Bloomfield Public Schools
Bloomfield, New Jersey 07003

Curriculum Guide

AP Biology
Grades 11-12

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Conforms to the Next Generation Science Standards and NJSLS Standards

Board Approved: September 12, 2017

COURSE: Advanced Placement Biology
GRADE LEVEL: 11/12
Revised: July 2017

Introduction:
Bloomfield High School offers the Advanced Placement Biology course for those students interested in pursuing a rigorous science course at the college level; the AP curriculum tailors well into the *Next Generation Science Standards* (NGSS), focusing on science as process, using inquiry-based methods to further student understanding.

The course syllabus reflects the College Board's emphasis on science practices and the Four Big Ideas below [verbatim from the College Board recommendations]:

· Big Idea 1: The process of evolution drives the diversity and unity of life
· Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain dynamic homeostasis
· Big Idea 3: Biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain dynamic homeostasis
· Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties. We will explicitly explore the enduring understandings as outlined below as we flesh out the framework of the Four Big Ideas.

The current course has been audited and approved by the College Board this aligns the current expectations of the *Next Generation Science Standards* with the language used by the College Board.

The BHS AP Biology course will explicitly explore the enduring understandings as defined (and required) by the College Board outlined below as we flesh out the framework of the Four Big Ideas; appropriate correlations with NGSS and the 5 E's (engage, explore, explain, elaborate, and evaluate) will be given to reflect the Bloomfield district's shift to this new paradigm in science education. The latest AP audit was written and submitted to the college board in November of 2016.

The Investigative Laboratory Component

Observation, reasoning, developing questions and testing them is the heart of science; many of our students come to AP Biology inadequately prepared to independently develop good experimental questions and pursue their answers. We spend about 40-50% of our time in laboratory activities. (4 of the 7 periods each week are designated as "lab periods," though many of the laboratory components spill into the 3 periods nominally dedicated to didactic work.)

At least two major lab activities (guided by the new *AP Biology Investigative Labs: an Inquiry Based Approach)* for each of the Four Big Ideas, emphasizing the development of the seven science practices listed below [verbatim from the College Board recommendations] will be conducted:

- SP1: The student can use representations and models to communicate scientific phenomena and solve scientific problems.
- SP 2: The student can use mathematics appropriately.
- SP3: The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course.
- SP4: The student can plan and implement data collection strategies appropriate to a particular scientific question.
- SP5: The student can perform data analysis and evaluation of evidence.
- SP6: The student can work with scientific explanations and theories.
- SP7: The student is able to connect and relate knowledge across various scales, concepts and representations in and across domains.

Pacing [with suggested unit lengths]:

Unit 1: *Introduction: Nature of science, Chemistry of Life [~3 weeks]*
Unit 2: *Evolution [~4 weeks]*
Unit 3: *Cell biology [~3 weeks]*
Unit 4: *Metabolism [~4 weeks]*
Unit 5: *Genetics: The Central Dogma [~4 week]*
Unit 6: *Organismal Biology [~6 weeks]*
Unit 7: *Ecology [~3 weeks]*

Resources: Electronic and text resources are listed in each unit. Teachers will be able to access the curriculum document on the district website.

Textbooks:
Reece, Jane, et al., *Campbell Biology,* 9th Edition, 2011, Pearson Benjamin Cummings. [Approved by our AP audit]
Avissar, Yael et al., *Biology*, OpenStax College, 2016
AP Biology Investigative Labs: an Inquiry Based Approach, the College Board, 2012
AP Biology Review book, Holtzclaw and Holtzclaw, 2015

Established Goals:
The College Board Biology Course and Exam Description 2015
Science: **http://www.nextgenscience.org/next-generation-science-standards**
Common Core Math: **http://www.corestandards.org/Math/**

http://www.state.nj.us/education/cccs/2016/math/crosswalk.pdf
Common Core ELA: **http://www.corestandards.org/ELA-Literacy/** :
http://www.state.nj.us/education/cccs/2016/ela/crosswalk.pdf
Technology: **http://www.state.nj.us/education/cccs/2014/tech/**

Modifications:
● Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. ● Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). ● Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies). ● Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). ● Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. ● Use project-based science learning to connect science with observable phenomena. ● Structure the learning around explaining or solving a social or community-based issue. ● Provide ELL students with multiple literacy strategies. ● Collaborate with after-school programs or clubs to extend learning opportunities. ● Restructure lesson using UDL principles (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA).

Unit # 1	Unit Name: *Introduction: Nature of science, Chemistry of Life*	Unit Length: *~3 weeks*

The nature of science is presented as 8 major themes in the *Next Generation Science Standards*, of which “four themes extend the scientific and engineering practices and four themes extend the crosscutting concepts.”

These NGSS themes are as follow:

- Scientific Investigations Use a Variety of Methods
- Scientific Knowledge is Based on Empirical Evidence
- Scientific Knowledge is Open to Revision in Light of New Evidence
- Scientific Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
- Science is a Way of Knowing
- Scientific Knowledge Assumes an Order and Consistency in Natural Systems
- Science is a Human Endeavor
- Science Addresses Questions About the Natural and Material World

These themes are integrated throughout the NGSS standards and are not of themselves a stand-alone unit. The College Board Advanced Placement science courses have parallel themes, again infused throughout the course, and listed in detail in the introduction to the curriculum. The pertinent Essential Knowledge and Enduring Understandings as approved by the College Board for the Bloomfield High School AP Biology course are appended to the end of each unit.

Much of the language of the “Student Learning Objectives” is taken verbatim from either the NGSS site or the College Board *AP Biology Course and Exam Description*. Other Student Learning Objectives are taken verbatim from New Jersey model curriculum.

ESSENTIAL QUESTIONS:
How do we know anything?
What, if anything, makes life chemically “special”?

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
1	Biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain dynamic homeostasis	HS-LS1-1 through 4 [CB: Big Idea One; EK 2.A.1-3]

2	Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.	HS-PS1-4 [CB EK 2.D.1]
3	Understand that smaller components work together to form more complex structures at the atomic, molecular and macromolecular levels (emergent properties).	HS-LS1-2 [CB EK 4.A.1, EK 4.B.1, EK 4.C.1, EK 2.D.1]
4	Grasp fundamental connection of science to empirical knowledge	NGSS themes: ● Scientific Knowledge is Based on Empirical Evidence ● Scientific Knowledge is Open to Revision in Light of New Evidence

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models 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 components of a system. (HS-LS1-2) ● Use a model based on evidence to illustrate the relationships between systems or between components of a	**PS1.B: Chemical Reactions** **LS1.A: Structure and Function** ● Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1) ● All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS-LS1-1) ● Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a	**Energy and Matter** ● The total amount of energy and matter in closed systems is conserved. - ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ● Science assumes the universe is a vast single system in which basic laws are consistent. **Systems and System Models**

system. (HS-LS1-4),(HS-LS1-5),(HS-LS1-7) **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. (HS-LS1-3) **Constructing Explanations and Designing Solutions** 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	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) **LS1.B: Growth and Development of Organisms** • In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. (HS-LS1-4)	• 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),(HS-LS1-4) **Energy and Matter** • Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-LS1-5), (HS-LS1-6) • Energy 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) **Structure and Function** • Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-LS1-1) **Stability and Change**

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) • 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) - ***Connections to Nature of Science*** **Scientific Investigations Use a Variety of Methods**	**LS1.C: Organization for Matter and Energy Flow in Organisms** • The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HS-LS1-5) • 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 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	• Feedback (negative or positive) can stabilize or destabilize a system. (HS-LS1-3)

• 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)	respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. (HS-LS1-7)	

Connections to other DCIs in this grade-band: HS.LS1.C ; HS.LS2.B ; HS.PS3.B

Articulation of DCIs across grade-bands: MS.PS1.A ; MS.PS1.B ; MS.LS1.C ; MS.LS2.B ; MS.ESS2.A

Common Core State Standards Connections:

ELA:

RST.11-12.1 Cite strong and thorough textual evidence and make relevant connections to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain. (HS-LS1-1),(HS-LS1-6)

WHST.9-12.2 Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content. (HS-LS1-1),(HS-LS1-6)

WHST.9-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, trying a new approach, or consulting a style manual (such as MLA or APA Style), focusing on addressing what is most significant for a specific purpose and audience. (Editing for conventions should demonstrate command of Language standards 1–3 up to and including grades 9–10) (HS-LS1-6)

NJSLSA.W.7. Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation. (HS-LS1-3)

RH.11-12.8. Evaluate an author’s claims, reasoning, and evidence by corroborating or challenging them with other sources.

W.9-10.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation (MLA or APA Style Manuals).

W.11-12.9.	Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS1-1),(HS-LS1-6)
SL.9-10.5	Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance findings, reasoning, and evidence and to add interest.) *(HS-LS1-2),(HS-LS1-4),(HS-LS1-5),(HS-LS1-7)*
Mathematics -	
MP.4	Model with mathematics. *(HS-LS1-4)*
HSF-S.ID.B.6a	Fit a function to the data (including with the use of technology); use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models. *(HS-LS1-4)*
HSF-BF.A.1	Write a function that describes a relationship between two quantities. *(HS-LS1-4)*
HSF-S.ID.B.6b	Informally assess the fit of a function by plotting and analyzing residuals, including with the use of technology. *(HS-LS1-4)*
MATH:	
MP.2	Reason abstractly and quantitatively. (HS-PS1-7)
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-PS1-7)
HSN-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling. *(HS-PS1-7)*
HSN-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. *(HS-PS1-7)*
Technology & Career Standards:	

8.1 Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge. **Career Ready Practices:** 1-12

Unit Plan		
Content Vocabulary	**Academic Vocabulary**	**Suggested Resources**
[drawn from NGSS document [“Understandings About the Nature of Science”]] Observation, experiment, natural world, methods, investigation, procedure, data, empirical, scientific inquiry, knowledge, phenomenon, logic, inference, deduction, model, evidence, nature, explanation, argumentation, hypothesis, theory, law, probability, validity, statistics, p value, reproducibility, science, technology, engineering, emergent properties	relate, sequence, functional, diagram, compare and contrast, describe, define, assume, locate, complementary, construct, specify, interpret, decipher, depict, explain, decide, claim, evidence, reason, decipher, elucidate, explicate	• Text • Classroom models • Online ancillaries provided via OpenStax • Mastering Biology • Bozeman Science AP Biology • David Knuffke AP Biology Prezis In addition, various resources will be provided by class website on a week to week basis depending on the needs and abilities of the students.

THE 5 “E”s	**Examples of Learning Activities for the specified “E”**	**SLO’s and Engineering Practices**
ENGAGE	**Examples of Engaging Activities:**	
	Man in a boat problem: students work together to solve counterintuitive problem using materials available in class.	SLO 4 **Engineering practices:** • Asking questions (for science) and defining problems (for engineering) • Developing and using models • Planning and carrying out investigations • Analyzing and interpreting data • Engaging in argument from evidence • Obtaining, evaluating, and communicating information
EXPLORE	**Examples of Exploring Activities:**	

	Molecular model building activity: students explore #d structure of molecules through modeling using specific rules of bonding for the most common elements of life (C, H, O, N)	SLO 1, SLO 3, SLO 4 **Engineering practices:** ● Asking questions (for science) and defining problems (for engineering) ● Developing and using models ● Analyzing and interpreting data ● Engaging in argument from evidence ● Obtaining, evaluating, and communicating information
EXPLAIN	**Examples of Explaining Activities:**	
	Water properties: multiple station demo exhibiting emergent properties of water	SLO 2, SLO 3, SLO 4 **Engineering practices:** ● Asking questions (for science) and defining problems (for engineering) ● Developing and using models ● Planning and carrying out investigations ● Analyzing and interpreting data ● Engaging in argument from evidence ● Obtaining, evaluating, and communicating information
ELABORATE/ EVALUATE	**Examples of Elaborating/ Evaluating Activities:**	
	Animal behavior lab: students design and develop own lab using local organisms as their specimens; thrust is on developing hypotheses and minimizing variables, as well as developing sense of what it means to provide evidence in statistical sense. (Students are introduced to Chi square and p values.)	SLO 2, SLO 3, SLO 4 **Engineering practices:** ● Asking questions (for science) and defining problems (for engineering) ● Developing and using models ● Planning and carrying out investigations ● Analyzing and interpreting data ● Engaging in argument from evidence ● Obtaining, evaluating, and communicating information
	College Board style monthly evaluations: Students will take	SLOs: all **Engineering practice(s)**

	monthly, cumulative exams following the style of the Advanced Placement Biology Examination (including questions released by the College Board specifically for this purpose) that include both multiple choice and FRQs (“free response questions”); these exams emphasize science practices.	● Developing and using models ● Planning investigations ● Analyzing and interpreting data ● Using mathematics and computational thinking ● Engaging in argument from evidence

College Board correlations as presented in current AP Biology CB approved syllabus for this unit:
Enduring Understandings (EU)/Essential Knowledge (EK)

EU 1.D: The origin of living systems is explained by natural processes.
EK 1.D.2: Scientific evidence from many different disciplines supports models of the origin of life.

EU 2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter.
EK 2.A.1: All living systems require constant input of free energy.
EK 2.A.2: Organisms capture and store free energy for use in biological processes.
EK 2.A.3: Organisms must exchange matter with the environment to grow, reproduce and maintain organization.

EU 2.C: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis.
EK 2.C.1: Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes.

EU 2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system’s environment.
EK 2.D.1: All biological systems from cells and organisms to populations, communities and ecosystems are affected by complex biotic and abiotic interactions involving exchange of matter and free energy.
EU 3.A: Heritable information provides for continuity of life.
EK 3.A.1: DNA, and in some cases RNA, is the primary source of heritable information.

EU 4.A: Interactions within biological systems lead to complex properties.

EK 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule.

EU 4.B: Competition and cooperation are important aspects of biological systems.
EK 4.B.1: Interactions between molecules affect their structure and function.

EU 4.C: Naturally occurring diversity among and between components within biological systems affects interactions with the environment.
EK 4.C.1: Variation in molecular units provides cells with a wider range of functions.

Unit #2	**Unit Name:** *Evolution*	**Unit Length:** ~4 weeks

Much of the language of the "Student Learning Objectives" is taken verbatim from either the NGSS site or the College Board *AP Biology Course and Exam Description*. Other Student Learning Objectives are taken verbatim from New Jersey model curriculum.

ESSENTIAL QUESTIONS:
Were humans inevitable?
How does life shape the environment?
How does the environment shape life?

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
1	Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.	Disciplinary Core Idea LS4.C (Adaptation), HS-LS4-4, HS-LS4-3, HS-LS4-5, and HS-LS2-8

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.	HS-LS4-2. [CB 1.A.1, 1.A.2]
3	Make predictions about the effects of artificial selection on the genetic makeup of a population over time.	LS4.C
4	Construct an argument using authentic genetic data for testing hypothetical relationships between various species based on morphology/phenotype.	HS-LS4-1, HS-LS4-3, HS-LS4-6 [CB 1.A.4, 1.B.2, 1.C.3]

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data 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) **Using Mathematics and Computational Thinking** 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	**LS4.A: Evidence of Common Ancestry and Diversity** ● 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**	**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. (HS-LS4-1),(HS-LS4-3) **Cause and Effect** ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

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. ● Create or revise a simulation of a phenomenon, designed device, process, or system. (HS-LS4-6) **Constructing Explanations and Designing Solutions** 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-LS4-2),(HS-LS4-4) **Engaging in Argument from Evidence** Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific	● Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. (HS-LS4-2),(HS-LS4-3) ● The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (HS-LS4-3) **LS4.C: Adaptation** ● Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. (HS-LS4-2)	(HS-LS4-2),(HS-LS4-4),(HS-LS4-5),(HS-LS4-6) - ***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)

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** 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) - ***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	● 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),(HS-LS4-6)	

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)	• 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)	

Connections to other DCIs in this grade-band: **HS.LS2.A** (HS-LS4-2),(HS-LS3-4),(HS-LS4-4),(HS-LS4-5); **HS.LS2.D** (HS-LS4-2),(HS-LS4-3),(HS-LS4-4),(HS-LS4-5); **HS.LS3.A** (HS-LS4-1); **HS.LS3.B** (HS-LS4-1),(HS-LS4-2),(HS-LS4-3),(HS-LS4-5); **HS.ESS1.C** (HS-LS4-1); **HS.ESS2.D** (HS-LS4-6); **HS.ESS2.E** (HS-LS4-2),(HS-LS4-5),(HS-LS4-6); **HS.ESS3.A** (HS-LS4-2),(HS-LS4-5),(HS-LS4-6); **HS.ESS3.C** (HS-LS4-6); **HS.ESS3.D** (HS-LS4-6)

Articulation of DCIs across grade-bands: MS.LS2.A (HS-LS4-2),(HS-LS4-3),(HS-LS4-5); **MS.LS2.C** (HS-LS4-5),(HS-LS4-6); **LS3.A** (HS-LS4-1); **LS3.B** (HS-LS4-1),(HS-LS4-2),(HS-LS4-3); **MS.LS4.A** (HS-LS4-1); **MS.LS4.B** (HS-LS4-2),(HS-LS4-3),(HS-LS4-4); **MS.LS4.C** (HS-LS4-2),(HS-LS4-3),(HS-LS4-4),(HS-LS4-5); **MS.ESS1.C** (HS-LS4-1); **HS.ESS3.C** (HS-LS4-5),(HS-LS4-6)

Common Core State Standards Connections:
ELA:
RST-11.12.1 Cite strong and thorough textual evidence and make relevant connections to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.
(HS-LS4-1),(HS-LS4-2),(HS-LS4-3),(HS-LS4-4)
RST-11.12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-LS4-5)
WHST.11-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS4-1),(HS-LS4-2),(HS-LS4-3),(HS-LS4-4)
WHST.9-10.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, trying a new approach, or consulting a style manual (such as MLA or APA Style), focusing on addressing what is most significant for a specific purpose and audience. (Editing for conventions should demonstrate command of Language standards 1–3 up to and including grades 9–10) (HS-LS4-6)
NJSLSA.W.7. Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation. (HS-LS4-6)

W.9-10.9. Draw evidence from literary or nonfiction informational texts to support analysis, reflection, and research. (HS-LS4-1),(HS-LS4-2),(HS-LS4-3),(HS-LS4-4),(HS-LS4-5) **SL.11-12.4.** Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience. (HS-LS4-1),(HS-LS4-2) **MATH:** **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)
Technology & Career Standards: **8.1 Educational Technology:** All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge. **Career Ready Practices:** 1-12

Unit Plan		
Content Vocabulary	**Academic Vocabulary**	**Recommended Resources**
evolution, fossil, strata, catastrophism, paleontology, uniformitarianism, natural selection, artificial selection, homolog, vestigial, convergent/divergent evolution, analogous, endemic, microevolution, variation, population, gene pool, Hardy-Weinberg principle, genetic drift, founder effect, bottleneck effect, gene flow, relative fitness, directional/disruptive/stabilizing selection, sexual selection/dimorphism, heterozygote advantage, speciation, hybrid, pre-/postzygotic, allopatric, sympatric, punctuated equilibrium, mass extinction, cladistic, phylogenetic tree	relate, sequence, functional, diagram, compare and contrast, describe, define, assume, locate, complementary, construct, specify, interpret, decipher, depict, explain, decide, claim, evidence, reason, decipher, elucidate, explicate, annotate, reason, delineate, specific, precise, accurate, itemize, assumption, salient, juxtapose, unilateral, bilateral, consolidate, infer, deduce, conclusion, calibrate, inverse, conversely	• Text • AP Biology review, Holtzclaw and Holtzclaw • Classroom models • Online ancillaries provided via OpenStax • Mastering Biology • Bozeman Science AP Biology • David Knuffke AP Biology Prezis In addition, various resources will be provided by class website on a week to week basis depending on the needs and abilities of the students.

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
	ACTIVITY: predator (students)/prey (paper clips), done outside in local park, used to analyze trends in populations. [May also be used during last unit for population trend studies.	SLO 1,SLO 2 **Engineering practice(s)** ● Asking questions and defining problems ● Developing and using models ● Planning and carrying out investigations ● Analyzing and interpreting data ● Using mathematics and computational thinking
EXPLORE	**Examples of Exploring Activities:**	
	LAB: Comparing DNA sequences to understand evolutionary relationships with BLAST I: The first part of this lab will familiarize the student with the Basic Local Alignment Search Tool (BLAST); once students become familiar with some of its properties, students will design and run experiment in Part II.	SLO 1, SLO 3, SLO 4 **Engineering practice(s)** ● Asking questions and defining problems ● Developing and using models ● Planning and carrying out investigations ● Analyzing and interpreting data ● Using mathematics and computational thinking ● Engaging in argument from evidence ● Obtaining, evaluating, and communicating information
EXPLAIN	**Examples of Explaining Activities:**	
	LAB: Hardy-Weinberg mathematical modeling: students randomly "mate" with each other under various condition to see trends in allele frequencies; a more advanced version of mathematical modeling can be done using spreadsheets (model simulations can be found in AP lab manual, Lab 2)	SLO 3, SLO 4 **Engineering practice(s)** ● Asking questions and defining problems ● Developing and using models ● Planning and carrying out investigations ● Analyzing and interpreting data ● Using mathematics and computational thinking ● Constructing explanations (for science) and designing solutions (for engineering) ● Engaging in argument from evidence

		● Obtaining, evaluating, and communicating information
ELABORATE	**Examples of Elaborating Activities:**	
	LAB: Artificial selection with Wisconsin fast plants: students grow plants then choose characteristic to select for artificially; experiment can run for several months.	SLO 1, SLO 3 **Engineering practice(s)** ● Asking questions and defining problems ● Developing and using models ● Planning and carrying out investigations ● Analyzing and interpreting data ● Using mathematics and computational thinking ● Constructing explanations (for science) and designing solutions (for engineering) ● Engaging in argument from evidence
EVALUATE	**Examples of Evaluating Activities:**	
	LAB: Comparing DNA sequences to understand evolutionary relationships with BLAST II: after the preliminary exposure to the BLAST website, exploring relationships between the genetic make-up of various organisms, student will develop testable hypotheses that will be tested using data generated by student requests in BLAST.	SLO 1, SLO 2 **Engineering practice(s)** ● Asking questions and defining problems ● Planning and carrying out investigations ● Analyzing and interpreting data ● Using mathematics and computational thinking ● Constructing explanations (for science) and designing solutions (for engineering) ● Engaging in argument from evidence ● Obtaining, evaluating, and communicating information
	College Board style monthly evaluations: Students will take monthly, cumulative exams following the style of	SLOs: all **Engineering practice(s)**

	the Advanced Placement Biology Examination (including questions released by the College Board specifically for this purpose) that include both multiple choice and FRQs (“free response questions”); these exams emphasize science practices.	● Developing and using models ● Planning investigations ● Analyzing and interpreting data ● Using mathematics and computational thinking ● Engaging in argument from evidence

College Board correlations as presented in current AP Biology CB approved syllabus for this unit:
Enduring Understandings (EU)/Essential Knowledge (EK)

EU 1.A: Change in the genetic makeup of a population over time is evolution.

EK 1.A.1: Natural selection is a major mechanism of evolution.
EK 1.A.2: Natural selection acts on phenotypic variations in populations.
EK 1.A.3: Evolutionary change is also driven by random processes.
EK 1.A.4: Biological evolution is supported by scientific evidence from many disciplines, including mathematics.

EU 1.B: Organisms are linked by lines of descent from common ancestry.

EK 1.B.1: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today.
EK 1.B.2: Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested.

EU 1.C: Life continues to evolve within a changing environment.

EK 1.C.1: Speciation and extinction have occurred throughout the Earth’s history.
EK 1.C.2: Speciation may occur when two populations become reproductively isolated from each other.
EK 1.C.3: Populations of organisms continue to evolve.

EU 1.D: The origin of living systems is explained by natural processes.

EK 1.D.1: There are several hypotheses about the natural origin of life on Earth, each with supporting scientific evidence.
EK 1.D.2: Scientific evidence from many different disciplines supports models of the origin of life.

EU 2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter.

Unit #3	**Unit Name:** *Cell Biology*	**Unit Length:** ~3 weeks

Much of the language of the "Student Learning Objectives" is taken verbatim from either the NGSS site or the College Board *AP Biology Course and Exam Description*. Other Student Learning Objectives are taken verbatim from New Jersey model curriculum.

ESSENTIAL QUESTIONS:
What makes life possible?
How are form and function entwined in living systems?

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
1	Explain the connection between the sequence and the subcomponents of a biomolecule and its properties.	LS1.A [College Board: EU4.A, EU4.B, EU4.C]
2	Construct models that explain the movement of molecules across membranes with membrane structure and function.	LS1.A [College Board:EU1.D, EU2A-D, EU4.A]
3	Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.	HS-LS1-2 [CB: ES1.B, EU2B-D, EU3.D, EU4.A-C]
4	Provide examples and explain how organisms use feedback systems to maintain their internal environments.	LS1.A [CB: EU2.B-D, EU3.D, EU4.C]
5	Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.	HS-LS1-3 [CB: EU2.B-D, EU3.D, EU4.C]
6	Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.	HS-LS1-4 [CB: EU2.C-D, EU3B&D]

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:		
Science and 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. (HS-LS1-1) **Developing and Using Models** ● Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-2) **Planning and Carrying Out Investigations** ● Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time),	**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. (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) ● Regions of DNA called genes determine the structure of proteins, which carry out the essential functions of life through systems of specialized cells. The sequence of genes contains instructions that code for proteins. (LS1.A)	**Systems and System Models** ● Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-2) **Stability and Change** ● Feedback (negative or positive) can stabilize or destabilize a system. (HS-LS1-3)

and refine the design accordingly. (HS-LS1-3)	• Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1) • Groups of specialized cells (tissues) use proteins to carry out functions that are essential to the organism. (LS1.A)	

Connections to other DCIs in this grade-band:
HS.PS1.B (HS-LS1-5),(HS-LS1-6),(HS-LS1-7); **HS.PS2.B** (HS-LS1-7); **HS.LS3.A** (HS-LS1-1); **HS.PS3.B** (HS-LS1-5),(HS-LS1-7)

Articulation of DCIs across grade-bands:
MS.PS1.A (HS-LS1-6); **MS.PS1.B** (HS-LS1-5),(HS-LS1-6),(HS-LS1-7); **MS.PS3.D** (HS-LS1-5),(HS-LS1-6),(HS-LS1-7); **MS.LS1.A** (HS-LS1-1),(HS-LS1-2),(HS-LS1-3),(HS-LS1-4); **MS.LS1.B** (HS-LS1-4); **MS.LS1.C** (HS-LS1-5),(HS-LS1-6),(HS-LS1-7); **MS.LS2.B** (HS-LS1-5),(HS-LS1-7); **MS.ESS2.E** (HS-LS1-6); **MS.LS3.A** (HS-LS1-1),(HS-LS1-4); **MS.LS3.B** (HS-LS1-1)

Common Core State Standards Connections:

English Language Arts/Literacy

RST.9-10.1 Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. (HS-LS1-1),(HS-LS1-6)

WHST.6-8.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS1-1),(HS-LS1-6)

W.11-12.2 Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content (HS-LS1-1),(HS-LS1-6)

W.11-12.5	Develop and strengthen writing as needed by planning, revising, editing, rewriting, trying a new approach, or consulting a style manual (such as MLA or APA Style), focusing on addressing what is most significant for a specific purpose and audience. (Editing for conventions should demonstrate command of Language standards 1–3 up to and including grades 11-12.) (HS-LS1-6)
NJSLSA.W.7	Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation. (HS-LS1-3)
W.9-10.8	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation (MLA or APA Style Manuals). *(HS-LS1-3)*
W.9-10.9.	Draw evidence from literary or nonfiction informational texts to support analysis, reflection, and research. (HS-LS1-1),(HS-LS1-6)
SL.9-10.5	Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance findings, reasoning, and evidence and to add interest. *(HS-LS1-2),(HS-LS1-4),(HS-LS1-5),(HS-LS1-7)*
Mathematics -	
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)*
S.ID.B.6b	Informally assess the fit of a function by plotting and analyzing residuals, including with the use of technology. *(HS-LS1-4)*

Technology & Career Standards:
8.1 Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
Career Ready Practices: 1-12

Unit Plan

Content Vocabulary	Academic Vocabulary	Recommended Resources
cell, organelle, cytosol, cytoplasm, nucleus, nucleolus, eukaryote, prokaryote, plasma membrane, ribosome, chromosome, chromatin, vesicle, endoplasmic reticulum (ER), smooth/rough ER, glycoprotein, Golgi apparatus, lysosome, phagocytosis, vacuole, mitochondrion, chloroplast, endosymbiont theory, thylakoid, plastid, peroxisome, centriole, microfilament, basal body, cell wall, extracellular matrix, plasmodesmata, tight junction, desmosome, gap junction, fluid mosaic model, integral/peripheral protein, selective permeability, diffusion, concentration gradient, passive/active transport, osmosis, tonicity, ion/gated channel, active transport, membrane potential, co-transport, endo-/exocytosis,	relate, sequence, functional, diagram, compare and contrast, describe, define, assume, locate, complementary, construct, specify, interpret, decipher, depict, explain, decide, claim, evidence, reason, decipher, elucidate, explicate, annotate, reason, delineate, specific, precise, accurate, itemize, assumption, salient, juxtapose, unilateral, bilateral, consolidate, infer, deduce, conclusion, calibrate, inverse, conversely	• Text • Classroom models • AP Biology Review, Holtclaw and Holtzclaw • Online ancillaries provided via OpenStax • Mastering Biology • Bozeman Science AP Biology • David Knuffke AP Biology Prezis In addition, various resources will be provided by class website on a week to week basis depending on the needs and abilities of the students.

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
	Osmosis lab intro: playing with dialysis tubing: This is a multiple series of labs over a period of two weeks; one of the more engaging ones is having the students "play" with dialysis tubing, exploring the ways it behaves under different concentration of solutions.	SLO 1, SLO 2 **Engineering practice(s):** • Asking questions (for science) and defining problems (for engineering) • Developing and using models • Analyzing and interpreting data • Constructing explanations (for science) and designing solutions (for engineering) • Engaging in argument from evidence • Obtaining, evaluating, and communicating information
EXPLORE/EXPLAIN	**Examples of Exploring Activities:**	

	ACTIVITY: meiosis modeling: students use a combination of materials (they are free to use supplies other than that given) to model meiosis with emphasis on genetic recombination); this deceptively simple lab requires (and leads to) a deeper understanding of the processes involved.	SLO 3, SLO 4, SLO 6 **Engineering practice(s):** ● Developing and using models ● Analyzing and interpreting data
ELABORATE	**Examples of Elaborating Activities:**	
	Onion mitosis lab: Students infer what percentage of time root cells spend in the various parts of the cell cycle by observing sections of onion root tips. [This can be expanded to allow students to prepare their own slides.]	SLO 3, SLO 4, SLO 6 **Engineering practice(s):** ● Asking questions (for science) and defining problems (for engineering) ● Planning and carrying out investigations ● Analyzing and interpreting data ● Using mathematics and computational thinking ● Constructing explanations (for science) and designing solutions (for engineering) ● Engaging in argument from evidence ● Obtaining, evaluating, and communicating information
EVALUATE	**Examples of Evaluating Activities:**	
	LAB: Diffusion and osmosis: multiple labs culminating in students identifying unknown solutions using newly acquired skills as well as figuring out the pressure potential of various vegetables.	SLO 1, SLO 2, SLO 5 **Engineering practice(s):** ● Asking questions (for science) and defining problems (for engineering) ● Developing and using models ● Planning and carrying out investigations ● Analyzing and interpreting data ● Using mathematics and computational thinking ● Constructing explanations (for science) and designing solutions (for engineering) ● Engaging in argument from evidence

		● Obtaining, evaluating, and communicating information
	College Board style monthly evaluations: Students will take monthly, cumulative exams following the style of the Advanced Placement Biology Examination (including questions released by the College Board specifically for this purpose) that include both multiple choice and FRQs ("free response questions"); these exams emphasize science practices.	SLOs: all **Engineering practice(s)** ● Developing and using models ● Planning ~~and carrying out~~ investigations ● Analyzing and interpreting data ● Using mathematics and computational thinking ● Engaging in argument from evidence

College Board correlations as presented in current AP Biology CB approved syllabus for this unit:
Enduring Understandings (EU)/Essential Knowledge (EK)

EU 1.B: Organisms are linked by lines of descent from common ancestry.
EK 1.B.1: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today.

EU 1.D: The origin of living systems is explained by natural processes.
EK 1.D.2: Scientific evidence from many different disciplines supports models of the origin of life.

EU 2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter.
EK 2.A.1: All living systems require constant input of free energy.
EK 2.A.2: Organisms capture and store free energy for use in biological processes.
EK 2.A.3: Organisms must exchange matter with the environment to grow, reproduce and maintain organization.

EU 2.B: Growth, reproduction and dynamic homeostasis require that cells create and maintain internal environments that are different from their external environments.

EK 2.B.1: Cell membranes are selectively permeable due to their structure.
EK 2.B.2: Growth and dynamic homeostasis are maintained by the constant movement of molecules across membranes.
EK 2.B.3: Eukaryotic cells maintain internal membranes that partition the cell into specialized regions.

EU 2.C: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis.
EK 2.C.1: Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes.
EK 2.C.2: Organisms respond to changes in their external environments.

EU 2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment.
EK 2.D.1: All biological systems from cells and organisms to populations, communities and ecosystems are affected by complex biotic and abiotic interactions involving exchange of matter and free energy.

EU 3.A: Heritable information provides for continuity of life.
EK 3.A.1: DNA, and in some cases RNA, is the primary source of heritable information.

EU 3.B: Expression of genetic information involves cellular and molecular mechanisms.
EK 3.B.1: Gene regulation results in differential gene expression, leading to cell specialization.
EK 3.B.2: A variety of intercellular and intracellular signal transmissions mediate gene expression.

EU 3.D: Cells communicate by generating, transmitting and receiving chemical signals.
EK 3.D.1: Cell communication processes share common features that reflect a shared evolutionary history.
EK 3.D.2: Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling.
EK 3.D.3: Signal transduction pathways link signal reception with cellular response.
EK 3.D.4: Changes in signal transduction pathways can alter cellular response.

EU 4.A: Interactions within biological systems lead to complex properties.
EK 4.A.2: The structure and function of subcellular components, and their interactions, provide essential cellular processes.

EU 4.B: Competition and cooperation are important aspects of biological systems.
EK 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.

EU 4.C: Naturally occurring diversity among and between components within biological systems affects interactions with the environment.

EK 4.C.1: Variation in molecular units provides cells with a wider range of functions.

Unit #4	**Unit Name:** *Metabolism*	**Unit Length:** ~4 weeks

Much of the language of the "Student Learning Objectives" is taken verbatim from either the NGSS site or the College Board *AP Biology Course and Exam Description*. Other Student Learning Objectives are taken verbatim from New Jersey model curriculum.

ESSENTIAL QUESTIONS:
What drives life?
What causes death?

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
1	Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.	HS-LS1-5 [College Board: EU2.A, EU2.D]
2	Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.	HS-LS2-3 [CB: EU2.D, EU2.A, EU4.A]
3	Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.	HS-LS2-5 [CB: EU2.D, EU2.A]

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models 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 components of a system. (HS-LS1-2) • Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-4),(HS-LS1-5),(HS-LS1-7) **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. (HS-LS1-3) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and	**LS1.C: Organization for Matter and Energy Flow in Organisms** • The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HS-LS1-5) • 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 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	**Systems and System Models** • Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-2),(HS-LS1-4) **Energy and Matter** • Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-LS1-5), (HS-LS1-6) • Energy cannot be created or destroyed—it only moves between one place and another place,

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) • 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) *Connections to Nature of Science* **Scientific Investigations Use a Variety of Methods** • Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. (HS-LS1-3)	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)	between objects and/or fields, or between systems. (HS-LS1-7) **Structure and Function** • Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-LS1-1) **Stability and Change** • Feedback (negative or positive) can stabilize or destabilize a system. (HS-LS1-3)
Connections to other DCIs in this grade-band: **HS.PS1.B** (HS-LS1-5),(HS-LS1-6),(HS-LS1-7); **HS.PS2.B** (HS-LS1-7); **HS.LS3.A** (HS-LS1-1); **HS.PS3.B** (HS-LS1-5),(HS-LS1-7)		
Articulation of DCIs across grade-bands: **MS.PS1.A** (HS-LS1-6); **MS.PS1.B** (HS-LS1-5),(HS-LS1-6),(HS-LS1-7); **MS.PS3.D** (HS-LS1-5),(HS-LS1-6),(HS-LS1-7); **MS.LS1.A** (HS-LS1-1),(HS-LS1-2),(HS-LS1-3),(HS-LS1-4); **MS.LS1.B** (HS-LS1-4); **MS.LS1.C** (HS-LS1-5),(HS-LS1-6),(HS-LS1-7); **MS.LS2.B** (HS-LS1-5),(HS-LS1-7); **MS.ESS2.E** (HS-LS1-6); **MS.LS3.A** (HS-LS1-1),(HS-LS1-4); **MS.LS3.B** (HS-LS1-1)		

Common Core State Standards Connections:
ELA/Literacy -

RST.9-10.1. Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. (HS-LS1-1),(HS-LS1-6)

RH.11-12.1. Accurately cite strong and thorough textual evidence, (e.g., via discussion, written response, etc.), to support analysis of primary and secondary sources, connecting insights gained from specific details to develop an understanding of the text as a whole. (HS-LS1-1),(HS-LS1-6)

WHST.6-8.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS1-1),(HS-LS1-6)

W.9-10.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, trying a new approach, or consulting a style manual (such as MLA or APA Style), focusing on addressing what is most significant for a specific purpose and audience. (Editing for conventions should demonstrate command of Language standards 1–3 up to and including grades 9–10) (HS-LS1-6)

NJSLSA.W.7. Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation. (HS-LS1-3)

W.9-10.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation (MLA or APA Style Manuals). *(HS-LS1-3)*

W.9-10.9. Draw evidence from literary or nonfiction informational texts to support analysis, reflection, and research. (HS-LS1-1),(HS-LS1-6)

SL.9-10.5. Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. *(HS-LS1-2),(HS-LS1-4),(HS-LS1-5),(HS-LS1-7)*

Mathematics - **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)* **S.ID.B.6a** Fit a function to the data (including with the use of technology); use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models. *(HS-LS1-4)* **S.ID.B.6b** Informally assess the fit of a function by plotting and analyzing residuals, including with the use of technology. *(HS-LS1-4)*
Technology & Career Standards: **8.1 Educational Technology:** All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge. **Career Ready Practices:** 1-12

Unit Plan		
Content Vocabulary	**Academic Vocabulary**	**Recommended Resources**
metabolism, energy, catabolic, anabolic, kinetic, heat, thermal, potential energy, chemical energy, thermodynamics, entropy, spontaneous, free energy, exergonic, endogonic, equilibrium, adenosine triphosphate (ATP), hydrolysis, enzyme, activation energy, catalyst, substrate, active site, induced fit, cofactor, inhibitor (competitive and noncompetitive), allosteric regulation, cooperativity, feedback	relate, sequence, functional, diagram, compare and contrast, describe, define, assume, locate, complementary, construct, specify, interpret, decipher, depict, explain, decide, claim, evidence, reason, decipher,	● Text ● Classroom models ● Online ancillaries provided via OpenStax ● Mastering Biology ● Bozeman Science AP Biology ● David Knuffke AP Biology Prezis

inhibition, fermentation, aerobic respiration, cellular respiration, oxidation/reduction (redox), NAD^+, electron transport chain, glycolysis, citric acid cycle , phosphorylation, acetyl CoA, chemiosmosis, ATP synthase, alcohol/lactic acid fermentation, photosynthesis, light reaction, Calvin cycle, $NADP^+$, carbon fixation, absorption spectrum, chlorophyll photosystem, reaction-center complex, cyclic/linear electron flow, rubisco, glyceraldehyde-3-phosphate (G-3-P), C_3/C_4/CAM plants, bundle sheath,	elucidate, explicate, annotate, reason, delineate, specific, precise, accurate, itemize, assumption, salient, juxtapose, unilateral, bilateral, consolidate, infer, deduce, conclusion, calibrate, inverse, conversely	• AP Biology Review, Holtclaw and Holtzclaw In addition, various resources will be provided by class website on a week to week basis depending on the needs and abilities of the students.

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
	Propane torch demo: students use a propane torch [with appropriate safety measures in place] to "sweat" a pipe; correlation is made with generic combustion reaction and specific propane combustion equation, which is then tied to respiration products (CO_2, H_2O)	SLO 1 **Engineering practice(s)** • Analyzing and interpreting data • Constructing explanations (for science) and designing solutions (for engineering) • Engaging in argument from evidence
	Making ethanol demo: unit-length activity during which students set up yeast/sugar solutions to witness alcoholic fermentation; multiple points discussed over the unit during fermentation (conservation of mass, energy flow, anaerobic vs. aerobic responses by "simple" organism, etc.	SLO 2, SLO 3 **Engineering practice(s)** • Developing and using models • Analyzing and interpreting data • Constructing explanations (for science) and designing solutions (for engineering) • Engaging in argument from evidence • Obtaining, evaluating, and communicating information

	Radiometer demo: Crooke's radiometer (introduced on Day 1 for year) demonstrated again to show conversion of light energy to mechanical energy; discussion of correlation to life follows	SLO 1 **Engineering practice(s)** ● Asking questions (for science) and defining problems (for engineering) ● Developing and using models ● Analyzing and interpreting data ● Constructing explanations (for science) and designing solutions (for engineering) ● Engaging in argument from evidence ● Obtaining, evaluating, and communicating information
	Conservation of energy/mass demos: Multiple demos with same theme—order requires input of free energy; order to disorder can release free energy.	SLO 1, SLO 3 **Engineering practice(s)** ● Asking questions (for science) and defining problems (for engineering) ● Developing and using models ● Engaging in argument from evidence ● Obtaining, evaluating, and communicating information ●
EXPLORE	**Examples of Exploring Activities:**	
	LAB: Respiration I: This is a multi-class lab that ultimately requires the students to design and test their own hypothesis. The initial lab walks the students through how a respirometer works, allowing students to see the direct effects of the gas exchange involved in preparation for designing own lab to test student-generated hypothesis.	SLO 2. SLO 3 **Engineering practice(s)** ● Asking questions (for science) and defining problems (for engineering) ● Developing and using models

		● Planning and carrying out investigations ● Analyzing and interpreting data ● Using mathematics and computational thinking ● Constructing explanations (for science) and designing solutions (for engineering) ● Engaging in argument from evidence ● Obtaining, evaluating, and communicating information
	LAB: Photosynthesis I: This is a multi-class lab that ultimately requires the students to design and test their own hypothesis. The initial lab walks the students through how the rate of photosynthesis can be measured indirectly by the changes in leaf disk density caused by O_2 production in preparation for designing own lab to test student-generated hypothesis.	SLO 2. SLO 3 **Engineering practice(s)** ● Asking questions (for science) and defining problems (for engineering) ● Developing and using models ● Planning and carrying out investigations ● Analyzing and interpreting data ● Constructing explanations (for science) and designing solutions (for engineering) ● Engaging in argument from evidence ● Obtaining, evaluating, and communicating information
EXPLAIN	**Examples of Explaining Activities:**	
	LAB: Enzyme catalysis activities: Students analyze effects of various factors on enzyme activity 9 measured in multiple ways, depending in part on question students seek to answer.	SLO 2 **Engineering practice(s)**

		- Asking questions (for science) and defining problems (for engineering) - Developing and using models - Planning and carrying out investigations - Analyzing and interpreting data - Engaging in argument from evidence - Obtaining, evaluating, and communicating information
ELABORATE/EVALUATION	**Examples of Elaborating/Evaluation Activities:**	
	LAB: Photosynthesis II: Using acquired knowledge of how respirometer functions, students design lab built around hypothesis generated by student.	SLO 2. SLO 3 **Engineering practice(s)** - Asking questions (for science) and defining problems (for engineering) - Developing and using models - Planning and carrying out investigations - Analyzing and interpreting data - Using mathematics and computational thinking - Constructing explanations (for science) and designing solutions (for engineering) - Engaging in argument from evidence - Obtaining, evaluating, and communicating information
	LAB: Respiration II: Using acquired knowledge of how photosynthesis can be measured, students design lab built around hypothesis generated by student.	SLO 1, SLO 2, SLO 3 **Engineering practice(s)**

		● Asking questions (for science) and defining problems (for engineering) ● Developing and using models ● Planning and carrying out investigations ● Analyzing and interpreting data ● Using mathematics and computational thinking ● Constructing explanations (for science) and designing solutions (for engineering) ● Engaging in argument from evidence ● Obtaining, evaluating, and communicating information
	College Board style monthly evaluations: Students will take monthly, cumulative exams following the style of the Advanced Placement Biology Examination (including questions released by the College Board specifically for this purpose) that include both multiple choice and FRQs (“free response questions”); these exams emphasize science practices.	SLOs: all **Engineering practice(s)** ● Developing and using models ● Planning investigations ● Analyzing and interpreting data ● Using mathematics and computational thinking ● Engaging in argument from evidence

College Board correlations as presented in current AP Biology CB approved syllabus for this unit:

Enduring Understandings (EU)/Essential Knowledge (EK)

EU 1.B: Organisms are linked by lines of descent from common ancestry.

EK 1.B.1: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today.

EU 2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment.

EK 2.D.2: Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments.

EU 2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter.

EK 2.A.1: All living systems require constant input of free energy.

EK 2.A.2: Organisms capture and store free energy for use in biological processes.

EK 2.A.3: Organisms must exchange matter with the environment to grow, reproduce and maintain organization.

EU 2.C: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis.

EK 2.C.1: Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes.

EK 2.C.2: Organisms respond to changes in their external environments.

EU 2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment.

EK 2.D.1: All biological systems from cells and organisms to populations, communities and ecosystems are affected by complex biotic and abiotic interactions involving exchange of matter and free energy.

EK 2.D.3: Biological systems are affected by disruptions to their dynamic homeostasis.

EU 2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination.

EK 2.E.1: Timing and coordination of specific events are necessary for the normal development of an organism, and these events are regulated by a variety of mechanisms.

EU 3.B: Expression of genetic information involves cellular and molecular mechanisms.

EK 3.B.2: A variety of intercellular and intracellular signal transmissions mediate gene expression.

EU 4.A: Interactions within biological systems lead to complex properties.

EK 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule.

EK 4.A.2: The structure and function of subcellular components, and their interactions, provide essential cellular processes.

EK 4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts.

EU 4.B: Competition and cooperation are important aspects of biological systems.

EK 4.B.1: Interactions between molecules affect their structure and function.

EK 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.

EU 4.C: Naturally occurring diversity among and between components within biological systems affects interactions with the environment.

EK 4.C.1: Variation in molecular units provides cells with a wider range of functions.

Unit #5	**Unit Name:** *Genetics: The Central Dogma*	**Unit Length:** ~4 weeks

Much of the language of the "Student Learning Objectives" is taken verbatim from either the NGSS site or the College Board *AP Biology Course and Exam Description*. Other Student Learning Objectives are taken verbatim from New Jersey model curriculum.

ESSENTIAL QUESTIONS:
What makes you you?

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
1	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.	LS1.B [College Board: EU1.B, EU2.E, EU3.A-C, EU4.A]
2	Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.	HS-LS3-1 [CB: EU3.A-C]

3	Create a visual representation to illustrate how changes in a DNA nucleotide sequence can result in a change in the polypeptide produced.	LS3.B [CB: EU3.C *et al.*]
4	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.	HS-LS3-2 [CB: EU3.A-C]

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems ● Ask questions that arise from examining models or a theory to clarify relationships. (HS-LS3-1) **Constructing Explanations and Designing Solutions** ● Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS1-1)	**LS1.A: Structure and Function** ● 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) **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	**Cause and Effect** ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HSLS3-1; HSLS3-2) **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). (HS-LS3-3)

Engaging in Argument from Evidence ● Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence. (HS-LS3-2) ● Use an oral and written argument supported by evidence to support or refute an explanation or a model for a phenomenon. (MS-LS1-3) ● Use an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-LS1-4)	or structural functions, and some have no as-yet known function. (HS-LS3-1) **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. (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)	

Connections to other DCIs in this grade-band: HS.LS2.A (HS-LS3-3); HS.LS2.C (HS-LS3-3); HS.LS4.B (HS-LS3-3); HS.LS4.C (HS-LS3-3)
Articulation of DCIs across grade-bands: MS.LS1.A (HS-LS1-4); MS.LS1.B (HS-LS1-4); MS.LS2.A (HS-LS3-3); MS.LS3.A (HS-LS1-4),(HS-LS3-1),(HS-LS3-2); MS.LS3.B (HS-LS3-1),(HS-LS3- 2),(HS-LS3-3); MS.LS4.C (HS-LS3-3)
Common Core State Standards Connections: *ELA/Literacy -*

RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. *(HS-LS3-1),(HS-LS3-2)*

RST.9-10.1. Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. *(HS-LS3-1),(HS-LS3-2)*

W.7.1. Write arguments to support claims with clear reasons and relevant evidence. (HS-LS3-2)

W.9-10.1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence. (HS-LS3-2)

WHST.6-8.1. Write arguments focused on discipline-specific content. (HS-LS3-2)

SL.9-10.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance findings, reasoning, and evidence and to add interest. *(HS-LS1-4)*

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)*

Technology & Career Standards: **8.1 Educational Technology:** All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge. **Career Ready Practices:** 1-12

Unit Plan		
Content Vocabulary	**Academic Vocabulary**	**Recommended Resources**
character, trait, allele, true-breeding, P/F_1/F_2 generation, hybridization, law of segregation, dominant, recessive, Punnett square, homo-/heterozygous genotype, phenotype, testcross, mono-/dihybrid, law of independent assortment, complete/incomplete dominance, codominance, epistasis, sex-linked gene, X-linked gene, Barr body, crossing over, recombinant, genetic map, lineage map, DNA, transformation, virus, double helix, antiparallel, semiconservative model, origin of replication replication fork, primase, DNA polymerase, leading/lagging strand, Okazaki fragment, gene expression, transcription, translation, messenger RNA (mRNA), triplet code, intron, exon, spliceosome, transfer RNA (tRNA), anticodon ribosomal RNA (rRNA), mutation, operon (repressible/inducible), cAMP, activator, cancer, tumor suppressor gene, proto-oncogene	relate, sequence, functional, diagram, compare and contrast, describe, define, assume, locate, complementary, construct, specify, interpret, decipher, depict, explain, decide, claim, evidence, reason, decipher, elucidate, explicate, annotate, reason, delineate, specific, precise, accurate, itemize, assumption, salient, juxtapose, unilateral, bilateral, consolidate, infer, deduce, conclusion, calibrate, inverse, conversely	● Text ● Classroom models ● Online ancillaries provided via OpenStax ● Mastering Biology ● Bozeman Science AP Biology ● David Knuffke AP Biology Prezis ● AP Biology Review, Holtclaw and Holtzclaw In addition, various resources will be provided by class website on a week to week basis depending on the needs and abilities of the students.

THE 5 "E"s	**Examples of Learning Activities for the specified "E"**	**SLO's and Engineering Practices**
ENGAGE	**Examples of Engaging Activities:**	

	Compare and contrast various lifeforms/KWL: How is Elvis like a geoduck clam? Initiate discussion re: connection between DNA and who we are.	SLO 2 **Engineering practice(s):** ● Asking questions (for science) and defining problems (for engineering) ● Engaging in argument from evidence
EXPLORE	**Examples of Exploring Activities:**	
	AMINO ACID modeling game: students take up various positions along long string as different amino acids with various properties, and then predict shape of "polypeptide" under various conditions.	SLO 1, SLO 2, SLO 3 **Engineering practice(s):** ● Developing and using models ● Constructing explanations (for science) and designing solutions (for engineering) ● Engaging in argument from evidence
EXPLAIN	**Examples of Explaining Activities:**	
	LAB: Bacterial transformation: students physically transform avirulent *E. coli* with a jellyfish gene combined with an ampicillin resistant gene to create fluorescent bacterial colonies. This allows tridents to see firsthand how DNA technology works.	SLO 2, SLO 3 **Engineering practice(s):** ● Planning and carrying out investigations ● Analyzing and interpreting data ● Using mathematics and computational thinking [calculate cfu's] ● Engaging in argument from evidence ● Obtaining, evaluating, and communicating information
	LAB: Restriction enzyme analysis of DNA: students "digest" strands of DNA using restriction enzymes, and then separate the DNA bands by size via gel electrophoresis. This allows tridents to see firsthand how DNA technology works.	SLO 2, SLO 3 **Engineering practice(s):** ● Planning and carrying out investigations ● Analyzing and interpreting data ● Using mathematics and computational thinking [calculate cfu's] ● Engaging in argument from evidence ● Obtaining, evaluating, and communicating information
ELABORATE	**Examples of Elaborating Activities:**	

	*INDEPENDENT STUDY: Mendelian genetics problem set: s*tudents work through increasingly complex genetic models, culminating in several problems that require students to reason out solution to novel problems.	SLO 1, SLO 2, SLO 4 **Engineering practice(s):** ● Developing and using models ● Analyzing and interpreting data ● Engaging in argument from evidence
EVALUATE	**Examples of Evaluating Activities:**	
	College Board style monthly evaluations: Students will take monthly, cumulative exams following the style of the Advanced Placement Biology Examination (including questions released by the College Board specifically for this purpose) that include both multiple choice and FRQs ("free response questions"); these exams emphasize science practices.	SLOs: all **Engineering practice(s)** ● Developing and using models ● Planning ~~and carrying out~~ investigations ● Analyzing and interpreting data ● Using mathematics and computational thinking ● Engaging in argument from evidence

College Board correlations as presented in current AP Biology CB approved syllabus for this unit:
Enduring Understandings (EU)/Essential Knowledge (EK)

EU 1.A: Change in the genetic makeup of a population over time is evolution.
EK 1.A.1: Natural selection is a major mechanism of evolution.
EK 1.A.3: Evolutionary change is also driven by random processes.
EK 1.A.4: Biological evolution is supported by scientific evidence from many disciplines, including mathematics.

EU 1.B: Organisms are linked by lines of descent from common ancestry.
EK 1.B.1: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today.

EU 1.C: Life continues to evolve within a changing environment.
EK 1.C.1: Speciation and extinction have occurred throughout the Earth's history.
EK 1.C.3: Populations of organisms continue to evolve.

EU 2.C: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis.

EK 2.C.1: Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes.

EU 2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment.

EK 2.D.1: All biological systems from cells and organisms to populations, communities and ecosystems are affected by complex biotic and abiotic interactions involving exchange of matter and free energy.

EU 2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination.

EK 2.E.1: Timing and coordination of specific events are necessary for the normal development of an organism, and these events are regulated by a variety of mechanisms.

EU 3.A: Heritable information provides for continuity of life.

EK 3.A.1: DNA, and in some cases RNA, is the primary source of heritable information.

EK 3.A.2: In eukaryotes, heritable information is passed to the next generation via processes that include the cell cycle and mitosis or meiosis plus fertilization.

EK 3.A.3: The chromosomal basis of inheritance provides an understanding of the pattern of passage (transmission) of genes from parent to offspring.

EK 3.A.4: The inheritance pattern of many traits cannot be explained by simple Mendelian genetics.

EU 3.B: Expression of genetic information involves cellular and molecular mechanisms.

EK 3.B.1: Gene regulation results in differential gene expression, leading to cell specialization.

EK 3.B.2: A variety of intercellular and intracellular signal transmissions mediate gene expression.

EU 3.C: The processing of genetic information is imperfect and is a source of genetic variation.

EK 3.C.1: Changes in genotype can result in changes in phenotype.

EK 3.C.2: Biological systems have multiple processes that increase genetic variation.

EK 3.C.3: Viral replication results in genetic variation and viral infection can introduce genetic variation into the hosts.

EU 4.A: Interactions within biological systems lead to complex properties.

EK 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule.
EK 4.A.2: The structure and function of subcellular components, and their interactions, provide essential cellular processes.
EK 4.A.3: Interactions between external stimuli and regulated gene expression result in specialization of cells, tissues and organs.
EK 4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts.

EU 4.B: Competition and cooperation are important aspects of biological systems.
EK 4.B.1: Interactions between molecules affect their structure and function.
EK 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.

EU 4.C: Naturally occurring diversity among and between components within biological systems affects interactions with the environment.
EK 4.C.1: Variation in molecular units provides cells with a wider range of functions.
EK 4.C.2: Environmental factors influence the expression of the genotype in an organism.

Unit #6	**Unit Name:** *Organismal Biology*	**Unit Length:** ~6 weeks

Much of the language of the "Student Learning Objectives" is taken verbatim from either the NGSS site or the College Board *AP Biology Course and Exam Description*. Other Student Learning Objectives are taken verbatim from New Jersey model curriculum.

ESSENTIAL QUESTIONS:
How are all organisms similar? Different?
What is a living being?

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
1	Compare and contrast various homeostatic mechanisms across various species.	HS-LS1-2, HS-LS1-3, HS-LS1-4 [CB: EU1.B, EU2.C-E, EU3.D]
2	Develop awareness of environmental constraints on physiological adaptations.	HS-LS1-2, HS-LS1-4 [CB: EU.A, C-D; EU4.B]

3	Observe patterns of evolutionarily conserved biochemical and homeostatic pathways across multiple species.	HS-LS1-3 [CB: EU1.B, EU2.C-E, EU3.D]
4	Explore comparative approaches to common problems among organisms: ● Transport ● Immunity ● Gas exchange ● Sensing environment ● Osmoregulation	HS-LS1-2, HS-LS1-4 [CB: EU1.B-D; EU2.A, C-D; EU4.A-C]

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models 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 components of a system. **Planning and Carrying Out Investigations** Planning and carrying out in 9-12 builds on K-8 experiences and progresses to include investigations that provide	**LS1.A: Structure and Function** ● Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1) ● 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	**Systems and System Models** ● Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions— including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-2), (HS-LS1-4) Energy and Matter ● Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-LS1-5), (HS-LS1-6) ● Energy cannot be created or destroyed—it only moves between one place and another place,

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** 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	(through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3) LS1.B: Growth and Development of Organisms ● In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. (HS-LS1-4) LS1.C: Organization for Matter and Energy Flow in Organisms ● 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	between objects and/or fields, or between systems. (HS-LS1-7) **Structure and Function** ● Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-LS1-1) Stability and Change ● Feedback (negative or positive) can stabilize or destabilize a system. (HSLS1-3)

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) ● 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)	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)	

Connections to other DCIs in this grade-band: **HS.PS1.B** (HS-LS1-5),(HS-LS1-6),(HS-LS1-7); **HS.PS2.B** (HS-LS1-7); **HS.LS3.A** (HS-LS1-1); **HS.PS3.B** (HS-LS1-5),(HS-LS1-7)

Articulation of DCIs across grade-bands: **MS.PS1.A** (HS-LS1-6); **MS.PS1.B** (HS-LS1-5),(HS-LS1-6),(HS-LS1-7); **MS.PS3.D** (HS-LS1-5),(HS-LS1-6),(HS-LS1-7); **MS.LS1.A** (HSLS1-1),(HS-LS1-2),(HS-LS1-3),(HS-LS1-4); **MS.LS1.B** (HS-LS1-4); **MS.LS1.C** (HS-LS1-5),(HS-LS1-6),(HS-LS1-7); **MS.LS2.B** (HS-LS1-5),(HS-LS1-7); **MS.ESS2.E** (HS-LS1-6); **MS.LS3.A** (HS-LS1-1),(HS-LS1-4); **MS.LS3.B** (HS-LS1-1)

Common Core State Standards Connections:
ELA/Literacy –

RST.11-12 .1.	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. *(HS-LS3-1),(HS-LS3-2)*
RH.9-10.1 .	Accurately cite strong and thorough textual evidence, to support analysis of primary and secondary sources, attending to such features as the date and origin of the information. (HS-LS1-1),(HS-LS1-6)
RST.11-12.9	Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. *(HS-LS3-1)*
WHST.6-8 .1.	Write arguments focused on *discipline-specific content.* (HS-LS3-2)
SL.9-10.5	Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance findings, reasoning, and evidence and to add interest. *(HS-LS1-4)*
W.9-10.1.	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

Mathematics -

MP.2	Reason abstractly and quantitatively. (HS-LS3-2),(HS-LS3-3)

Technology & Career Standards:
8.1 Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
Career Ready Practices: 1-12

Unit Plan		
Content Vocabulary	**Academic Vocabulary**	**Recommended Resources**
cell, tissue, organ, organ system, organism, plant, root, shoot, leaf, node/internode, stem, axillary bud, apical dominance, leaf, blade, petiole, veins, dermal tissue, epidermis, cuticle, periderm, phloem, xylem, stele, ground tissue, pith, cortex, parenchyma, collenchymas, sclerenchyma, sieve-tube element, tracheid, companion cell, meristem, vascular cambium, cork, root cap, endodermis, pericycle, stomata, guard cell mesophyll, morphogenesis, growth, development, differentiation, pattern formation, solute potential pressure potential, protoplast, turgor pressure, aquaporin, bulk flow, flaccid/turgid, plasmolysis, transpiration, guttation, cohesion-tension hypothesis, circadian rhythm, angiosperm, fertilization, anther, style, pistil, ovary, pollen grain, pollen tube, megaspore, fruit, anatomy, physiology, epithelial, muscle, connective, adipose, skeletal, hormone, feedback, acclimatization, countercurrent exchange, metabolic rate, nutrition, vitamin, mineral, absorption, elimination, digestion, circulatory system, heart, blood, breathing, respiration, ventilation, CO_2, O_2, immune system, antibody, antigen, inflammation, fever, osmoregulation, excretion, endocrine, hormone, nervous system, neuron, neurotransmitter, reproductive system. [Please note: AP Biology focuses on immune, endocrine, and nervous systems], behavior, fixed action pattern, migration, communication, pheromone, innate behavior cognition altruism, inclusion fitness	relate, sequence, functional, diagram, compare and contrast, describe, define, assume, locate, complementary, construct, specify, interpret, decipher, depict, explain, decide, claim, evidence, reason, decipher, elucidate, explicate, annotate, reason, delineate, specific, precise, accurate, itemize, assumption, salient, juxtapose, unilateral, bilateral, consolidate, infer, deduce, conclusion, calibrate, inverse, conversely	• Text • Classroom models • AP Biology Review, Holtclaw and Holtzclaw • Online ancillaries provided via OpenStax • Mastering Biology • Bozeman Science AP Biology • David Knuffke AP Biology Prezis In addition, various resources will be provided by class website on a week to week basis depending on the needs and abilities of the students.

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
	Weird organisms show and tell: Students are shown wide variety of organisms from several kingdoms and asked to speculate on functions	SLO 1, SLO 3 SLO 4 **Engineering practice(s):** • Asking Questions (for science) and Defining Problems (for engineering)

	of specific part, organisms' habitats and niches, etc.	● Constructing Explanations (for science) and Designing Solutions (for engineering) ● Engaging in Argument from Evidence
EXPLORE/EXPLAIN	**Examples of Exploring/Explaining Activities:**	
	POGIL activities based on various organ systems: Process Oriented Guided Inquiry Learning is a system developed to get student to look at new information critically. Students typically work in small groups with assigned roles.	SLO 2, SLO 3 SLO 4 **Engineering practice(s):** ● Developing and Using Models ● Analyzing and Interpreting Data ● Using Mathematics and Computational Thinking ● Constructing Explanations (for science) and Designing Solutions (for engineering) ● Engaging in Argument from Evidence ● Obtaining, Evaluating, and Communicating Information
ELABORATE	**Examples of Elaborating Activities:**	
	Dissections: student dissect various species of organisms with attention to the functional and spatial relationships between the organs	SLO 4 **Engineering practice(s):** ● Asking Questions (for science) and Defining Problems (for engineering) ● Planning and Carrying out Investigations ● Constructing Explanations (for science) and Designing Solutions (for engineering) ● Engaging in Argument from Evidence ● Obtaining, Evaluating, and Communicating Information
EVALUATE	**Examples of Evaluating Activities:**	
	College Board style monthly evaluations: Students will take monthly, cumulative exams following the style of the Advanced Placement Biology Examination (including questions released by the College Board specifically for	SLOs: all **Engineering practice(s)** ● Developing and using models ● Planning ~~and carrying out~~ investigations ● Analyzing and interpreting data

	this purpose) that include both multiple choice and FRQs (“free response questions”); these exams emphasize science practices.	● Using mathematics and computational thinking ● Engaging in argument from evidence

College Board correlations as presented in current AP Biology CB approved syllabus for this unit:
Enduring Understandings (EU)/Essential Knowledge (EK)

EU 1.B: Organisms are linked by lines of descent from common ancestry.
EK 1.B.1: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today.

EU 1.C: Life continues to evolve within a changing environment.
EK 1.C.3: Populations of organisms continue to evolve.

EU 1.D: The origin of living systems is explained by natural processes.
EK 1.D.2: Scientific evidence from many different disciplines supports models of the origin of life.

EU 2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter.
EK 2.A.1: All living systems require constant input of free energy.
EK 2.A.2: Organisms capture and store free energy for use in biological processes.
EK 2.A.3: Organisms must exchange matter with the environment to grow, reproduce and maintain organization.

EU 2.C: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis.
EK 2.C.1: Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes.
EK 2.C.2: Organisms respond to changes in their external environments.

EU 2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system’s environment.
EK 2.D.1: All biological systems from cells and organisms to populations, communities and ecosystems are affected by complex biotic and abiotic interactions involving exchange of matter and free energy.
EK 2.D.2: Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments.
EK 2.D.3: Biological systems are affected by disruptions to their dynamic homeostasis.

EK 2.D.4: Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis.

EU 2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination.

EK 2.E.2: Timing and coordination of physiological events are regulated by multiple mechanisms.

EU 3.B: Expression of genetic information involves cellular and molecular mechanisms.

EK 3.B.2: A variety of intercellular and intracellular signal transmissions mediate gene expression.

EU 3.C: The processing of genetic information is imperfect and is a source of genetic variation.

EK 3.C.2: Biological systems have multiple processes that increase genetic variation.

EU 3.D: Cells communicate by generating, transmitting and receiving chemical signals.

EK 3.D.1: Cell communication processes share common features that reflect a shared evolutionary history.

EK 3.D.2: Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling.

EK 3.D.3: Signal transduction pathways link signal reception with cellular response.

EK 3.D.4: Changes in signal transduction pathways can alter cellular response.

EU 3.E: Transmission of information results in changes within and between biological systems.

EK 3.E.1: Individuals can act on information and communicate it to others.

EK 3.E.2: Animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce responses.

EU 4.A: Interactions within biological systems lead to complex properties.

EK 4.A.3: Interactions between external stimuli and regulated gene expression result in specialization of cells, tissues and organs.

EK 4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts.

EU 4.B: Competition and cooperation are important aspects of biological systems.

EK 4.B.1: Interactions between molecules affect their structure and function.

EK 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.

EU 4.C: Naturally occurring diversity among and between components within biological systems affects interactions with the environment. EK 4.C.1: Variation in molecular units provides cells with a wider range of functions.

Unit #7	Unit Name: *Ecology*	Unit Length: ~3 weeks

Much of the language of the "Student Learning Objectives" is taken verbatim from either the NGSS site or the College Board *AP Biology Course and Exam Description*. Other Student Learning Objectives are taken verbatim from New Jersey model curriculum.

ESSENTIAL QUESTIONS:
What is our place in the living universe?
Are we in danger of extinction?

#	STUDENT LEARNING OBJECTIVES (SLO)	Corresponding DCIs and PEs
1	Illustrate how interactions among living systems and with their environment result in the movement of matter and energy.	LS2.A [College Board: EU2.A, C-D; EU3.E, EU4.A-C]
2	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 [CB: EU2.A, c-D; EU4.A-C]
3	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.	HS-LS2-1 [CB: EU2.A, C-D; EU4.B]
4	Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.	HS-LS2-1 [CB: EU2.A, C-D; EU4.B]
5	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-LS2-6 [CB: EU2.A, C-D; EU4.B]

<table>
<tr><td colspan="3">The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:</td></tr>
<tr><td>Science and Engineering Practices</td><td>Disciplinary Core Ideas</td><td>Crosscutting Concepts</td></tr>
<tr><td>Using Mathematics and Computational Thinking
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)
Engaging in Argument from Evidence

Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-6)</td><td>LS2.A: Interdependent Relationships in Ecosystems
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

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</td><td>Scale, Proportion, and Quantity
The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-LS2-1)
Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (HS-LS2-2)
Stability and Change

Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6)</td></tr>
</table>

	terms of resources and habitat availability. (HS-LS2-2),(HS-LS2-6)	
Connections to other DCIs in this grade-band: HS.ESS2.D (HS-LS2-7),(HS-LS4-6); **HS.ESS2.E** (HS-LS2-2),(HS-LS2-6),(HS-LS2-7),(HS-LS4-6); **HS.ESS3.A** (HS-LS2-2),(HS-LS2-7), (HS-LS4-6); **HS.ESS3.C** (HS-LS2-2),(HS-LS2-7),(HS-LS4-6); **HS.ESS3.D** (HS-LS2-2),(HS-LS4-6)		
Articulation of DCIs across grade-bands: MS.LS1.B (HS-LS2-8); **MS.LS2.A** (HS-LS2-1),(HS-LS2-2),(HS-LS2-6); **MS.LS2.C** (HS-LS2-1),(HS-LS2-2),(HS-LS2-6),(HS-LS2-7),(HS-LS4-6); **MS.ESS2.E** (HS-LS2-6); **MS.ESS3.A** (HS-LS2-1); **MS.ESS3.C** (HS-LS2-1),(HS-LS2-2),(HS-LS2-6),(HS-LS2-7),(HS-LS4-6); **MS.ESS3.D** (HS-LS2-7)		

Common Core State Standards Connections:

ELA/Literacy -

RST.9-10.8 Determine if the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. (HS-LS2-6),*(HS-LS2-7),(HS-LS2-8)*

RST.9-10.1. Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. *(HS-LS2-1),(HS-LS2-2),*(HS-LS2-3),(HS-LS2-6),(HS-LS2-8)

RH.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, qualitatively, as well as in words) in order to address a question or solve a problem. *(HS-LS2-6),(HS-LS2-7),(HS-LS2-8)*

RH.11-12.8. Evaluate an author's claims, reasoning, and evidence by corroborating or challenging them with other sources. (HS-LS2-6),(HS-LS2-7),(HS-LS2-8)

WHST.9-10 .2 WHST.9-10.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. *(HS-LS2-1),(HS-LS2-2)*,(HS-LS2-3)

W.9-10.2 Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content. *(HS-LS2-1),(HS-LS2-2)*,(HS-LS2-3)

W.9-10.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, trying a new approach, or consulting a style manual (such as MLA or APA Style), focusing on addressing what is most significant for a specific purpose and audience. (Editing for conventions should demonstrate command of Language standards 1–3 up to and including grades 9–10) (HS-LS2-3)

NJSLSA.W.7. Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation. (HS-LS2-7)

Mathematics -

MP.2 Reason abstractly and quantitatively. (HS-LS2-1),(HS-LS2-2),(HS-LS2-4),(HS-LS2-6),*(HS-LS2-7)*

MP.4 Model with mathematics. *(HS-LS2-1),(HS-LS2-2),(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-LS2-1),(HS-LS2-2),(HS-LS2-4),*(HS-LS2-7)*

HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. *(HS-LS2-1),(HS-LS2-2),(HS-LS2-4),(HS-LS2-7)*

HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-LS2-1),(HS-LS2-2),(HS-LS2-4),*(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)

S.ID.B.6a

S.ID.B.6b	Fit a function to the data (including with the use of technology); use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models. *(HS-LS1-4)* Informally assess the fit of a function by plotting and analyzing residuals, including with the use of technology. *(HS-LS1-4)*
Technology & Career Standards: **8.1 Educational Technology:** All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge. **Career Ready Practices:** 1-12	

Unit Plan		
Content Vocabulary	**Academic Vocabulary**	**Recommended Resources**
Ecology, organism, population, community, ecosystem, biome, climate, abiotic, aquatic, pelagic, dispersal limit, benthic, littoral, aphotic, limnetic, temperate, tropical, desert, tundra, savanna, eutrophic, oligotrophic, sediment, latitude, density, demographic, life table, cohort, survivorship curve, immigration, emigration, per capita, exponential, logarithmic, carrying capacity, logistic model, semelparity, iteroparity, K lection, r selection, ecological footprint, carrying capacity, interspecific competition, niche, competitive exclusion, resource partitioning , predation, parasitism, character displacement, aposematic coloration, cryptic coloration, symbiosis, commensalism, host, mutualism, diversity, keystone species, succession, evapotranspiration, pathogen, primary producer,	relate, sequence, functional, diagram, compare and contrast, describe, define, assume, locate, complementary, construct, specify, interpret, decipher, depict, explain, decide, claim, evidence, reason, decipher, elucidate, explicate, annotate, reason, delineate, specific, precise, accurate, itemize, assumption, salient, juxtapose, unilateral, bilateral, consolidate, infer, deduce, conclusion, calibrate, inverse, conversely	● Text ● Classroom models ● AP Biology Review, Holtclaw and Holtzclaw ● Online ancillaries provided via OpenStax ● Mastering Biology ● Bozeman Science AP Biology ● David Knuffke AP Biology Prezis In addition, various resources will be provided by class

consumer, detritivore, gross primary production, limiting nutrient, biogeochemical cycles, restoration ecology		website on a week to week basis depending on the needs and abilities of the students.

THE 5 "E"s	Examples of Learning Activities for the specified "E"	SLO's and Engineering Practices
ENGAGE	**Examples of Engaging Activities:**	
	ACTIVITY: Photographing local organisms—typically a summer project, students photograph and ID organisms from at least 4 Kingdoms and 2 domains. Activity helps make students aware of what lives right in their own backyards.	SLO 1, SLO 3 **Engineering practice(s):** ● Obtaining, Evaluating, and Communicating Information
EXPLORE/ EXPLAIN	**Examples of Exploring/Explaining Activities:**	
	LAB: Transpiration: Students set plant up in photometers and subject plants to various environmental pressures and record transpiration rates.	SLO 1, SLO 2, SLO 3, SLO 4, SLO 5 **Engineering practice(s):** ● Asking Questions (for science) and Defining Problems (for engineering) ● Developing and Using Models ● Planning and Carrying out Investigations ● Analyzing and Interpreting Data ● Using Mathematics and Computational Thinking ● Constructing Explanations (for science) and Designing Solutions (for engineering) ● Engaging in Argument from Evidence ● Obtaining, Evaluating, and Communicating Information
ELABORATE	**Examples of Elaborating Activities:**	
	End of year projects: Our town project: students attempt to estimate how much life sustaining matter enters town, how much leaves. (Ours is a city of ~50K people, and lots of pets!)	SLO 1, SLO 2, SLO 3, SLO 4, SLO 5 **Engineering practice(s):** ● Asking Questions (for science) and Defining Problems (for engineering)

		- Developing and Using Models - Planning and Carrying out Investigations - Analyzing and Interpreting Data - Using Mathematics and Computational Thinking - Constructing Explanations (for science) and Designing Solutions (for engineering) - Engaging in Argument from Evidence - Obtaining, Evaluating, and Communicating Information
EVALUATE	**Examples of Evaluating Activities:**	
	College Board style monthly evaluations: Students will take monthly, cumulative exams following the style of the Advanced Placement Biology Examination (including questions released by the College Board specifically for this purpose) that include both multiple choice and FRQs ("free response questions"); these exams emphasize science practices.	SLOs: all **Engineering practice(s)** - Developing and using models - Planning investigations - Analyzing and interpreting data - Using mathematics and computational thinking - Engaging in argument from evidence

College Board correlations as presented in current AP Biology CB approved syllabus for this unit:
Enduring Understandings (EU)/Essential Knowledge (EK)

EU 1.C: Life continues to evolve within a changing environment.

EK 1.C.1: Speciation and extinction have occurred throughout the Earth's history.
EK 1.C.3: Populations of organisms continue to evolve.

EU 2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter.

EK 2.A.1: All living systems require constant input of free energy.
EK 2.A.2: Organisms capture and store free energy for use in biological processes.
EK 2.A.3: Organisms must exchange matter with the environment to grow, reproduce and maintain organization.

EU 2.C: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis.

EK 2.C.1: Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes.

EK 2.C.2: Organisms respond to changes in their external environments.

EU 2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment.

EK 2.D.1: All biological systems from cells and organisms to populations, communities and ecosystems are affected by complex biotic and abiotic interactions involving exchange of matter and free energy.

EK 2.D.3: Biological systems are affected by disruptions to their dynamic homeostasis.

EK 2.D.4: Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis.

EU 2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination.

EK 2.E.3: Timing and coordination of behavior are regulated by various mechanisms and are important in natural selection.

EU 3.E: Transmission of information results in changes within and between biological systems.

EK 3.E.1: Individuals can act on information and communicate it to others.

EU 4.A: Interactions within biological systems lead to complex properties.

EK 4.A.5: Communities are composed of populations of organisms that interact in complex ways.

EK 4.A.6: Interactions among living systems and with their environment result in the movement of matter and energy.

EU 4.B: Competition and cooperation are important aspects of biological systems.

EK 4.B.3: Interactions between and within populations influence patterns of species distribution and abundance.

EK 4.B.4: Distribution of local and global ecosystems changes over time.

EU 4.C: Naturally occurring diversity among and between components within biological systems affects interactions with the environment.

EK 4.C.3: The level of variation in a population affects population dynamics.

EK 4.C.4: The diversity of species within an ecosystem may influence the stability of the ecosystem.