Passaic County Technical Institute

Wayne, NJ

Biology Honors Curriculum

August 2015

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I. Course Description

Honors Biology course is a full year in-depth study of the major concepts of the living world. The core principles of science are used to promote deep understanding and appreciation of complexity, diversity, and interconnectedness of life on earth. The course focuses on: correlation between structure and function starting at molecular level and up to the level of organisms; principles of classical and molecular genetics and evolutionary theory; energy transformations within living systems; and interactions between organisms and their environment. The study of history of major discoveries in
Biology will facilitate the understanding and give insight into modern and future problems and solutions. The emphasis is placed on the modern biotechnological and technical advances as applicable to medicine, food production, and human wellness. Students will be able to apply knowledge gained in this course to their everyday lives, make informed choices as members of the community, as well as to further their career in medicine, food services, cosmetology, and other related vocational areas.

Honors Biology course is supplemented with the required laboratory component corresponding to the material studied in the classroom. Students will gain skills using laboratory apparatus and correct laboratory techniques and procedures. They will learn uses of classical and contemporary equipment in biological laboratory. Dissections of chosen organisms will be used to promote the understanding of organization and functions of living things. Students will design and carry out long and short-term investigations using principles of scientific method and use proper formats for reporting their findings.

II. Course Objectives/Outline

Content Area:	**Biology**		Grade(s)	9/10/11
Unit Plan Title:	**1. Structure and Function**	Time Frame	7 Weeks	

Learning Objectives
1. Explain the connection between the sequence and the subcomponents of a biomolecule and its properties including visual identification or the molecular sequence and structure of selected molecules. LS1.A 2. Construct models that explain the movement of molecules across membranes with membrane structure and function emphasizing chemical structure and properties of membranes. LS1.A 3. Create representations that explain how genetic information flows from a sequence of nucleotides in a gene to a sequence of amino acids in a protein. LS1.A 4. 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 including identification of selected cell or tissue types, whole body systems, specific protein structures and functions, and simplified biochemistry of protein synthesis. HS-LS1-1 5. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms including selected interactions at the molecular level, and visual identification of specific cells, tissues and organs. LS1.A 6. Provide examples and explain how organisms use feedback systems to maintain their internal environments. LS1.A 7. Plan and conduct an investigation to provide evidence that some feedback mechanisms maintain homeostasis including possible modeling of selected cellular processes involved in the feedback mechanism. HS-LS1-1

Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models (pp. 56-59. NRC, 2012) Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Develop and use a model based on evidence to illustrate the relationships between systems or between	**LS1.A: Structure and Function** (pp. 143-145, NRC, 2012) • 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.	**Systems and System Models** (pp. 91-94, NRC, 2012) • 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** (pp. 96-98, NRC, 2012) • Investigating or designing new systems or structures

components of a system. (HS-LS1-2) **Planning and Carrying Out Investigations** (pp. 59-61, NRC, 2012) 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. (HS-LS1-3) **Constructing Explanations and Designing Solutions** (pp. 67-71, NRC, 2012) Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. 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-LS1-1)	(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) 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)	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** (pp. 98-101, NRC, 2012) • Feedback (negative or positive) can stabilize or destabilize a system. (HS-LS1-3) - ***Connections to Nature of Science*** **Scientific Investigations Use a Variety of Methods** (pp. 96-101, Appendix H) 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)

Common Core

- **Common Core Writing Standards:**
  WHST.9-10.2, WHST.9-10.3, WHST.9-10.4, WHST.9-10.5, WHST.9-10.10
- **Common Core Reading Standards:**

RST.9-10.1, RST.9-10.2, RST.9-10.3, RST.9-10.4, RST.9-10.7, RST.9-10.8, RST.9-10.9

Content Area:	**Biology**		Grade(s)	9, 10
Unit Plan Title:	**2. Matter and Energy in Organisms and Ecosystem**	Time Frame	6 Weeks	

Learning Objectives

1. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy including main biochemical steps. HS-LS1-5
2. 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 including selected details of the specific chemical reactions and visual identification of macromolecules. HS-LS1-6
3. 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 including identification of the steps and selected processes involved in cellular respiration. HS-LS1-7
4. Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere including main chemical steps of photosynthesis and respiration. HS-LS2-5
5. Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions including the main chemical processes of aerobic and anaerobic respiration . HS-LS2-3
6. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem demonstrating sufficient reasoning to describe the cycling of matter and flow of energy. HS-LS2-4
7. Use visual representations to illustrate how interactions among living systems and with their environment result in the movement of matter and energy. LS1.C

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models (pp. 56-59, NRC, 2012) Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-	**LS1.C: Organization for Matter and Energy Flow in Organisms** (pp. 147-148, NRC, 2012) • 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) • 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	**Systems and System Models** (pp. 91-94, NRC, 2012) • 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-LS2-5) **Energy and Matter** (pp. 94-96, NRC, 2012)

LS1-5),(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(pp. 64-67, NRC, 2012)

Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

- Use mathematical representations of phenomena or design solutions to support claims. (HS-LS2-4)

Constructing Explanations and Designing Solutions (pp. 67-71, NRC, 2012)

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

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),(HS-LS2-3)

Using Mathematics and Computational Thinking (pp. 64-67, NRC, 2012)

Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple

(such as proteins or DNA), used for example to form new cells. (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. (HS-LS1-6),(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. (HS-LS1-7)

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems (pp. 152-154, NRC, 2012)

- Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (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. (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. (HS-LS2-5)

PS3.D: Energy in Chemical Processes (pp. 128-130, NRC, 2012)

- 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 cannot be created or destroyed—it only moves 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)

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Connections to Nature of Science

Scientific Knowledge is Open to Revision in Light of New Evidence (pp. 96-101, Appendix H)

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)9/10/11

Cause and Effect (pp. 87-89, NRC, 2012)

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS2-8),(HS-LS4-6)

Scale, Proportion, and Quantity (pp. 89-91, NRC, 2012)

- 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 (pp. 98-101, NRC, 2012)

- Much of science deals with constructing explanations of how things change and how they

computational simulations are created and used based on mathematical models of basic assumptions. • Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (HS-LS2-1) • 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-LS4-6) **Engaging in Argument from Evidence** (pp. 71-74, NRC, 2012) Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. • 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 to determine the merits of arguments. (HS-LS2-8)	• 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)* **LS2.A: Interdependent Relationships in Ecosystems** (pp. 150-152, NRC, 2012) • 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 such 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. (HS-LS2-1),(HS-LS2-2)	remain stable. (HS-LS2-6),(HS-LS2-7) - ***Connections to Nature of Science*** **Scientific Knowledge is Open to Revision in Light of New Evidence** (pp. 96-101, Appendix H) • 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. (HS-LS2-6),(HS-LS2-8)

Common Core

Common Core State Standards Connections: ELA/Literacy –

- **Common Core Writing Standards:**
  WHST.9-10.2, WHST.9-10.3, WHST.9-10.4, WHST.9-10.5, WHST.9-10.10
- **Common Core Reading Standards:**

RST.9-10.1, RST.9-10.2, RST.9-10.3, RST.9-10.4, RST.9-10.7, RST.9-10.8, RST.9-10.9

Mathematics -
MP.2 Reason abstractly and quantitatively. (HS-LS2-4)
MP.4 Model with mathematics. (HS-LS2-4)
HSN.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-LS2-4)
HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-LS2-1),(HS-LS2-2),(HS-LS2-7)
(HS-LS2-4)

HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-LS2-1),(HS-LS2-2),(HS-LS2-7) **HSS-ID.A.1** Represent data with plots on the real number line. (HS-LS2-6) **HSS-IC.A.1**Understand statistics as a process for making inferences about population parameters based on a random sample from that population. (HS-LS2-6) **HSS-IC.B.6**Evaluate reports based on data. (HS-LS2-6)

Content Area:	**Biology**		Grade(s)	9, 10
Unit Plan Title:	**3.Population Dynamics and Interactions in Ecosystems**	Time Frame	7 Weeks	
Learning Objectives				

1. Graph real or simulated populations and analyze the trends to understand consumption patterns and resource availability, and make predictions as to what will happen to the population in the future. LS2.A
2. Provide evidence that the growth of populations are limited by access to resources, and how selective pressures may reduce the number of organisms or eliminate whole populations of organisms. LS2.A
3. Provide examples of adaptations that have evolved in prey populations due to selective pressures over long periods of time. LS2.A
4. Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce. LS2.D
5. Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales including selecting or deriving mathematical equations to make comparisons. HS-LS2-8
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. **HS-LS2-1**
7. Make scientific claims and predictions about how specific human activities that impact species diversity within an ecosystem ultimately influence ecosystem stability. HS-LS2-6
8. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales using provided and collected data. HS-LS2-2
9. Design, evaluate, and refine a solution or simulation for reducing the impacts of human activities on the environment and biodiversity. HS-LS2-7; HS-LS4-6

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Using Mathematics and Computational Thinking (pp. 64-67, NRC, 2012) Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (HS-LS2-1)	**LS2.A: Interdependent Relationships in Ecosystems** (pp. 150-152, NRC, 2012) • 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 such 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. (HS-LS2-1),(HS-LS2-2) **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** (pp. 154-156, NRC, 2012) • 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	**Systems and System Models** (pp. 91-94, NRC, 2012) • 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-LS2-5) **Scientific Knowledge is Open to Revision in Light of New Evidence** (pp. 96-101, Appendix H) • 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. (HS-LS2-6),(HS-LS2-8)

• 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-LS4-6) **Engaging in Argument from Evidence** (pp. 71-74, NRC, 2012) Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. • 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 to determine the merits of arguments. (HS-LS2-8)	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) **LS2.D: Social Interactions and Group Behavior** (pp. 156-157, NRC, 2012) • Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HS-LS2-8) **LS4.C: Adaptation** (pp. 164-166, NRC, 2012) • 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-LS4-6) **LS4.D: Biodiversity and Humans** (pp. 166-167, NRC, 2012) • 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),(HS-LS4-6.)*	

	ETS1.B: Developing Possible Solutions (pp. 206-208, NRC, 2012) • 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 HS-LS2-7),(secondary to HS-LS4-6)* 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 HS-LS4-6)*	

Common Core

Common Core State Standards Connections

- **Common Core Writing Standards:**
- WHST.9-10.2, WHST.9-10.3, WHST.9-10.4, WHST.9-10.5, WHST.9-10.10
- **Common Core Reading Standards:**

RST.9-10.1, RST.9-10.2, RST.9-10.3, RST.9-10.4, RST.9-10.7, RST.9-10.8, RST.9-10.9

*Ma*thematics -
MP.2 Reason abstractly and quantitatively. (HS-LS2-4)
MP.4 Model with mathematics. (HS-LS2-4)
HSN.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-LS2-4)
HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-LS2-4)
HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-LS2-4)

HSS-ID.A.1	Represent data with plots on the real number line. (HS-LS2-6)
HSS-IC.A.1	Understand statistics as a process for making inferences about population parameters based on a random sample from that population. (HS-LS2-6)
HSS-IC.B.6	Evaluate reports based on data. (HS-LS2-6)

Content Area:	**Biology**		Grade(s)	9/10/11
Unit Plan Title:	**4.Inheritance and Variation**	Time Frame	11 Weeks	

Learning Objectives

1. Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms including steps and processes of mitosis. HS-LS1-4
2. Compare the products of meiosis and mitosis including steps and processes ob both mitosis and meiosis. LS1.A, LS3.A
3. Explain how the process of meiosis results in the passage of traits from parent to offspring, and how that results in increased genetic diversity necessary for evolution including the phases of meiosis and selected biochemical mechanisms of main steps in the process. LS3.A
4. Demonstrate by modelling the relationships between the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring HS-LS3-1
5. 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 including selected steps in the biochemistry of protein synthesis. HS-LS1-1
6. Create a visual representation to illustrate how changes in a DNA nucleotide sequence can result in a change in the polypeptide produced including selected enzymes and factors involved and discription of the steps of transcription and translation LS3.B
7. 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 including identifying phases of meiosis and selected biochemical mechanism of specific steps in the process **HS-LS3-2**
8. Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population including selected explanations for Hardy-Weinberg calculations HS-LS1-4, LS3.B.
9. Model the effects of various factors on genetic equilibrium in populations applying Hardy-Weinberg equilibrium principle HS-LS1-4, LS3.B

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems (pp. 54-56, NRC, 2012) Asking questions and defining problems in 9-12 builds on K-8 experiences and progresses to formulating, refining, and evaluating empirically testable questions	**LS1.A: Structure and Function** (pp. 143-145, NRC, 2012) • 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	**Cause and Effect** (pp. 87-89, NRC, 2012) • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS3-1),(HS-LS3-2)

and design problems using models and simulations.

- Ask questions that arise from examining models or a theory to clarify relationships. (HS-LS3-1)

Developing and Using Models (pp. 56-59, NRC, 2012)

Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

- Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-4)

Analyzing and Interpreting Data (pp. 61-63, NRC, 2012)

Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze 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 (pp. 71-74, NRC, 2012)

Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence. (HS-LS3-2)

Disciplinary Core Idea is also addressed by HS-LS1-1.)

LS1.B: Growth and Development of Organisms (pp. 145-147, NRC, 2012)

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)

LS3.A: Inheritance of Traits (pp. 158-159, NRC, 2012)

- 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)

LS3.B: Variation of Traits (pp. 160-161, NRC, 2012)

- 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. (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)

Scale, Proportion, and Quantity (pp. 89-91, NRC, 2012)

- 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). (HS-LS3-3)

Systems and System Models (pp. 91-94, NRC, 2012)

- 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)

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Connections to Nature of Science

Science is a Human Endeavor (Appendix H)

- Technological advances have influenced the progress of science and science has influenced advances in technology. (HS-LS3-3)

Science and engineering are influenced by society and society is influenced by science and engineering. (HS-LS3-3)

Common Core

Common Core State Standards Connections: ELA/Literacy –
Common Core Writing Standards:
WHST.9-10.2, WHST.9-10.3, WHST.9-10.4, WHST.9-10.5, WHST.9-10.10

Common Core Reading Standards:
RST.9-10.1, RST.9-10.2, RST.9-10.3, RST.9-10.4, RST.9-10.7, RST.9-10.8, RST.9-10.9

Mathematics -

MP.2	Reason abstractly and quantitatively. (HS-LS3-2),(HS-LS3-3)
MP.4	Model with mathematics. (HS-LS1-4)
HSF-IF.C.7	Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. (HS-LS1-4)
HSF-BF.A.1	Write a function that describes a relationship between two quantities. (HS-LS1-4)

Content Area:	**Biology**	Grade(s)	9/10/11
Unit Plan Title:	**5. Evolutionary Synthesis and Diversity of Life**	Time Frame	9 Weeks

Learning Objectives

1. Examine a group of related organisms using a phylogenic tree or cladogram in order to (1) identify shared characteristics, (2) make inferences about the evolutionary history of the group, and (3) identify character data that could extend or improve the phylogenetic tree LS4.A
2. Identify shared patterns of structures and development across major taxa; examine major derived characters in main groups of organisms HS-LS4-1
3. Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence LS4.C
4. Make predictions about the effects of artificial selection on the genetic makeup of a population over time LS4.C
5. 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 including basic statistical and graphical analysis using data on allele frequency. HS-LS4-3

6. Construct an explanation based on evidence for how natural selection leads to adaptation of populations in comparison to other mechanisms of evolution, such as genetic drift, gene flow through migration, and co-evolution. HS-LS4-4
7. Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce HS-LS2-8
8. 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 HS-LS4-5
9. 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 HS-LS4-2
10. Analyze evidence and make predictions regarding relationships between groups of organisms using modeling techniques LS4.C

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data (pp. 61-63, NRC, 2012) Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze 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** (pp. 67-71, NRC, 2012) Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • 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	**LS4.A: Evidence of Common Ancestry and Diversity** (pp. 162-163, NRC, 2012) • Genetic information, like the fossil record, 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** (pp. 163-164, NRC, 2012) • 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** (pp. 164-166, NRC, 2012)	**Patterns** (pp. 85-87, NRC, 2012) • 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. (HS-LS4-1),(HS-LS4-3) **Cause and Effect** (pp. 87-89, NRC, 2012) • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS4-2),(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),(HS-LS4-4) **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

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<td>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 (pp. 71-74, NRC, 2012)

Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current or historical episodes in science.

• Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS4-5)

Obtaining, Evaluating, and Communicating Information (pp. 74-77, NRC, 2012)

Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.

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)</td>
<td>• 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)</td>
<td>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)</td>
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Common Core

- **Common Core Writing Standards:**
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Mathematics -

MP.2 Reason abstractly and quantitatively. (HS-LS4-1),(HS-LS4-2),(HS-LS4-3),(HS-LS4-4),(HS-LS4-5)

MP.4 Model with mathematics. (HS-LS4-2)

III. Methods of Student Evaluation

Assessment can be divided into two general categories: formal (graded) and informal/classroom-based (both graded and ungraded). The key to effectively assessing a student's mastery of skills is to match the assessment method to the learning objective.

Formal Assessments

- Evaluation
- Class participation
- Creative assignments
- Homework and classwork assignments
- Reports and presentations
- Research methodology
- Technological applications
- Unit tests
- Various speaking and listening assignments
- Multiple choice exams
- Quizzes (announced and unannounced)
- Essays
- Formal lab reports
- Scientific journal reviews
- Projects
- Short answer and problem solving tests
- Tests and quizzes on blackboard
- Case Study analysis

Informal Assessments

- Instructor’s observations of note-taking, and organization of notebooks and assignments
- Cooperative learning activities, including labs
- Creative project assignments
- Laboratory behavior
- Observing citizenship and appropriate social responses
- Instructor’s observations of time management skills

Mastering of the core proficiencies of Biology shall be evaluated in accordance with the general grading policies as listed in the student handbook:

- Tests – 40%
- Laboratory Reports and Projects – 20%
- Quizzes – 20%
- Class Participation – 10%

IV. Instructional Strategies Based on Instructional Goals

- Graphs and other visuals
- Engaging in discussions
- Reading silently and aloud
- Listening and speaking activities
- Watching and responding to media
- Brainstorming
- Listening
- Mapping
- Revising and editing
- Participating in small and large groups
- Researching to make connections to texts and classroom discussions
- Collaborative projects
- Answering questions (oral and written)

- Summarizing
- Debating
- Analyzing texts, discussions, etc.
- Peer teaching
- Competing in teams/debating
- Playing games
- Creating games
- Note taking and note making
- Writing

V. Scope and Sequence

Key: I – Introduced, D-developed in Depth, R-Reinforced

Skill/Concepts to be Learned	Grade 9	Grade 10
Select and use appropriate instrumentation to design and conduct experiments	IDR	IDR
Use technology to present the design and results of investigation	IDR	IDR
Evaluate conclusions, weigh evidence, and recognize that arguments may not have earned merit	IDR	IDR
Explain how experimental results lead to further investigation	IDR	IDR
Recognize the role of the scientific community in responding to changing social and political conditioning	IDR	IDR
Recognize the role of the scientific community in responding to changing social and political conditioning	IDR	IDR
Identify and explain the structure and function of molecules that control cellular activities.	IDR	IDR
Explain how plants convert light energy to chemical energy.	IDR	IDR
Investigate and describe the complementary relationship between photosynthesis and cellular respiration.	IDR	IDR
Identify and describe organisms that possess characteristics of living and non-living things	IDR	IDR
Describe how plants produce substances high in energy content that become the primary source of energy for animal life.	IDR	IDR
Compare and contrast the life cycles of living things as they interact with ecosystems.	IDR	IDR
Describe how information is encoded in genetic material.	IDR	IDR
Explain how DNA can be altered by natural or artificial means to produce changes in a species	IDR	IDR

Explain that through evolution the earth's present species developed from earlier, distinctly different species	IDR	IDR
Explain how the theory of natural selection accounts for an increase in the proportion of individuals with advantageous characteristics within species.	IDR	IDR
Estimate the closeness of relationship between species based on variety of evidence	IDR	IDR
Demonstrate through modeling how the sorting and recombination of genes during sexual reproduction has an effect on variation in offspring.	IDR	IDR
Explain the regulation of interaction between parts of a biological system based on the feedback mechanisms	IDR	IDR
Evaluate and predict how the changes in species diversity can result from the disruption of complex interactions in ecosystems	IDR	IDR

VI. Pacing Chart

<u>Marking Period 1-</u>

- *Unit 1* **Structure and Function**
  - **Science of Biology and Laboratory Techniques**: (2 weeks) Students will be able to discuss characteristics of life and levels of organization; give brief explanations for three foundational theories in Biology; identify positive and negative feedback as mechanisms of regulation of homeostasis; explain the application of deductive and inductive reasoning in scientific method; use and explain the principles of operation and applications of light compound, fluorescent, and electron microscopes.
  - **Chemistry of Life** (2 weeks) Students will be able to describe the formation of compounds stressing recognition and understanding of bonding; explain application of isotopes in paleontology and medicine; explain dependence of life existence on water properties; explain importance of buffers in homeostasis; correlate the structure and composition with functions in carbohydrates, proteins, lipids, and nucleic acids; correlate the three-dimensional structure of a molecule with its ability to perform a particular function using enzymes as an example.
  - **Cells and membranes (**3 weeks**)** Students will be able to explain the statements of the cell theory, correlate the functions of the membrane with its main functions; explain the mechanisms of cellular transport; predict the outcomes of osmotic equilibrium shifts in given conditions; describe structure and functions and explain origin of endomembrane system in eukaryotic cells; compare the structures and functioning of eukaryotic and prokaryotic cells; explain how in multicellular organisms cells join together and differentiate.

- *Unit 2:* **Matter and Energy in Organisms and Ecosystem**
    - **Energy at Cellular Level:** (3weeks): Students will be able to explain the structure and function of ATP as an energy currency in cells and describe the coupling between exergonic and endergonic reactions; describe structure, functions, and origin of mitochondrion and chloroplast and briefly explain the significance of steps in biochemical pathways in photosynthesis and respiration.

<u>Marking Period 2-</u>

- *Unit 2:* **Matter and Energy in Organisms and Ecosystem**
    - **Biogeochemical Cycles and Energy Transfer** (3 weeks): Students will be able to describe the cycles of matter through biotic and abiotic parts of ecosystems and recognize importance of symbiotic organisms such as nitrogen-fixing bacteria; analyze unidirectional flow of energy through ecosystems through the processes of food webs and chains as well as trophic levels.
- *Unit 3:* **Population Dynamics and Interactions in Ecosystems**
    - **Ecology Interactions** (3 weeks): Students will be able to describe and model interactions between parts of ecosystems; predict outcomes of interference in ecological relationships; give examples and explain types of symbiotic relationships; describe major components of aquatic and terrestrial ecosystems; compare and contrast primary and secondary succession.
    - **Populations** (2 weeks): Students will be able to explain the dynamic changes in populations using population density, distribution, and growth and survivorship curves; analyze carrying capacity of the environment; explain how competition may lead to resources partitioning; list factors that may determine whether a population may become extinct.
    - **Biodiversity and Human Impact** (2 week): Students will be able to discuss the direct and indirect values of biodiversity with reference to medicinal, agricultural, and consumptive values as well as waste disposal, fresh water saoilerosion, and regulation of climate; analyze the role of human activity in loss of biodiversity and identify possible solutions using principles of conservation biology.

<u>Marking Period 3-</u>

- *Unit 4:* **Inheritance and Variation**
    - **Cell Reproduction and Division** (3 weeks): Students will be able to explain the mechanisms and significance of sexual and asexual reproduction in living things and relate processes in cell division to inheritance variation and mutations.
    - **DNA, RNA, and Protein Synthesis** (3 weeks): Students will be able to explain the history of DNA discovery; describe the process of DNA replication, and gene expression (including regulation of transcription and translation and role of various RNA molecules).

- **Genetics** (5 weeks): Student will be able to predict the phenotypic and genotypic outcomes in offspring using knowledge of inheritance patterns for non-linked genes; examine methods and give examples of applications of genetic engineering and biotechnology.

Marking Period 4-

- *Unit 5:* **Evolutionary Synthesis and Diversity of Life**
  - **History of Life** (1 weeks): Students will be able to describe the methods of examining the past in biology and explain the major events and patterns in the history of life on Earth.
  - **Evolutionary theory** (3 weeks): Students will be able to explain the origin of new species and changes in populations using understanding of factors leading to shifts in allele frequencies including natural selection and genetic drift. Students will be able to explain how changes on molecular level can lead to changes on the large scale.
  - **Primates and Human evolution** (1 week): Students will be able to examine patterns and trends in evolutionary histories of Homo sapiens and related species
  - **Life diversity and phylogenetic relationships** (4 weeks): Students will be able to analyze modern and classical taxonomical practices, such as hierarchical Linnaean classification and cladistics; examine patterns in evolution by examining major characteristics and evolutionary histories of representatives of kingdoms Eubacteria, Archaebacteria, Protista (5 supergroups), Fungi, Plantae, and Animalia (9 phyla)

VII. Proficiencies

Students will demonstrate the ability to:

1. Construct an explanation based on evidence to explain the relationships between DNA and characteristics of an organism
2. Develop and use a model to illustrate the hierarchical organization of interacting systems within an organism and within and between parts of ecosystems
3. Conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis
4. Use a model to illustrate the role of cellular division and differentiation in development of multicellular organisms.
5. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
6. Construct an explanation based on evidence for biochemical pathways of respiration and photosynthesis
7. Use a model to illustrate that cellular respiration is a chemical process resulting in a net transfer of energy
8. Use mathematical and/or computational representations of factors that affect carrying capacity of ecosystems
9. Use mathematical representations to support and revise explanations about factors affecting biodiversity
10. Construct and revise an explanation based on evidence for the cycling of matter and flow of energy

11. 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
12. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity
13. Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.
14. Defend a claim regarding the sources of inheritable genetic variations, such as new recombination in meiosis, viable errors occurring during replication, and/or mutations caused by environmental factors
15. Apply concepts of elementary statistics and probability to explain the variation and distribution of expressed traits in a population
16. Clearly communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence
17. Construct an explanation based on evidence using understanding of factors influencing evolutionary process, namely the mechanism of natural selection, such as the potential for a species to increase in number, the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, competition for limited resources, and the proliferation of those organisms that are better able to survive and reproduce in the environment
18. Apply concepts of statistics to support explanations that organisms with an favorable adaptations will proportionally increase in a population given the continuously applied selective pressure
19. Evaluate the evidence supporting claims that changes in environmental conditions may result in: increases in the number of individuals of some species, the emergence of new species over time, and the extinction of other species
20. Fluently utilize available standard biological laboratory equipment in order to conduct investigations and collect data.