Davison Community Schools
ADVISORY CURRICULUM COUNCIL
Phase II, *April 1st 2014*

AP Biology

Course Essential Questions (from Phase I report):

AP Biology Big Ideas

Big Idea 1 – The process of evolution drives the diversity and unity of life.

How does the process of evolution drive the diversity and unity of life?

Big Idea 2 – Biological systems utilize free energy and molecular building blocks to grow, reproduce, and to maintain dynamic homeostasis.

How do biological systems utilize free energy and molecular building blocks to grow, reproduce, and to maintain dynamic homeostasis?

Big Idea 3 – Living systems store, retrieve, transmit, and respond to information essential to life processes.

How do living systems store, retrieve, transmit, and respond to information essential to life processes?

Big Idea 4 – Biological systems interact, these systems and their interactions possess complex properties.

How do biological systems interact, these systems and their interactions possess complex properties?

Phase II Curriculum

Unit 1: Chemistry of Life & Cells

Essential Questions:	**Essential Understanding:**
▼ What types of molecules do organisms use for building blocks and excrete as wastes? ▼ How do structures of biologically important molecules (carbohydrates, lipids, proteins, and nucleic acids) account for their functions? ▼ How does cell structure and function help to maintain dynamic homeostasis in living organisms?	∇ Organisms use sugars, fatty acids, amino acids and nucleotides for building blocks and waste. ∇ Macromolecules create three dimensional shapes that allow for the molecule to perform specific jobs with in the cells based on their biochemistry. ∇ The high surface area to volume ratio, small size, and compartmentalization allows for efficient utilization cellular resources.

Curriculum Standards- DOK noted where applicable with Standards

AP Biology College Board Curriculum & Science Practices 1.0-7.0

- ∇ 2.B.1. Cell membranes are selectively permeable due to their structure.
- ∇ 2.B.2. Growth and homeostasis is maintained by the constant movement of molecules across membranes.
- ∇ 2.B.3. Eukaryotic cells maintain internal membranes that partition the cell into specialized regions.
- ∇ 4.A.1. The subcomponents of a biological polymer and their sequence determine the properties of that polymer.
- ∇ 4.A.2. Interactions of subcellular structures, including a repertory of eukaryotic organelles possessing specialized functions, provide essential cellular functions and activities.

LEARNING TARGETS	
Knowledge/Content **I Know** …	**Skills/Processes** **I Can** …
I know growth, reproduction, and homeostasis require that cells create and maintain internal environments that are different from their external environments. I know interactions within biological systems lead to complex properties. I know what type of molecules make up cells. I know the cell structures found in typical prokaryotic and eukaryotic cells. I know the jobs/function of common cell structures.	I can investigate and quantify factors that affect enzyme action. I can use representations and models to pose scientific questions about the properties of cell membranes and selective permeability based on molecular structure. I can construct models that connect the movement of molecules across membranes with membrane structure and function. I can calculate surface area-to-volume ratios to predict which cell(s) might eliminate wastes or procure nutrients faster by diffusion. I can explain the connection between the sequence and the subcomponents of a biological polymer and its properties. I can refine representations and models to explain how the subcomponents of a biological polymer and their sequence determine the properties of that polymer. I can use models to predict and justify that changes in the subcomponents of a biological polymer affect the functionality of the molecule.
Phase III Textbook/Materials	
Phase IV Summative Assessment Evidence	
Common Summative Unit Assessments:	**Agreed Upon Interim Summative Assessments:** (*identifies Performance Task)
Phase V Learning Plan	

Phase II Curriculum

Unit 2: Cellular Processes

Essential Questions:	**Essential Understanding:**
▼ Why do growth, reproduction, and maintenance of the organization of living systems require free energy and matter? ▼ What mechanisms and structural features of cells allow organisms to capture, store, and use free energy? ▼ How do cells communicate?	∇ Organisms use energy and matter to grow and maintain homeostasis. ∇ Light energy from the sun is converted to stored energy through photosynthesis then; stored energy is used to make ATP energy for cellular activities through respiration. ∇ Cells communicate through direct contact or chemical signaling.

Curriculum Standards- DOK noted where applicable with Standards

AP Biology College Board Curriculum & Science Practices 1.0-7.0

- ∇ 2.A.1. All living systems require constant input of energy.
- ∇ 2.A.2. Organisms capture, use, and store energy in biological processes such as growth, reproduction and maintaining homeostatic processes.
- ∇ 2.A.3. Organisms must exchange matter with the environment to grow, reproduce, and maintain organization.
- ∇ 2.A.4. Programmed cell death (apoptosis) plays a role in development and differentiation, allows molecules to be reused, and helps maintain homeostasis within a biological system.
- ∇ 2.C.1. Positive feedback mechanisms amplify responses and processes in biological organisms.
- ∇ 2.C.2. Organisms use negative feedback mechanisms to maintain their internal environments and respond to external environmental changes.
- ∇ 2.C.3. Organisms constantly respond to changes in their external environments.
- ∇ 3.D.1 Cell communication involves processes resulting from evolution that are shared common features.
- ∇ 3.D.2. Cells communicate with each other through direct contact with other cells or from a distance *via* chemical signaling.
- ∇ 3.D.3. Signal transduction pathways link signal reception with cellular response.
- ∇ 3.D.4. Errors in normal signal transduction may alter cellular response.
- ∇ 4.B.1. Interactions between molecules affect their structure and function.

LEARNING TARGETS

Knowledge/Content **I Know** …	**Skills/Processes** **I Can** …
I know growth, reproduction, and maintaining organization of living systems require energy and matter. I know growth and homeostasis of a biological system are influenced by changes in the system's environment. I know cells communicate by generating, transmitting, and receiving chemical signals. I know competition and cooperation are important aspects of biological systems.	I can investigate photosynthetic rate under a variety of conditions. I can investigate some aspect of cellular respiration in organisms. I can investigate diffusion and osmosis in model systems and in plant tissue. I can compare mitotic rate after exposure to lectin or other substances presumed to affect mitotic rate. I can justify a scientific claim that free energy is required for living systems to maintain organization,

	to grow or to reproduce, but that multiple strategies exist in different living systems. I can use representations to pose scientific questions about what mechanisms and structural features allow organisms to capture, store and use free energy. I can represent graphically or model quantitatively the exchange of molecules between an organism and its environment, and the subsequent use of these molecules to build new molecules that facilitate dynamic homeostasis, growth and reproduction. I can analyze data to identify how molecular interactions affect structure and function. I can evaluate scientific questions concerning organisms that exhibit complex properties due to the interaction of their constituent parts. I can make a prediction about the interactions of subcellular organelles. I can construct explanations based on scientific evidence as to how interactions of subcellular structures provide essential functions. I can use representations and models to analyze situations qualitatively to describe how interactions of subcellular structures, which possess specialized functions, provide essential functions. The student is able to construct an explanation of how certain drugs affect signal reception and, consequently, signal transduction pathways. I can construct explanations of cell communication through cell-to-cell direct contact or through chemical signaling. I can create representation(s) that depict how cell-to cell communication occurs by direct contact or from a distance through chemical signaling. I can describe a model that expresses the key elements of signal transduction pathways by which a signal is converted to a cellular response. I can justify claims based on scientific evidence that changes in signal transduction pathways can alter cellular response. I can describe a model that expresses key elements to show how change in signal transduction can alter cellular response. I can use representation(s) and appropriate models to

	describe features of a cell signaling pathway. I can represent the connection between meiosis and increased genetic diversity necessary for evolution. I can evaluate evidence provided by data sets to support the claim that heritable information is passed from one generation to another generation through mitosis, or meiosis followed by fertilization. I can predictions about natural phenomena occurring during the cell cycle. I can describe the events that occur in the cell cycle. I can describe the role of programmed cell death in development and differentiation, the reuse of molecules, and the maintenance of dynamic homeostasis. I can use representations or models to analyze quantitatively and qualitatively the effects of disruptions to dynamic homeostasis in biological systems.
Phase III Textbook/Materials	
Phase IV Summative Assessment Evidence	
Common Summative Unit Assessments:	**Agreed Upon Interim Summative Assessments:** (*identifies Performance Task)
Phase V Learning Plan	

Phase II Curriculum

Unit 3: Genetics (Heredity)

Essential Questions:	**Essential Understanding:**
▼ How is heritable information passed to the next generation via processes that include the cell cycle and mitosis and meiosis plus fertilization? ▼ How does the chromosomal basis of inheritance provide an understanding of the pattern passage (transmission) of genes from parent to offspring? ▼ What is the primary source of heritable information, and how are cellular and molecular mechanisms involved in the expression of this heritable information? ▼ How can genetic engineering techniques manipulate the heritable information of DNA?	∇ Heritable information stored in DNA is passed to new cells during mitosis and meiosis. ∇ Genes are segments of DNA that are passed from parent to offspring when chromosomes are copied and separated into new cells. ∇ Genes contain the inheritable information that control cellular activities, build structures, and make molecules through protein synthesis. ∇ Cloning, transformation, and recombinant DNA are processes that can change the DNA of a cell or organism.

Curriculum Standards- DOK noted where applicable with Standards

- ∇ 3.A.1 DNA, and in some cases RNA, is the primary source of heritable information.
- ∇ 3.A.2 In most eukaryotes, heritable information is passed to the next generation through mitosis or meiosis plus fertilization.
- ∇ 3.A.3 Mendelian genetics provides a basic understanding of the underlying causes of the pattern traits from parent to offspring.
- ∇ 3.A.4 The inheritance pattern of many traits cannot be explained by simple Mendelian genetics.
- ∇ 3.B.1 Cells can be activated, produce new products, and retain their activated state through gene regulation
- ∇ 3.B.2 A variety of intercellular and intracellular signal transmissions mediate gene expression.
- ∇ 3.C.1 Changes in genotype can result in changes in phenotype.
- ∇ 3.C.2 Biological systems possess multiple mechanisms that increase genetic variation.
- ∇ 3.D.1 Cell communication involves processes resulting from evolution that are shared common features.
- ∇ 4.A.3. Interactions between external stimuli and gene expression result in specialization of cells, tissues, and organs.
- ∇ 4.A.4. Organisms exhibit complex properties due to interactions between their constituent parts.
- ∇ 4.C.2. Environmental factors influence the expression of the genotype in an organism.

LEARNING TARGETS

Knowledge/Content **I Know** …	**Skills/Processes** **I Can** …
I know heritable information provides for continuity of life. I know expression of genetic information involves cellular and molecular mechanisms. I know transfer of genetic information may produce variation.	I can calculate the rate of crossing over during meiosis. I can investigate restriction enzyme analysis. I can transform bacteria. I can predict the effects of a change in an

I know interactions within biological systems lead to complex properties.	environmental factor on the genotypic expression of the phenotype. I can use evidence to justify a claim that a variety of phenotypic responses to a single environmental factor can result from different genotypes within the population. I can refine representations to illustrate how interactions between external stimuli and gene expression result in specialization of cells, tissues and organs. I can describe the connection between the regulation of gene expression and observed differences between individuals in a population. I can explain how the regulation of gene expression is essential for the processes and structures that support efficient cell function. I can use representations to describe how gene regulation influences cell products and function. I can explain how signal pathways mediate gene expression, including how this process can affect protein production. I can use representations to describe mechanisms of the regulation of gene expression. I can predict how a change in genotype, when expressed as a phenotype, provides a variation that can be subject to natural selection. I can create a visual representation to illustrate how changes in a DNA nucleotide sequence can result in a change in the polypeptide produced. I can explain the connection between genetic variations in organisms and phenotypic variations in populations. I can compare and contrast processes by which genetic variation is produced and maintained in organisms from multiple domains. I can construct an explanation of the multiple processes that increase variation within a population. I can apply mathematical routines to determine Mendelian patterns of inheritance provided by data sets. I can explain deviations from Mendel's model of the inheritance of traits.

	I can explain how the inheritance patterns of many traits cannot be accounted for by Mendelian genetics. I can describe representations of an appropriate example of inheritance patterns that cannot be explained by Mendel's model of the inheritance of traits. I can describe the connection between the regulation of gene expression and observed differences between different kinds of organisms. I can construct a representation that connects the process of meiosis to the passage of traits from parent to offspring. I can pose questions about ethical, social or medical issues surrounding human genetic disorders. I can construct an explanation, using visual representations or narratives, as to how DNA in chromosomes is transmitted to the next generation via mitosis, or meiosis followed by fertilization. I can construct scientific explanations that use the structures and mechanisms of DNA and RNA to support the claim that DNA and, in some cases, that RNA are the primary sources of heritable information. I can justify the selection of data from historical investigations that support the claim that DNA is the source of heritable information. I can describe representations and models that illustrate how genetic information is copied for transmission between generations. I can describe representations and models illustrating how genetic information is translated into polypeptides. I can justify the claim that humans can manipulate heritable information by identifying at least two commonly used technologies.
Phase III Textbook/Materials	
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Phase II Curriculum

Unit 4: Evolution

Essential Questions:	**Essential Understanding:**
▼ How is natural selection a major mechanism of evolution? ▼ How is biological evolution supported by scientific evidence from many disciplines, including mathematics? ▼ How is the origin of life explained through evolution? ▼ How do phylogenetic trees graphically model evolutionary history?	∇ Natural selection shows that certain alleles are more beneficial for survival allowing those alleles to be passed to offspring, changing the allele frequency which shows evolution. ∇ The Hardy-Weinberg equation calculates allele frequency in a population, changes in the frequency result in biological evolution. ∇ Changes in DNA and environment promote evolution creating new species. ∇ Phylogenetic tress show derived traits which connect common ancestry among certain organisms.

Curriculum Standards- DOK noted where applicable with Standards

- ∇ 1.A.1 Natural selection is a major mechanism of evolution.
- ∇ 1.A.2 Natural selection acts on phenotypic variations in populations.
- ∇ 1.A.3 Evolutionary change is also driven by genetic drift and artificial selection.
- ∇ 1.A.4 Biological evolution is supported by evidence from many scientific disciplines.
- ∇ 1.B.1 Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today.
- ∇ 1.B.2 A phylogenetic tree and/or a cladogram is a graphical representation (model) of evolutionary history that can be tested.
- ∇ 1.B.3 Non-eukaryotes can transfer genetic information laterally through the mechanisms of transformation, transduction and conjugation; most eukaryotes do not transfer information laterally.
- ∇ 1.C.1 Speciation and extinction have occurred throughout the Earth's history.
- ∇ 1.C.2 Speciation may occur when two populations become reproductively isolated from each other
- ∇ 1.C.3 Populations of organisms continue to evolve.
- ∇ 1.D.1 There are causal models about the origin of life on Earth.
- ∇ 1.D.2 Evidence from many different scientific disciplines supports models of the origin of life.

LEARNING TARGETS

Knowledge/Content **I Know** …	**Skills/Processes** **I Can** …
I know **c**hange in the genetic makeup of a population over time is evolution. I know organisms are linked by lines of descent from common ancestry. I know life continues to evolve within a changing environment. I know the origin of living systems is explained by natural processes.	I can grow organisms, plants, and select for specific traits over several generations. I can investigate factors affecting Hardy-Weinberg Equilibrium. I can use NCBI to compare DNA and protein sequences for organisms to test student-generated hypotheses on their relatedness. I can use data from mathematical models based on the

	Hardy-Weinberg equilibrium to analyze genetic drift and effects of selection in the evolution of specific populations. I can convert a data set from a table of numbers that reflect a change in the genetic makeup of a population over time and to apply mathematical methods and conceptual understandings to investigate the cause(s) and effect(s) of this change. I can evaluate evidence provided by data to qualitatively and quantitatively investigate the role of natural selection in evolution. I can justify data from mathematical models based on the Hardy-Weinberg equilibrium to analyze genetic drift and the effects of selection in the evolution of specific populations. I can apply mathematical methods to data from a real or simulated population to predict what will happen to the population in the future. I can make predictions about the effects of genetic drift, migration and artificial selection on the genetic makeup of a population. I can evaluate data based evidence that describes evolutionary changes in the genetic makeup of a population over time. I can evaluate evidence provided by data from many scientific disciplines that support biological evolution. I can connect evolutionary changes in a population over time to a change in the environment. I can refine evidence based on data from many scientific disciplines that support biological evolution. I can design a plan to answer scientific questions regarding how organisms have changed over time using information from morphology, biochemistry and geology. I can justify the scientific claim that organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. I can connect scientific evidence from many scientific disciplines to support the modern concept of evolution. I can pose scientific questions about a group of organisms whose relatedness is described by a

	phylogenetic tree or cladogram in order to (**1**) identify shared characteristics, (**2**) make inferences about the evolutionary history of the group, and (**3**) identify character data that could extend or improve the phylogenetic tree. I can construct and/or justify mathematical models, diagrams or simulations that represent processes of biological evolution. I can evaluate evidence provided by a data set in conjunction with a phylogenetic tree or a simple cladogram to determine evolutionary history and speciation. I can pose scientific questions that correctly identify essential properties of shared, core life processes that provide insights into the history of life on Earth. I can create a phylogenetic tree or simple cladogram that correctly represents evolutionary history and speciation from a provided data set. I can analyze data related to questions of speciation and extinction throughout the Earth's history. I can design a plan for collecting data to investigate the scientific claim that speciation and extinction have occurred throughout the Earth's history. I can use theories and models to make scientific claims and/ or predictions about the effects of variation within populations on survival and fitness. I can use data from a real or simulated population(s), based on graphs or models of types of selection, to predict what will happen to the population in the future. I can evaluate given data sets that illustrate evolution as an ongoing process. I can describe a scientific hypothesis about the origin of life on Earth. I can justify the selection of data that address questions related to reproductive isolation and speciation. I can evaluate scientific questions based on hypotheses about the origin of life on Earth. I can describe speciation in an isolated population and connect it to change in gene frequency, change in environment, natural selection and/or genetic drift.

	I can describe the reasons for revisions of scientific hypotheses of the origin of life on Earth. I can describe a model that represents evolution within a population. I can evaluate scientific hypotheses about the origin of life on Earth. I can evaluate the accuracy and legitimacy of data to answer scientific questions about the origin of life on Earth. I can justify the selection of geological, physical, and chemical data that reveal early Earth conditions. I can to describe basic chemical processes for cell communication shared across evolutionary lines of descent. I can generate scientific questions involving cell communication as it relates to the process of evolution. I can analyze data to support the claim that responses to information and communication of information affect natural selection. I can construct explanations based on scientific evidence that homeostatic mechanisms reflect continuity due to common ancestry and/or divergence due to adaptation in different environments. I can analyze data to identify phylogenetic patterns or relationships, showing that homeostatic mechanisms reflect both continuity due to common ancestry and change due to evolution in different environments. I can connect differences in the environment with the evolution of homeostatic mechanisms.
Phase III Textbook/Materials	
Phase IV Summative Assessment Evidence	
Common Summative Unit Assessments:	**Agreed Upon Interim Summative Assessments:** (*identifies Performance Task)
Phase V Learning Plan	

Phase II Curriculum

Unit 5: Organism Form and Function (Taxonomy)

Essential Questions:	**Essential Understanding:**
▼ How do homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments? ▼ How do cell-to-cell signaling pathways regulate important complex responses in living systems? ▼ How are signaling pathways involved in the functioning of the nervous and immune systems? ▼ What important mechanisms are responsible for normal development of an organism?	∇ Similarities in DNA from common ancestry produce similar structures that carryout specific functions to maintain homeostasis in an environment. ∇ Signal transduction pathways use ligands and receptors are used to regulate internal mechanisms that are impacted by the environment. ∇ Receptor molecules and ligands regulate the nervous and immune systems. ∇ Presence and activation of specific genes control development of organisms.

Curriculum Standards- DOK noted where applicable with Standards

- ∇ 2.C.2. Organisms use negative feedback mechanisms to maintain their internal environments and respond to external environmental changes.
- ∇ 2.C.3. Organisms constantly respond to changes in their external environments.
- ∇ 2.D.3. Biological systems are affected by disruptions to their homeostasis.
- ∇ 2.D.4. Plants and animals have a variety of chemical defenses against infections that affect homeostasis.
- ∇ 2.E.1. Timing and coordination of several events are necessary for the normal development of an organism, and these events require regulation by multiple mechanisms.
- ∇ 2.E.2. Timing and coordination of physiological events are regulated by multiple mechanisms
- ∇ 2.E.3. Timing and coordination of behavior is regulated by several mechanisms.
- ∇ 3.C.3 Viruses reproduce and can introduce genetic variation into their hosts.
- ∇ 3.E.1. Organisms exchange information with each other in response to internal changes and external cues, which may change behavior.
- ∇ 3.E.2. Multi-cellular animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce responses.
- ∇ 3.E.3. Individuals can act on information and communicate it to others.

LEARNING TARGETS

Knowledge/Content **I Know** …	**Skills/Processes** **I Can** …
I know organisms use feedback mechanisms to regulate growth and maintain homeostasis. I know growth and homeostasis of a biological system are influenced by changes in the system's environment. I know many biological processes involved in growth, reproduction, and homeostasis include temporal aspects. I know transmission of non-heritable information	I can investigate the movement of water through plants in a model system. I can investigate animal behavior. I can describe specific examples of conserved core biological processes and features shared by all domains or within one domain of life, and how these shared, conserved core processes and features support the concept of common ancestry for all organisms. I can justify the selection of data regarding the types of molecules that an animal, plant or bacterium will take up as necessary building blocks and excrete as

results in changes within and between biological systems.	waste products. I can create a visual representation to describe how nervous systems transmit information. I can create a visual representation to describe how the vertebrate brain integrates information to produce a response. I can analyze data that indicate how organisms exchange information in response to internal changes and external cues, and which can change behavior. I can create a representation that describes how organisms exchange information in response to internal changes and external cues, and which can result in changes in behavior. I can describe how organisms exchange information in response to internal changes or environmental cues. I can construct and explanation, based on scientific theories and models, about how nervous systems detect external and internal signals, transmit and integrate information, and produce responses. I can describe how nervous systems detect external and internal signals. I can describe how nervous systems transmit information. I can describe how the vertebrate brain integrates information to produce a response. I can create a visual representation of complex nervous systems to describe/explain how these systems detect external and internal signals, transmit and integrate information, and produce responses. I can create a visual representation to describe how nervous systems detect external and internal signals. I can construct an explanation of how viruses introduce genetic variation in host organisms. I can use representations and appropriate models to describe how viral replication introduces genetic variation in the viral population. I can justify scientific claims, using evidence, to describe how timing and coordination of behavioral events in organisms are regulated by several mechanisms. I can connect concepts in and across domain(s) to

	predict how environmental factors affect responses to information and change behavior. I can create representations and models to describe immune responses. I can create representations or models to describe nonspecific immune defenses in plants and animals. I can connect concepts in and across domains to show that timing and coordination of specific events are necessary for normal development in an organism and that these events are regulated by multiple mechanisms. I can use a graph or diagram to analyze situations or solve problems (quantitatively or qualitatively) that involves timing and coordination of events necessary for normal development in an organism. I can justify scientific claims with scientific evidence to show that timing and coordination of several events are necessary for normal development in an organism and that these events are regulated by multiple mechanisms. I can design a plan for collecting data to support the scientific claim that the timing and coordination of physiological events involve regulation. I can justify scientific claims with evidence to show how timing and coordination of physiological events involve regulation. I can connect concepts that describe mechanisms that regulate the timing and coordination of physiological events. I can make predictions about how positive feedback mechanisms amplify activities and processes in organisms based on scientific theories and models. I can justify that positive feedback mechanisms amplify responses in organisms. I can justify the selection of the kind of data needed to answer scientific questions about the relevant mechanism that organisms use to respond to changes in their external environment.
Phase III Textbook/Materials	
Phase IV Summative Assessment Evidence	

Common Summative Unit Assessments:	**Agreed Upon Interim Summative Assessments:** (*identifies Performance Task)
Phase V Learning Plan	

Phase II Curriculum

Unit 6: Ecology

Essential Questions:	**Essential Understanding:**
▼ What results from the interactions of populations within a community? ▼ What factors govern energy capture, allocation, storage, and transfer between producers and consumers in a terrestrial ecosystem? ▼ What are the consequences of human actions on both local and global ecosystems?	∇ Transfer of energy and nutrients occurs through community interactions. ∇ Limiting factors in the environment control the transfer of energy and matter from producers to consumers in a land ecosystem. ∇ Reduction or overproduction of biotic and abiotic resources negatively impact ecosystems on all levels.

Curriculum Standards- DOK noted where applicable with Standards

- ∇ 2.C.2. Organisms use negative feedback mechanisms to maintain their internal environments and respond to external environmental changes.
- ∇ 2.C.3. Organisms constantly respond to changes in their external environments.
- ∇ 2.D.1. All biological systems from cells to populations, communities, and ecosystems are affected by complex biotic and abiotic interactions.
- ∇ 3.E.1. Organisms exchange information with each other in response to internal changes and external cues, which may change behavior.
- ∇ 3.E.3. Individuals can act on information and communicate it to others.
- ∇ 4.A.5. Communities are composed of populations of organisms that interact in complex ways.
- ∇ 4.A.6. Interactions among living systems and with their environment result in the movement of matter and energy.
- ∇ 4.B.2. Interactions between cells affect the fitness of the organism.
- ∇ 4.B.3. Cooperative interactions within organisms increase efficiency in the use of energy and matter.
- ∇ 4.B.4 Interactions between and within populations influence patterns of species distribution and abundance
- ∇ 4.B.5 Global distribution of ecosystems changes substantially over time.
- ∇ 4.C.3. The level of variation in a population affects population dynamics.
- ∇ 4.C.4. Diversity of species within an ecosystem may influence the stability of the ecosystem

LEARNING TARGETS

Knowledge/Content **I Know** …	**Skills/Processes** **I Can** …
I know growth and homeostasis of a biological system are influenced by changes in the system's environment. I know transmission of non-heritable information results in changes within and between biological systems. I know interactions within biological systems lead to complex properties. I know competition and cooperation are important aspects of biological systems.	I can develop and analyze model systems that describe energy flow. I can predict how changes in free energy availability affect organisms, populations and ecosystems. I can use data analysis to refine observations and measurements regarding the effect of population interactions on patterns of species distribution and abundance. I can explain how the distribution of ecosystems changes over time by identifying large-scale events

I know variation within biological systems affects interactions with the environment.	that have resulted in these changes in the past. I can predict consequences of human actions on both local and global ecosystems. I can construct explanations based on evidence of how variation in molecular units provides cells with a wider range of functions. I can construct explanations of the influence of environmental factors on the phenotype of an organism. I can make scientific claims and predictions about how species diversity within an ecosystem influences ecosystem stability. I can justify the selection of the kind of data needed to answer scientific questions about the interaction of populations within communities. I can apply mathematical routines to quantities that describe communities composed of populations of organisms that interact in complex ways. I can predict the effects of a change in the community's populations on the community. I can use representations and models to analyze how cooperative interactions within organisms promote efficiency in the use of energy and matter. I can apply mathematical routines to quantities that describe interactions among living systems and their environment, which result in the movement of matter and energy. I can use visual representations to analyze situations or solve problems qualitatively to illustrate how interactions among living systems and with their environment result in the movement of matter and energy. I can predict the effects of a change of matter or energy availability on communities. I can analyze data to identify possible patterns and relationships between a biotic or abiotic factor and a biological system (cells, organisms, populations, communities or ecosystems). I can refine scientific models and questions about the effect of complex biotic and abiotic interactions on all biological systems, from cells and organisms to populations, communities and ecosystems.

	I can design a plan for collecting data to show that all biological systems (cells, organisms, populations, communities and ecosystems) are affected by complex biotic and abiotic interactions.
Phase III Textbook/Materials	
Phase IV Summative Assessment Evidence	
Common Summative Unit Assessments:	**Agreed Upon Interim Summative Assessments:** (*identifies Performance Task)
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