respiratory system

Time Allotment:

- Approximately 2 weeks

UNIT 7

Body Systems: Nervous System

Unit Essential Questions:

- How do the structures of the nervous system work to carry out the essential functions?
- How does the structure of the neuron aid in sending signals to the brain?

Essential Vocabulary:

Central Nervous System	Cerebrum	Synapse
Brain	Frontal Lobe	Neurotransmitters
Spinal Cord	Temporal Lobe	Mechanoreceptors
Peripheral Nervous System	Parietal Lobe	Photoreceptors
Somatic Nervous System	Occipital Lobe	Chemoreceptors
Autonomic Nervous System	Neuron	Reflex Arc
Motor Division	Cell Body	Interneuron
Sensory Division	Axon	Sensory & Motor Neuron
Brainstem	Dendrite	Nodes of Ranvier
Cerebellum	Myelin Sheath	

Scope and Sequence:

- Nervous system structure and functions
  - Divisions of the nervous system
  - Neurons
- Reflex arc
  - Responding to stimuli in an internal or external environment
  - Neurotransmitters and chemical signaling in plants

Assured Assessments:

Formative:

- Table comparing neurotransmitters or chemical signaling in plants and animals
- Modeling neurons, parts of the brain, and the flow of a reflex chart

Summative:

- Students will participate in an assessment consisting of multiple-choice questions, and interpreting and analyzing data, related to human body systems.

Resources:

Core

- Miller, Kenneth R., and Joseph S. Levine. *Biology*. New York: Pearson, 2014. Print.
- "Body Systems Organizer and Homeostasis Modeling."
- "Brain Hat."
- "Divisions of the Central Nervous System Graphic Organizer."
- "Factors that affect Reaction Rates Lab."
- Lab: Comparing the responses of plants and humans to a stimuli in the external environment

Supplemental

- "Neuron and Synapse Active Reading."
- "Parts of the Brain Active Reading."
- "Reflex Lab."

Time Allotment:

- Approximately 2 weeks

UNIT 8
Ecology and Human Impact

Unit Goals
At the completion of this unit, students will:

NGSS.HS-LS2-3	Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
NGSS.HS-LS2-4	Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
NGSS.HS-LS2-6	Evaluate 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.
NGSS.HS-LS2-8	Evaluate evidence for the role of group behavior on individual and species' chances to survive and reproduce.
NGSS.HS-LS2-1	Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
NGSS.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.
NGSS.HS-LS2-7	Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
NGSS.HS-LS4-6	Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
NGSS.HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
NGSS.HS-ESS3-3	Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity.
NGSS.HS-LS2-5	Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere

CCS.ELA-Literacy.RST.9-10.1	Cite specific textual evidence to support analysis of science and technical texts, attending to the precise detail of explanations or descriptions.
ISTE Computational Thinker (Standard 5b)	Collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models: ● Develop a model based on evidence to illustrate the relationships between systems or components of a system. (NGSS.HS-LS2- 5) Using Mathematics and Computational Thinking: ● Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (NGSS.HS-LS2-1) ● Use mathematical representations of phenomena or design solutions to support and revise explanations. (NGSS.HS-LS2-2) ● Use mathematical representations of phenomena or design solutions to support claims. (NGSS.HS-LS2-4) ● Create or revise a simulation of a phenomenon, designed device, process, or system. (NGSS.HS-LS4-6) ● Create a computational model or simulation of a phenomenon, designed device, process, or system. (NGSS.HS-ESS3-3) 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	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. (NGGS.HS-LS2-3) ● 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. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. 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. (NGSS.HS-LS2-4) ● Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. (NGSS.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 NGSS.HS- LS2-5)	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. (NGSS.HS-LS2-5) Energy and Matter: ● Energy cannot be created or destroyed – it only moves between one place and another place, between objects and/or fields, or between systems. (NGSS.HS-LS2-4) ● Energy drives the cycling of matter within and between systems. (NGSS.HS-LS2-3) Cause and Effect: ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (NGSS.HS-LS2-8, NGSS.HS-LS4-6) Scale, Proportion, and Quantity: ● The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (NGSS.HS-LS2-1) ● Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a

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. (NGSS.HS-LS-2-3) ● Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations. (NGSS.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. (NGSS.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. (NGSS.HS-LS2-6) ● Evaluate the evidence behind currently accepted explanations to determine the merits of arguments. (NGSS.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	LS2.A: Interdependent Relationships in Organisms: ● Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges as predation, competition, and disease. 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. (NGSS.HS- LS2-1, NGSS.HS-LS2-2) 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. (NGSS.HS-LS2-2, NGSS.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. (NGSS.HS-LS2-7)	model at another scale. (NGSS.HS-LS2-2) Stability and Change: ● Much of science deals with constructing explanations of how things change and how they remain stable. (NGSS.HS- LS2-6, NGSS.HS-LS2-7) ● Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (NGSS.HS-ESS3-3) ● Feedback (negative or positive) can stabilize or destabilize a system. (NGSS.HS-ESS3-4) Connections to Engineering, Technology, and Applications of Science: Influence of Engineering, Technology, and Science on Society and the Natural World: ● Modern civilization depends on major technological systems. (NGSS.HS-ESS3-3) ● Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (NGSS.HS-ESS3-4) ● New technologies can have deep impacts on society and the environment, including some that were not anticipated. (NGSS.HS-ESS3-3)

reinterpretation of existing evidence. (NGSS.HS-LS2- 2, NGSS.HS-LS2-3) ● 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. (NGSS.HS-LS2-6, NGSS.HS-LS2-8)	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. (NGSS.HS-LS2-8) 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. (NGSS.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. (NGSS.HS-LS4-6) 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 NGSS.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	Science Is a Human Endeavor: ● Science is a result of human endeavors, imagination, and creativity. (NGSS.HS- ESS3-3)

	preserving landscapes of recreational or inspirational value. (secondary to NGSS.HS-LS2-7) 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 NGSS.HS-LS2-7, secondary to NGSS.HS- LS4-6, secondary to NGSS.HS-ESS3-4) ● 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. (secondary to NGSS.HS- LS4-6) ESS3.C: Human Impacts on Earth Systems: ● The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (NGSS.HS- ESS3-3) ● Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (NGSS.HS-ESS3-4)	

Unit Essential Questions

- Why are biogeochemical cycles essential in ecosystems?
- What is the relationship between energy and matter in an ecosystem?
- What are the components of an ecosystem, and how are they interdependent?
- How do biotic and abiotic factors interact within an ecosystem?
- How do limiting factors affect the carrying capacity of ecosystems?
- What is the role of group behavior on individuals' and species' chances to survive and reproduce?
- In what ways do human activities affect ecosystems?

Essential Vocabulary:

Carbon Cycle	Food web	Carnivore
Nitrogen Cycle	Organism	10 % rule
Nitrogen Fixation	Producer	Gross Primary
Nitrification	Consumer	Productivity (GPP)
Denitrification	Herbivore	Net Primary Productivity
Food chain	Omnivore	(NPP)
Population	Symbiosis	Invasive Species
Birth Rate	Predation	Biodiversity
Death Rate	Competition	Primary Succession
Immigration	Parasitism	Secondary Succession
Emigration	Mutualism	Disturbance
Carrying Capacity	Commensalism	Bioaccumulation
Community	Keystone Species	Biomagnification

Scope and Sequence

- Biogeochemical cycles (carbon and nitrogen)
- Food webs, food chains, and energy pyramids (10% rule)
- GPP (Gross Primary Productivity) and NPP (Net Primary Productivity)
- Population dynamics: Four factors that influence population growth, limiting factors, carrying capacity, survivorship curves
- Relationships in a community: Mutualism, commensalism, parasitism, predation, and competition
- Costs and benefits of group behavior: Flocking, herding, swarming, schooling
- Ecological succession: Primary vs. secondary
- Biodiversity: Invasive species, keystone species
- Human impact on ecosystems and biodiversity: Climate change, bioaccumulation/ biomagnification, eutrophication, habitat destruction, invasive species

Assured Assessments

Formative Assessments:

Constructing and Interpreting a food web

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, and interpreting and analyzing data, related to ecology.

Resources

Core

- Miller, Kenneth R., and Joseph S. Levine. *Biology*. New York: Pearson, 2014. Print.
- "Analyzing Group Behavior." Trumbull High School..
- "Carbon/Nitrogen Cycle Diagrams Guided Questioning." Trumbull High School.
- "Energy Flow in an Ecosystem." Trumbull High School.
- "Importance of Biodiversity and Invasive Species." Trumbull High School.
- "Introduction to Ecological Succession." Trumbull High School.
- "Marine Energy Pyramid." Trumbull High School.
- Human Impact Research Project- research and defend methods of mitigation

Supplemental

- Avril Gulf Tuna Population Simulation." https://sepuplhs.org/high/sgi/teachers/fishery_sim.html. Accessed January 21, 2020. Web.
- "Turtle Case Study."
- "Lesson of the Kaibab."
- "Symbiotic Scenarios."
- Avril Gulf Tuna Population Simulation."
- "Symbiotic Relationships Woods Walk."

Time Allotment

- Approximately 4 weeks

COURSE CREDIT

1.00 credits in science
Three classes every four days, for a full year

ASSURED STUDENT PERFORMANCE RUBRICS

- Trumbull High School School-Wide Writing Rubric (attached)
- Trumbull High School School-Wide Problem-Solving Rubric (attached)
- Trumbull High School School-Wide Independent Learning and Thinking Rubric (attached)

Trumbull High School School-Wide Writing Rubric

Category/ Weight	Exemplary 4 Student work:	Goal 3 Student work:	Working Toward Goal 2 Student work:	Needs Support 1-0 Student work:
Purpose X____	● Establishes and maintains a clear purpose ● Demonstrates an insightful understanding of audience and task	● Establishes and maintains a purpose ● Demonstrates an accurate awareness of audience and task	● Establishes a purpose ● Demonstrates an awareness of audience and task	● Does not establish a clear purpose ● Demonstrates limited/no awareness of audience and task
Organization X__	● Reflects sophisticated organization throughout ● Demonstrates logical progression of ideas ● Maintains a clear focus ● Utilizes effective transitions	● Reflects organization throughout ● Demonstrates logical progression of ideas ● Maintains a focus ● Utilizes transitions	● Reflects some organization throughout ● Demonstrates logical progression of ideas at times ● Maintains a vague focus ● May utilize some ineffective transitions	● Reflects little/no organization ● Lacks logical progression of ideas ● Maintains little/no focus ● Utilizes ineffective or no transitions
Content X____	● Is accurate, explicit, and vivid ● Exhibits ideas that are highly developed and enhanced by specific details and examples	● Is accurate and relevant ● Exhibits ideas that are developed and supported by details and examples	● May contain some inaccuracies ● Exhibits ideas that are partially supported by details and examples	● Is inaccurate and unclear ● Exhibits limited/no ideas supported by specific details and examples
Use of Language X _____	● Demonstrates excellent use of language ● Demonstrates a highly effective use of standard writing that enhances communication ● Contains few or no errors. Errors do not detract from meaning	● Demonstrates competent use of language ● Demonstrates effective use of standard writing conventions ● Contains few errors Most errors do not detract from meaning	● Demonstrates use of language ● Demonstrates use of standard writing conventions ● Contains errors that detract from meaning	● Demonstrates limited competency in use of language ● Demonstrates limited use of standard writing conventions ● Contains errors that make it difficult to determine meaning

Trumbull High School School-Wide Problem-Solving Rubric

Category/ Weight	Exemplary 4	Goal 3	Working Toward Goal 2	Needs Support 1-0
Understanding X___	● Student demonstrates clear understanding of the problem and the complexities of the task	● Student demonstrates sufficient understanding of the problem and most of the complexities of the task	● Student demonstrates some understanding of the problem but requires assistance to complete the task	● Student demonstrates limited or no understanding of the fundamental problem after assistance with the task
Research X___	● Student gathers compelling information from multiple sources including digital, print, and interpersonal	● Student gathers sufficient information from multiple sources including digital, print, and interpersonal	● Student gathers some information from few sources including digital, print, and interpersonal	● Student gathers limited or no information
Reasoning and Strategies X_____	● Student demonstrates strong critical thinking skills to develop a comprehensive plan integrating multiple strategies	● Student demonstrates sufficient critical thinking skills to develop a cohesive plan integrating strategies	● Student demonstrates some critical thinking skills to develop a plan integrating some strategies	● Student demonstrates limited or no critical thinking skills and no plan
Final Product and/or Presentation X__	● Solution shows deep understanding of the problem and its components ● Solution shows extensive use of 21st-century technology skills	● Solution shows sufficient understanding of the problem and its components ● Solution shows sufficient use of 21st-century technology skills	● Solution shows some understanding of the problem and its components ● Solution shows some use of 21st-century technology skills	● Solution shows limited or no understanding of the problem and its components ● Solution shows limited or no use of 21st-century technology skills

Trumbull High School School-Wide Independent Learning and Thinking Rubric

Category/ Weight	Exemplary 4	Goal 3	Working Toward Goal 2	Needs Support 1-0
Proposal X___	● Student demonstrates a strong sense of initiative by generating compelling questions, creating uniquely original projects/work	● Student demonstrates initiative by generating appropriate questions, creating original projects/work	● Student demonstrates some initiative by generating questions, creating appropriate projects/work	● Student demonstrates limited or no initiative by generating few questions and creating projects/work
Independent Research & Development X _____	● Student is analytical, insightful, and works independently to reach a solution	● Student is analytical, and works productively to reach a solution	● Student reaches a solution with direction	● Student is unable to reach a solution without consistent assistance
Presentation of Final Product X_	● Presentation shows compelling evidence of an independent learner and thinker ● Solution shows deep understanding of the problem and its components ● Solution shows extensive and appropriate application of 21st-century skills	● Presentation shows clear evidence of an independent learner and thinker ● Solution shows adequate understanding of the problem and its components ● Solution shows adequate application of 21st-century skills	● Presentation shows some evidence of an independent learner and thinker ● Solution shows some understanding of the problem and its components ● Solution shows some application of 21st-century skills	● Presentation shows limited or no evidence of an independent learner and thinker ● Solution shows limited or no understanding of the problem and its components ● Solution shows limited or no application of 21st-century skills