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NORTHERN YORK COUNTY SCHOOL DISTRICT

Advanced Placement Biology

July 2014

I. Philosophy/Overview

AP Biology is designed to offer students a solid foundation in introductory college-level biology. By structuring the course around the four big ideas, enduring understandings and science practices, students will develop an appreciation for the study of life and help them identify and understand unifying principles within a diversified biological world. What we know today about biology is a result of inquiry. Science is a way of knowing. Therefore, the process of inquiry in science and developing critical thinking skills is the most important part of this course. At the end of the course, students will have an awareness of the integration of other sciences in the study of biology, understand how the species to which we belong is similar to, yet different from, other species, and be knowledgeable and responsible citizens in understanding biological issues that could potentially impact their lives.

II. Core Concepts

Four "big ideas" provide students with enduring understandings that students should retain from their learning experiences in the course. In addition to a deep and meaningful understanding of the four big ideas, students who complete an AP Biology course will develop their skills in scientific investigation and reasoning. Students will engage in scientific inquiry and develop their skills in relation to science practices identified in the AP Biology curriculum as those that are necessary to scientific investigation. Students will be engaged in laboratory investigations for at least 25% of the time they spend in class and will complete a minimum of 8 inquiry-based investigations (two per big idea). These investigations will be supplemented with various other activities.

A. The Big Ideas and Enduring Understandings

The course will present the four big ideas identified as unifying principles in the study of biology. Each big idea has "enduring understandings" which are the core concepts that you should retain and understand in order to develop a lasting understanding of the big ideas. In addition, each enduring understanding has supporting statements of "essential knowledge" that you must know to fully comprehend the enduring understanding. The big ideas and their supporting enduring understandings are listed below. Each unit references these enduring understandings. You will notice that enduring understandings and big ideas overlap and are covered in more than one unit – this is because the big ideas are all connected to each other and developing an understanding of one will help you understand others.

1. **Big Idea 1: The process of evolution drives the diversity and unity of life.**
   Enduring Understanding 1A: Change in the genetic makeup of a population over time is evolution.
   Enduring Understanding 1B: Organisms are linked by lines of descent from common ancestry.
   Enduring Understanding 1C: Life continues to evolve within a changing environment.
   Enduring Understanding 1D: The origin of living systems is explained by natural processes.

2. **Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis**.
   Enduring Understanding 2A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter.
   Enduring Understanding 2B: Growth, reproduction and dynamic homeostasis require that cells create and maintain internal environments that are different from their external environments.
   Enduring Understanding 2C: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis.
   Enduring Understanding 2D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment.
   Enduring Understanding 2E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination.

3. **Big Idea 3: Living systems store, retrieve, transmit and respond to information essential to life processes.**
   Enduring Understanding 3A: Heritable information provides for continuity of life.
   Enduring Understanding 3B: Expression of genetic information involves cellular and molecular mechanisms.
   Enduring Understanding 3C: The processing of genetic information is imperfect and is a source of genetic variation.
   Enduring Understanding 3D: Cells communicate by generating, transmitting and receiving chemical signals.
   Enduring Understanding 3E: Transmission of information results in changes within and between biological systems.

4. **Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties.**
   Enduring Understanding 4A: Interactions within biological systems lead to complex properties.
   Enduring Understanding 4B: Competition and cooperation are important aspects of biological systems.
   Enduring Understanding 4C: Naturally occurring diversity among and between components within biological systems affects interactions with the environment.

5. **The sequence of "Big Ideas" will be as follows:**

   Semester One: Big Ideas 2 and 3 will be covered

   Semester Two: Big Ideas 1 and 4 will be covered

B. Science Practices

1. In addition to developing your understanding of biology content, the goal of this course is also to help you develop the habits of mind that scientists use in their work. As such, the AP Biology course is also designed around seven science practices that will be developed through investigations and activities you participate in during class. Engaging in these practices will enable you to gather and analyze evidence and develop your own testable explanations for scientific problems. You will find evidence of activities that help you develop these practices in the schedule following this section. Activities and discussions that develop science practices will be followed by "SP 1, 2, 3, etc" depending on which practice is being targeted during that activity.

   A. **Science Practice 1**: The student can use representations and models to communicate scientific phenomena and solve scientific problems.
   B. **Science Practice 2**: The student can use mathematics appropriately.
   C. **Science Practice 3**: The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course.
   D. **Science Practice 4**: The student can plan and implement data collection strategies appropriate to a particular scientific question.
   E. **Science Practice 5**: The student can perform data analysis and evaluation of evidence.
   F. **Science Practice 6**: The student can work with scientific explanations and theories.
   G. **Science Practice 7**: The student is able to connect and relate knowledge across various scales, concepts and representations in and across domains.

III. Procedures for Assessment and Evaluation

Students will show evidence of mastery of the thematic essential questions using assessment tools which include, but are not limited to: Lab work, homework, class work, quizzes, chapter tests, and simulated AP-format questions. In addition to informal teacher assessments, students will be given a summative evaluation at the end of each unit following the guidelines and rubrics required by the College Board.

Grading System:

93-100	=	A	(excellent progress)
85-92	=	B	(above average progress)
77-84	=	C	(average progress)
70-76	=	D	(below average progress)
Below 70	=	F	(failing)
Unfinished	=	I	(some incomplete work)

IV. Text

Urry, L.A., et al. *Campbell Biology in Focus, AP Edition*. Pearson, 2014.

V. Resources:

A. General Resources

AP Biology Investigative Labs: An Inquiry-Based Approach. New York: The College Board, 2012.
AP Biology Lab Manual. New York: The College Board, 2001.

B. Additional Resources

"Darwin Lives! Modern Humans Are Still Evolving." Eben, Harrell. Time.com. Accessed December 19, 2011. http://www.time.com/time/health/article/0,8599,1931757,00.html.
"Evolution: Species and Speciation." Connecting Concepts: Interactive Lessons in Biology. Accessed December 19, 2011. http://ats.doit.wisc.edu/biology/ev/sp/sp.htm.
"'Instant' Evolution Seen in Darwin's Finches, Study Says." Inman, Mason. National Geographic News. Accessed November 30, 2011. http://news.nationalgeographic.com/news/2006/07/060714-evolution.html.
Lamb, Trevor D. "Evolution of the Eye." *Scientific American* 305, no. 1 (2011): 64–69.
"Lesson 6: Why Does Evolution Matter Now?" PBS. Accessed December 7, 2011. http://www.pbs.org/wgbh/evolution/educators/lessons/lesson6/index.html.
"Making Cladograms: Phylogeny, Evolution, and Comparative Anatomy." ENSI (Evolution & the Nature of Science Institutes). Accessed November 30, 2011. http://www.indiana.edu/~ensiweb/lessons/mclad.html.
"Peanut Variation Lab." Accessed December 13, 2011. http://www.biology.fourcroy.org/chapters/90_ca_std/handouts/05peanutlab.htm.
"Speciation in Real Time." Understanding Evolution. Accessed December 19, 2011. http://evolution.berkeley.edu/evolibrary/news/100201_speciation.
"Visualizing Life on Earth: Data Interpretation in Evolution." Understanding Evolution. Accessed December 13, 2011. http://evolution.berkeley.edu/evolibrary/article/0_0_0/ldg_01.
"Welcome to Evolution 101!" Understanding Evolution. Accessed December 7, 2011. http://evolution.berkeley.edu/evolibrary/article/evo_01.
"Hardy-Weinberg Equilibrium." Stanhope, Judith. Accessed December 13, 2011. http://www.woodrow.org/teachers/bi/1994/hwintro.html.

"Amazing Cells: Cells Communicate." Genetic Science Learning Center: *Learn.Genetics*. Accessed November 30, 2011. http://learn.genetics.utah.edu/content/begin/cells/.
"CELLS *alive!*" Accessed December 19, 2011. http://cellsalive.com/.
"Cell Size." Massengale's Biology Junction. Accessed November 30, 2011. http://www.biologyjunction.com/cell_size.htm.
"Enzymes Help Us Digest Food." Hands-on Activities for Teaching Biology to High School or Middle School Students. Serendip. Accessed November 30, 2011. http://serendip.brynmawr.edu/sci_edu/waldron/#enzymes.
"LabBench Activity: Enzyme Catalysis." PHSchool — The Biology Page. Pearson. Accessed November 30, 2011. http://www.phschool.com/science/biology_place/labbench/lab2/intro.html.
"Cracking the Code of Life: See Your DNA." NovaTeachers. PBS. Accessed November 30, 2011. http://www.pbs.org/wgbh/nova/teachers/activities/2809_genome.html.
Gattaca. Directed by Andrew Niccol. 1997. Culver City, CA: Sony, 1998. DVD.
" Genetic Disease Information — *pronto!*" Human Genome Project Information. Genomics.energy.gov. Accessed November 30, 2011. http://www.ornl.gov/sci/techresources/Human_Genome/medicine/assist.shtml.
"Microscopic Close Up: Mammal Cell Undergoing Mitosis in Orange Environment." Google Videos. Accessed November 30, 2011. http://video.google.com/videoplay?docid=8057806780595432977#.
"Mitosis & Meiosis: Doing It on the Table." ENSI (Evolution & the Nature of Science Institutes). Accessed December 19, 2011. http://www.indiana.edu/~ensiweb/lessons/gen.mm.html.
"Rediscovering Biology: Unit 7: Genetics of Development: Animations and Images." Annenberg Learner. Accessed November 30, 2011. http://www.learner.org/courses/biology/units/gendev/images.html.
"A Science Odyssey: You Try It: DNA Workshop." PBS. Accessed December 19, 2011. http://www.pbs.org/wgbh/aso/tryit/dna/.
Skloot, Rebecca. *The Immortal Life of Henrietta Lacks*. New York: Random House, 2010.

Northern York County School District Curriculum

Course Name	Advanced Placement Biology
Grade Level	11-12
Credits	1.00 Credits (Weighted GPA)

Unit 1	**The Nature of Science and The Chemistry of Life**			
Time Frame	**1 week**			
1.1	Organisms possess life characteristics and can be grouped into three major categories called domains: Archaea, Bacteria, and Eukarya. Biology is based on scientific principles, which provide unifying themes throughout this course. AP Laboratory #1 – Artificial Selection, AP Laboratory #13 – Enzyme Acitivity / Science Practices 1-7			
Key Understandings	**Essential Questions**	**Concepts**	**PA Academic Standards**	**Terminology**
Enduring understanding 1.A: Change in the genetic makeup of a population over time is evolution. **Enduring understanding 1.B**: Organisms are linked by lines of descent from common ancestry. **Enduring understanding 1.D**: The origin of living systems is explained by natural processes. **Enduring understanding 2.A**: Growth, reproduction and maintenance of the organization of living systems require free energy and matter. **Enduring understanding 3.A**: Heritable information provides for	1. What are the four big ideas? 2. What are the methods involved in scientific investigation? 3. How is the biosphere organized? How does one level of organization depend on another? 4. What are elements that make up living organisms? 5. What is the difference between organic and inorganic compounds? 6. What are the major categories of organic molecules? 7. What are the unique properties of water? Why are these properties vital to living organisms? 8. How does the structure of the water molecule determine these properties? 9. How is energy transferred in metabolic reactions? 10. What is the relationship between an enzyme and its substrate?	**1.A.1**: Natural selection is a major mechanism of evolution. **1.B.1**: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. **1.B.2**: Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested. **1.D.1**: There are several hypotheses about the natural origin of life on Earth, each with supporting scientific evidence.	**3.1.B.A1** Compare and contrast the cellular structures and degrees of complexity of prokaryotic and eukaryotic organisms. **3.1.B.A8** Recognize that systems within cells and multi-cellular organisms interact to maintain homeostasis. **3.1.10.A1.** Explain the characteristics of life common to all organisms. **3.1.12.A1.** Relate changes in the	Prokaryotes Photosynthesis Organelles Cellular specialization Eukaryotes Domains Deoxyribonucleic Acid Metabolism Homeostasis Natural Selection Adaptations Theory Controlled Experiment Biosphere Polarity Hydrophobic Hydrophilic Surface tension pH scale

continuity of life. **Enduring understanding 4.A**: Interactions within biological systems lead to complex properties. **Enduring understanding 4.B**: Competition and cooperation are important aspects of biological systems.		**1.D.2**: Scientific evidence from many different disciplines supports models of the origin of life. **2.A.3**: Organisms must exchange matter with the environment to grow, reproduce and maintain organization. **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. **4.A.4**: Organisms exhibit complex properties due to interactions between their constituent parts. **4.B.1**: Interactions between molecules affect their structure and function. **4.B.4**: Distribution of local and global ecosystems changes over time.	environment to various organisms' ability to compensate using homeostatic mechanisms **3.1.12.A5.** Analyze how structure is related to function at all levels of biological organization from molecules to organisms.	

Unit 2	Principles of Cellular Life: A tour of the Cell
Time Frame	**3 weeks**
2.1	The Cell Theory states that the cell is the fundamental unit of biological structure and function. In Prokaryotic cells there are no Internal compartments. In eukaryotes, internal membranes partition the cell into specialized regions that allow cell processes to operate with optimal efficiency. Each compartment or membrane-bound organelle enables localization of chemical reactions. Extracellular structures allow cells to communicate with the external environment. AP Laboratory # 4 - Diffusion and Osmosis / Science Practices 1 -7

Key Understandings	Essential Questions	Concepts	PA Academic Standards	Terminology
Enduring understanding 2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter. **Enduring understanding 2.B**: Growth, reproduction and dynamic homeostasis require that cells create and maintain internal environments that are different from their external environments. **Enduring understanding 3.A**: Heritable information provides for continuity of life. **Enduring understanding 3.D**: Cells communicate by generating, transmitting and receiving chemical signals. **Enduring understanding 4.A**: Interactions within biological systems lead to complex properties. **Enduring understanding 4.B**: Competition and cooperation are important aspects of biological systems.	1. How is the cell the basic unit of life? 2. What are the basic features of Prokaryotic cells? 3. What the basic features of Eukaryotic cells? 4. How do materials enter and leave the cell? 5. What are the relationships between structure and function of cell organelles? 6. How is the cell the basic unit of life? 7. What role does the cellmembrane play in cellular homeostasis? 8. What are the relationships between structure and function of cell organelles? 9. How are the characteristics of life manifested by the cell?	**2.A.1:** All living systems require constant input of free energy. **2.A.2**: Organisms capture and store free energy for use in biological processes. **2.A.3**: Organisms must exchange matter with the environment to grow, reproduce and maintain organization. **2.B.1**: Cell membranes are selectively permeable due to their structure. **2.B.2**: Growth and dynamic homeostasis are maintained by the constant movement of molecules across membranes. **2.B.3**: Eukaryotic cells maintain internal membranes that partition the cell into specialized regions. **3.A.1:** DNA, and in some cases RNA, is the primary source of heritable information.	**3.1.B.A1** Compare and contrast the cellular structures and degrees of complexity of prokaryotic and eukaryotic organisms. **3.1.B.A5** Relate the structure of cell organelles to their function (energy capture and release, transport, waste removal, protein synthesis, movement. Explain how the cell membrane functions as a regulatory structure and protective barrier for the cell. **3.1.B.A8** Recognize that systems within cells and multi-cellular organisms interact to maintain homeostasis.	Fluid Mosaic Selective Permeability Diffusion Osmosis Active Transport Sodium-Potassium Pump Endocytosis Exocytosis Ion channels Protein kinases G Protein-linked receptors Plasma membrane Cytosol Mitochondria Extracellular matrix Gap junctions Organelles Protocell Extracellular structures Tight junctions Cellulose Dynamic instability Endomembrane system Vacuole Nucleoid

Enduring understanding 4.C: Naturally occurring diversity among and between components within biological systems affects interactions with the environment		**3.D.2**: Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling. **4.A.2**: The structure and function of subcellular components, and their interactions, provide essential cellular processes. **4.B.2**: Cooperative interactions within organisms promote efficiency in the use of energy and matter. **4.C.1**: Variation in molecular units provides cells with a wider range of functions.		

Unit 3	Cells and Energy - Introduction to Metabolism			
Time Frame	**3 Weeks**			
3.1	Energy is the capacity to do work. The flow of energy among atoms and molecules obeys the Laws of Thermodynamics. All chemical reactions fall into 2 categories which are known as exergonic and endergonic reactions. Energy released by chemical reactions within a cell is captured and transported by ATP and electron carriers. Cellular reactions are linked in sequences called metabolic pathways. AP Laboratory # 5 – Photosynthesis, AP Laboratory #6 – Cellular Respiration / Science Practices 1 – 7.			
Key Understandings	**Essential Questions**	**Concepts**	**PA Academic Standards**	**Terminology**
Enduring understanding 1.B: Organisms are linked by lines of descent from common ancestry. **Enduring understanding 2.A**: Growth, reproduction and maintenance of the organization of living systems require free energy and matter **Enduring understanding 4.A**: Interactions within biological systems lead to complex properties. **Enduring understanding 4.B**: Competition and cooperation are important aspects of biological systems. **Enduring understanding 4.C**: Naturally occurring diversity among and between components within biological systems affects interactions with the environment.	1. What is the difference between an aerobic and anaerobic? 2. What are the major stages of aerobic respiration and where inside cells do they take place? 3. What is energy? 4. How does energy flow in chemical reactions? 5. How is free energy used in biological systems to facilitate growth, reproduction and homeostasis? 6. How is energy stored in biological systems? 7. How is cellular energy carried between coupled reactions? 8. How do cells control their metabolic reactions?	**1.B.1**: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. **2.A.1:** All living systems require constant input of free energy. **2.A.2**: Organisms capture and store free energy for use in biological processes. **2.A.3**: Organisms must exchange matter with the environment to grow, reproduce and maintain organization. **4.A.1:** The subcomponents of biological molecules and their sequence determine the properties of that molecule. **4.A.2**: The structure and function of subcellular components, and their interactions, provide essential cellular processes. **4.A.4**: Organisms exhibit complex properties due to interactions between their constituent parts.	**3.1.12.A1.** Relate changes in the environment to various organisms' ability to compensate using homeostatic mechanisms. **3.1.C.A1.** Explain the chemistry of metabolism **3.1.B.A2.** Identify the initial reactants, final products, and general purposes of photosynthesis and cellular respiration. Explain the important role of ATP in cell metabolism. Describe the relationship between photosynthesis and cellular respiration in photosynthetic organisms. Explain why many biological macromolecules such as ATP and lipids contain high energy bonds.	Energy Kinetic Energy Potential Energy 1st Law of Thermodynamics 2nd Law of Thermodynamics Entropy Chemiosmosis ATP ADP Cellular Respiration Glycolysis Coenzyme A Fermentation Catabolism Anabolism Photosynthesis Photobiology Calvin cycle NADPH Photosytem I Photosytem II Citric acid cycle Electron transport ATP Synthetase Energy coupling Activation energy Catalyst Substrate

		4.A.6: Interactions among living systems and with their environment result in the movement of matter and energy. **4.B.1**: Interactions between molecules affect their structure and function. **4.B.2**: Cooperative interactions within organisms promote efficiency in the use of energy and matter. **Essential knowledge 4.C.1**: Variation in molecular units provides cells with a wider range of functions.	Explain the importance of enzymes as catalysts in cell reactions.	

Unit 4	Cell Communication and The Cell Cycle			
Time Frame	**3 weeks**			
4.1	Cell division is necessary for the reproduction, growth and repair of organisms. Asexual reproduction produces organisms which are identical to the parent. In sexual reproduction, two haploid gametes unite to form a diploid zygote. Cell division occurs in phases known as IPMAT and is regulated by cyclins and CDK's. Meiosis is composed of two cycles producing haploid gametes. All cells have a preprogrammed death which is a necessary process in living things. AP Laboratory # 7 – Cell Division: Mitosis and Meiosis / Science Practices 1-7			
Key Understandings	**Essential Questions**	**Concepts**	**PA Academic Standards**	**Terminology**
Enduring understanding 1.A: Change in the genetic makeup of a population over time is evolution. **Enduring understanding 2.A**: Growth, reproduction and maintenance of the organization of living systems require free energy and matter. **Enduring understanding 2.C**: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis **Enduring understanding 3.D**: Cells communicate by generating, transmitting and receiving chemical signals **Enduring understanding 2.E**: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination.	1. How do meiosis and sexual reproduction produce genetic variability? 2. What are the events of cytokinesis? 3. What are the stages of the cell cycle? 4. How is DNA in eukaryotic cells organized into chromosomes? 5. What are the functions of Cellular Reproduction? 6. What are the stages of the cell cycle? 7. How is the cell cycle regulated in a normal cell? How is this regulation disrupted in cancerous cells? 8. What are the major events in cell division and what are the differences in division between plant and animal cells? 9. What are the differences between the processes of mitosis and meiosis? 10. How is meiosis a source of genetic variation? Why is genetic variation important for evolution? 11. What is the difference between sexual and asexual reproduction? 12. What are similarities and differences between prokaryotic cell reproduction, viral replication, reproduction in flowering plants and animal reproduction? What is the relationship of each of these to genetic variation? 13. What are some modern biotechnological ?	**1.A.3**: Evolutionary change is also driven by random processes. **2.A.3**: Organisms must exchange matter with the environment to grow, reproduce and maintain organization. **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. **2.C.1**: Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes. **2.C.2**: Organisms respond to changes in their external environments. **2.E.2**: Timing and coordination of physiological events are regulated by multiple mechanisms.	**3.1.B.A3**. Explain how all organisms begin their life cycles as a single cell and that in multicellular organisms, successive generations of embryonic cells form by cell division **3.1.10.A4.** Describe the cell cycle and the process and significance of mitosis. **3.1.B.A4.** Summarize the stages of the cell cycle. Examine how interactions among the different molecules in the cell cause the distinct stages of the cell cycle which can also be influenced by other signaling molecules. Explain the role of mitosis in the formation of new cells and its importance in	Allele Interphase Prophase Metaphase Ananphase Telophase Asexual Reproduction Sexual Reproductiopn Binary Fission Cell Cycle Cell division Cell plate Centriole Centromere Chiasmata Chromosome Crossing over Cytokinesis Haploid Diploid Duplicated chromosomes Gamete Karyotype Meiosis I and II Mitosis Recombination Cloned cells Somatic

Enduring understanding 3.A: Heritable information provides for continuity of life. **Enduring understanding 3.C**: The processing of genetic information is imperfect and is a source of genetic variation. **Enduring understanding 4.A**: Interactions within biological systems lead to complex properties. **Enduring understanding 4.C**: Naturally occurring diversity among and between components within biological systems affects interactions with the environment.	14. practices in relation to reproduction? 15. What are stem cells and how is development/differentiation regulated?	**2.E.3**: Timing and coordination of behavior are regulated by various mechanisms and are important in natural selection. **3.A.3**: The chromosomal basis of inheritance provides an understanding of the pattern of passage (transmission) of genes from parent to offspring. **3.A.4**: The inheritance pattern of many traits cannot be explained by simple Mendelian genetics. **3.C.2**: Biological systems have multiple processes that increase genetic variation. **3.D.1**: Cell communication processes share common features that reflect a shared evolutionary history. **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**: Changes in signal transduction pathways can alter cellular response. **4.A.2**: The structure and function of subcellular components, and their interactions, provide essential cellular processes. **4.A.4**: Organisms exhibit complex properties due to	maintaining chromosome number during asexual reproduction. Compare and contrast a virus and a cell. Relate the stages of viral cycles to the cell cycle **3.1.12.A4.** Explain how the cell cycle is regulated	Germ Spindle Cell cycle check points Polyploidy Nondisjunction Translocation

		interactions between their constituent parts. **4.C.3**: The level of variation in a population affects population dynamics.		

Unit 5	DNA – The molecular basis of Inheritance			
Time Frame	**5 Weeks**			
5.1	Genes are particulate and are inherited according to Mendel's Laws. DNA structure reflects its role as the genetic material. Genetics show that genes code for protein by utilizing the processes of transcription and translation. Prokaryotic and Eukaryotic genes are regulated gene expression. Genome sequencing has provided insight into how genes are expressed. DNA can genetically transform cells and organisms. Changes in gene expression underline cell differentiation in development. AP Laboratory # 8 – Biotechnology: Bacterial Transformation / Science Practices 1-7			
Key Understandings	**Essential Questions**	**Concepts**	**PA Academic Standards**	**Terminology**
Enduring understanding 1.A: Change in the genetic makeup of a population over time is evolution. **Enduring understanding 2.E**: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination. **Enduring understanding 3.A**: Heritable information provides for continuity of life. **Enduring understanding 3.B**: Expression of genetic information involves cellular and molecular mechanisms. **Enduring understanding 3.C**: The processing of genetic information is imperfect and is a source of genetic variation. **Enduring understanding 4.A**: Interactions within biological systems lead to complex properties. **Enduring understanding 4.C**: Naturally occurring diversity among and between components within	1. How does DNA replication ensure genetic constancy? 2. How are genes and proteins related? 3. What is biotechnology? 4. How does DNA recombination occur? 5. What are genes composed of? 6. How are genes and proteins related? 7. How are genes related? 8. How is the sequence of a messenger RNA molecule translated into a protein? 9. What are the major events that lead to our current understanding of DNA as the genetic material of living organisms? 10. What is the basic structure of the DNA molecule and how does this structure make replication possible? 11. What are the major steps in DNA replication? 12. What are the similarities and differences between DNA and RNA?	**1.A.2**: Natural selection acts on phenotypic variations in populations. **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. **3.A.1:** DNA, and in some cases RNA, is the primary source of heritable information. **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. **3.A.3**: The chromosomal basis of inheritance provides an understanding of the pattern of passage (transmission) of genes from parent to offspring. **3.A.4**: The inheritance pattern of many traits cannot be explained by simple Mendelian genetics.	**3.1.10.B3**. Describe the basic structure of DNA and its function in genetic inheritance. Describe the role of DNA in protein synthesis as it relates to gene expression. **3.1.B.B3.** Describe the basic structure of DNA, including the role of hydrogen bonding. Explain how the process of DNA replication results in the transmission and conservation of the genetic code. Describe how transcription and translation result in gene expression. Differentiate among the end products of replication, transcription, and translation. **3.1.C.B3.** Describe the structure of the DNA and RNA molecules.	F1 generation F2 generation Punnett square Law of segregation Test cross Dihybrid cross Pedigrees Mutations Epistasis Phenotype Genotype Plasmids Transformation Base pairs Double helix Replication forks Okazaki fragments Leading strand Lagging strand Telomere Mutagens One gene-one polypeptide Introns Exons Elongation Termination 5' 3' Codons Transcription

biological systems affects interactions with the environment.	13. How does the structure of DNA determine the structure of a polypeptide? 14. How do changes in the structure of DNA change a polypeptide and how does this affect an organism's phenotype? 15. What are the types of mutations that can occur in DNA and what are some of the agents that cause them? 16. How is gene expression controlled in eukaryotes versus prokaryotes? 17. What are techniques that are being used to manipulate the genome (recombinant DNA, transgenic organisms, etc)? 18. What are some possible implications of manipulating the genome? How or who should regulate this? 19. What is epigenetics and what are the implications for future studies in gene expression?	**3.B.1**: Gene regulation results in differential gene expression, leading to cell specialization. **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 have multiple processes that increase genetic variation. **3.C.3**: Viral replication results in genetic variation, and viral infection can introduce genetic variation into the hosts. **4.A.3**: Interactions between external stimuli and regulated gene expression result in specialization of cells, tissues and organs **4.C.2**: Environmental factors influence the expression of the genotype in an organism.	**3.1.12.B3.** Analyze gene expression at the molecular level. Explain the impact of environmental factors on gene expression.	Translation Polyribosome Proteolysis Glycosylation Phosphorylation

Unit 6	Genomes and Evolutionary Concepts
Time Frame	**4 weeks**
6.1	Evolution may be measured by changes in Allele Frequencies. Mutation, Selection, Gene Flow, Genetic Drift and Nonrandom mating may lead to Evolutionary changes over time. Selection can be Stabilizing, Directional or Disruptive. Genomes may reveal both Neutral and the Selective Processes of Evolution. Life may be viewed through its evolutionary history and by using phylogeny may become comparative and predictive. Speciation is the process which produces the splits among lineages in the tree of life. According to science, events in the earth's history can be dated and read through the fossil record. AP Laboratory # 2 – Mathematical Modeling: Hardy-Weinberg, AP Laboratory #3 – Comparing DNA sequences to understand evolutionary relationship with BLAST / Science Practices 1-7

Key Understandings	Essential Questions	Concepts	PA Academic Standards	Terminology
Enduring understanding 1.A: Change in the genetic makeup of a population over time is evolution. **Enduring understanding 1.B**: Organisms are linked by lines of descent from common ancestry. **Enduring understanding 1.C**: Life continues to evolve within a changing environment. **Enduring understanding 2.D**: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment. **Enduring understanding 2.E**: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination. **Enduring understanding 3.A**: Heritable information provides for continuity of life. **Enduring understanding 3.C**: The processing of genetic information is	1. What is the history of evolutionary thought? 2. How do we distinguish between Lamarck's idea of evolution and Darwin's? 3. What evidence did Darwin use to develop the theory of natural selection? What is all current evidence of evolutionary change? 4. What is the difference between microevolution and macroevolution? 5. How do interactions between populations and their environments drive natural selection? 6. What is the relationship between alleles, allele frequency and gene pools of populations? 7. What is Hardy-Weinberg equilibrium and how can we use the Hardy-Weinberg Equation to calculate allele frequencies? 8. How do we define "species?" 9. What are the different	**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 random processes. **1.A.4**: Biological evolution is supported by scientific evidence from many disciplines, including mathematics. **1.B.2**: Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested. **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.	**3.1.10.C1.** Explain the mechanisms of biological evolution **3.1.B.C1.** Describe species as reproductively distinct groups of organisms. Analyze the role that geographic isolation can play in speciation. Explain how evolution through natural selection can result in changes in biodiversity through the increase or decrease of genetic diversity within a population. Describe how the degree of kinship between species can be inferred from the similarity in their DNA sequences **3.1.12.C1.** Analyze how natural selection leads to speciation. **3.1.10.C2.** Explain the role of mutations and gene recombination in changing a	Evolution Evolutionary theory Natural selection Adaptation Gene flow Genetic drift Population bottlenecks Nonrandom mating Sexual selection Phylogeny Homologies Synapomorphy Convergent evolution Maximum likelihood Molecular clock Polyphyletic Speciation Biological species concept Allopatric speciation Post-zygotic isolating mechanisms Radiometric dating Half-lives Sedimentary rocks Biotas Flora Mass extinction

imperfect and is a source of genetic variation. **Enduring understanding 4.B**: Competition and cooperation are important aspects of biological systems. **Enduring understanding 4.C**: Naturally occurring diversity among and between components within biological systems affects interactions with the environment.	modes of speciation? 10. How do phylogenetic trees represent the relationship between taxonomy and evolutionary history? 11. What are the current hypotheses regarding the origin of life? 12. What is the basic timeline for the evolution of life? 13. What is the endosymbiotic theory and what is the evidence that supports this explanation of the evolution of eukaryotic cells? 14. How is life organized in systematic biology? 15. What is the difference between the kingdoms in terms of evolution, structure and function of structures, processes, organization, role in biosphere and life cycles?	**1.C.3**: Populations of organisms continue to evolve. **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. **2.D.2**: Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments. **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. **2.E.2**: Timing and coordination of physiological events are regulated by multiple mechanisms. **E2.E.3**: Timing and coordination of behavior are regulated by various mechanisms and are important in natural selection. **3.A.3**: The chromosomal basis of inheritance provides an understanding of the pattern of passage (transmission) of genes from parent to offspring. **3.A.4**: The inheritance pattern of many traits cannot be explained by simple Mendelian genetics. **3.C.2**: Biological systems have multiple processes that increase genetic variation.	population of organisms **3.1.10.C3.** Interpret data from fossil records, anatomy and physiology, and DNA studies relevant to the theory of evolution **3.1.12.C3.** Analyze the evidence to support various theories of evolution (gradualism, punctuated equilibrium). Evaluate survival of the fittest in terms of species that have remained unchanged over long periods of time.	

		3.C.3: Viral replication results in genetic variation, and viral infection can introduce genetic variation into the hosts. **4.B.3**: Interactions between and within populations influence patterns of species distribution and abundance. **4.B.4**: Distribution of local and global ecosystems changes over time. **4.C.1**: Variation in molecular units provides cells with a wider range of functions. **4.C.2**: Environmental factors influence the expression of the genotype in an organism **4.C.3**: The level of variation in a population affects population dynamics. **4.C.4**: The diversity of species within an ecosystem may influence the stability of the ecosystem.		

Unit 7	Plant Diversity – Form and Function			
Time Frame	**4 Weeks**			
7.1	According to science, prokaryotic diversity reflects the origins of life. Viruses may have evolved many times. Protists are critical components of many ecosystems. Flowers and fruits increase the reproductive success of angiosperms. Seeds protect the plant embryos. Major groups of Fungi differ in their life cycles. Life on land contributed to vertebrate diversification. The plant body is organized and constructed in a distinctive way. Plants acquire mineral nutrients from the soil. Plant develop in response to the environment. Angiosperms reproduce sexually. Plants adapt to environmental stresses. AP Laboratory #11 – Transpiration / Science Practices 1-7			
Key Understandings	**Essential Questions**	**Concepts**	**PA Academic Standards**	**Terminology**
Enduring understanding 2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter. **Enduring understanding 2.C**: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis. **Enduring understanding 2.D**: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment **Enduring understanding 2.E**: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination. **Enduring understanding 3.B**: Expression of genetic information involves cellular and molecular mechanisms.	1. What are the organs of a plant? 2. How do vibrio populations detect when they are dense enough to produce bioluminescence? 3. Red tides are harmful, but can dinoflagellates also be beneficial to marine ecosystems? 4. What was Darwin's explanation for the three distinct flowers growing on a single orchid plant? 5. Have antibiotics derived from fungi eliminated the danger of bacterial diseases in human populations? 6. Besides the insects, which other groups of animals are thought to contain many more species than are known at present? 7. What are the properties of the kenaf plant that make it suitable for papermaking? 8. How can soil be managed for optimal plant growth? 9. How did an understanding of angiosperm reproduction allow floriculturists to develop a commercially successful poinsettia? 10. What changes in their growth patterns made the new strains of cereal crops produced by the green revolution so successful?	**2.A.3**: Organisms must exchange matter with the environment to grow, reproduce and maintain organization. **2.C.1**: Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes. **2.C.2**: Organisms respond to changes in their external environments. **2.D.3**: Biological systems are affected by disruptions to their dynamic homeostasis. **2.D.4**: Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis. **2.E.2**: Timing and coordination of physiological events are regulated by multiple mechanisms. **3.B.2**: A variety of intercellular	**3.1.10.A8.** Investigate the spatial relationships of organisms' anatomical features using specimens, models, or computer programs. **3.1.12.A6.** Analyze how cells in different tissues/organs are specialized to perform specific functions. **3.1.12.A5.** Analyze how structure is related to function at all levels of biological organization from molecules to organisms. **3.1.10.A3.** Compare and contrast the life cycles of different organisms. **3.1.12.A2.** Evaluate how organisms must derive energy from their environment or their food in order to survive.	Bacilli Helices Cocci Gram-positive Gram-negative Mycoplasmas Cyanobacteria Spirochetes Biofilms Nitrifiers Endosymbiosis Rhizaria Conjugation Seed plants Overtopping Pollen tube Ovule Pollen grains Gymnosperms Angiosperms Carpels Monoecious Dioecious Monocots Eudicots Yeasts Coenocytic Symbiotic Mutualistic Mating types

Enduring understanding 3.D: Cells communicate by generating, transmitting and receiving chemical signals. **Enduring understanding 3.E**: Transmission of information results in changes within and between biological systems **Enduring understanding 4.A**: Interactions within biological systems lead to complex properties. **Enduring understanding 4.B**: Competition and cooperation are important aspects of biological systems.		and intracellular signal transmissions mediate gene expression. **3.D.1**: Cell communication processes share common features that reflect a shared evolutionary history. **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**: Changes in signal transduction pathways can alter cellular response. **3.E.1**: Individuals can act on information and communicate it to others. **3.E.2**: Animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce responses. **4.A.3**: Interactions between external stimuli and regulated 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.A.5**: Communities are composed of populations of		Plasmogamy Sponges Radial symmetry Bilaterial symmetry Placozoans Polyp Medusa Planula Crustaceans Roots Root system Stems Leaves Primary growth Secondary growth Root cap Zone of cell division Vascular cambium Nitrogenase Apoplast Symplast Dormancy Germinates Genetic screens Acid growth hypothesis Apical hook Circadian rhythms Embryo sac Perennials Annuals Biennials Grafting Stomatal Crypts Succulence

		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**: Cooperative interactions within organisms promote efficiency in the use of energy and matter.		

Unit 8	Animal Diversity – Form and Function			
Time Frame	**6 Weeks**			
8.1	Multicellular animals require a stable internal environment. Living systems are temperature-sensitive. Hormones are chemical messengers. The adaptive immune response is specific. Reproduction can be sexual or asexual. Gametogenesis produces haploid cells. Fertilization activates development. Nervous systems consist of neurons and glia. Photoreceptors detect light. The characteristics of muscle cells determine muscle performance. Respiratory gases are transported in the blood. Circulatory systems can be open or closed. Digestive systems break down macromolecules. Excretory systems maintain homeostasis. AP Laboratory #9 –Biotechnology: Restriction Enzyme Analysis, AP Laboratory #10 –Energy Dynamic /Science Practices 1-7			
Key Understandings	**Essential Questions**	**Concepts**	**PA Academic Standards**	**Terminology**
Enduring understanding 2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter. **Enduring understanding 2.C**: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis. **Enduring understanding 2.D**: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment **Enduring understanding 2.E**: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination. **Enduring understanding 3.B**: Expression of genetic information involves cellular and molecular mechanisms. **Enduring understanding 3.D**: Cells communicate by generating, transmitting and receiving chemical signals.	1. What can ground squirrels do to lower the metabolic demands of surviving through the winter? 2. How does each of the following systems contribute to the maintenance of homeostasis in animals? a. Cardiovascular and respiratory system in relation to gas exchange b. Digestive system in terms of nutrient absorption c. Endocrine system d. Nervous system in terms of sensory perception and response 3. How do the transformative effects of testosterone exemplify the way many hormones work? 4. How can a person survive an infection and be resistant to further infection? 5. How does the Sonic hedgehog pathway control development of the vertebrate brain and eyes? 6. How can a small brain tumor so dramatically affect	**2.A.3**: Organisms must exchange matter with the environment to grow, reproduce and maintain organization. **2.C.1**: Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes. **2.C.2**: Organisms respond to changes in their external environments. **2.D.3**: Biological systems are affected by disruptions to their dynamic homeostasis. **2.D.4**: Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis. **2.E.2**: Timing and coordination of physiological events are regulated by multiple mechanisms. **3.B.2**: A variety of intercellular and intracellular signal transmissions mediate gene expression.	**3.1.10.A8.** Investigate the spatial relationships of organisms' anatomical features using specimens, models, or computer programs. **3.1.12.A6.** Analyze how cells in different tissues/organs are specialized to perform specific functions. **3.1.12.A5.** Analyze how structure is related to function at all levels of biological organization from molecules to organisms. **3.1.10.A3.** Compare and contrast the life cycles of different organisms. **3.1.12.A2.** Evaluate how organisms must derive energy from their environment or their food in order to survive.	Tissues Organs Organ systems Negative feedback Positive feedback Metabolic rate Endotherms Metabolism BMR Hypothalamus Endocrine cells Target cells Hormones Peptide hormones Thyroid gland Pituitary gland Androgens Estrogens Progesterone Pathogens Innate immunity Adaptive immunity Inflammation Cellular immune response Mast cells Immunoglobulin T cells Regeneration Budding

Enduring understanding 4.A: Interactions within biological systems lead to complex properties. **Enduring understanding 4.B**: Competition and cooperation are important aspects of biological systems.	personality ad behavior? 7. How do kangaroo rats, rattlesnakes, owls and bats see in the dark? 8. How do musculoskeletal systems maximize force generation and do so at a minimal metabolic cost? 9. How are bar-headed geese able to sustain the high metabolic cost of flight at altitudes higher than Mount Everest? 10. What are the critical factors which determine whether a person recovers from a heart attack? 11. How does food provide energy and nutrients? 12. How do excretory systems of animals maintain homeostasis?	**3.D.1**: Cell communication processes share common features that reflect a shared evolutionary history. **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**: Changes in signal transduction pathways can alter cellular response. **4.A.3**: Interactions between external stimuli and regulated 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.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**: Cooperative interactions within organisms promote efficiency in the use of energy and matter.		Spawing Germ cells Cleavage Blastula Mosaic development Endoderm Mesoderm Ectoderm Forebrain Hindbrain Midbrain Extraembryonic membranes Neurons Glia Afferent neurons Efferent neurons Membrane potential Resting potential Sodium-potassium pump Voltage-gated channels Photoreceptors Receptor proteins Olfaction gestation Eye cups Photosensitivity Tympanic membrane Oval window Retina Rod cells Cone cells Skeletal systems Osteoblasts Compact bone Joints Tendons Ligaments Respiratory gases Alveoli Hemoglobin Open circulatory system Closed circulatory system Capillaries Arterioles

				Venules Ventricle atrium Sinoatrial Pacemaker Macronutrients Micronutrients Essential amino acids Urine Osmolarity Kidney Nephron ANP

Unit 9	Ecology and The Biosphere			
Time Frame	**3 Weeks**			
9.1	Ecological systems vary in space and over time. Human activities affect ecological systems on a global scale. Life histories determine population growth rates. Ecology provides tools for managing populations. Communities change over space and time. Species diversity affects community function. Climate and nutrients affect ecosystem function. Rapid climate change affects species and communities. AP Laboratory #12 – Fruit Fly Behavior / Science Practices 1-7			
Key Understandings	**Essential Questions**	**Concepts**	**PA Academic Standards**	**Terminology**
Enduring understanding 2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter. **Enduring understanding 2.C**: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis. **Enduring understanding 2.D**: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment. **Enduring understanding 2.E**: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination. **Enduring understanding 3.E**: Transmission of information results in changes within and between biological systems. **Enduring understanding 4.A**: Interactions within biological systems lead to complex properties. **Enduring understanding 4.B**:	1. Why did the rangeland restoration method that worked in Europe fail to work in the Borderlands? 2. How does understanding population Ecology of disease vectors help us to combat infectious disease? 3. How could the intricate relationship between leaf-cutter ants and fungi devolped? 4. Can we use principles of community ecology to improve methods of coffee cultivation? 5. How do both the environment and genes influence behavior? 6. What are some types of animal behaviors in various environments? In response to varying stimuli? 7. What are the various means of communication between animals? 8. How do various behaviors (societal, altruistic) and reproductive strategies influence organisms' fitness? 9. What characteristics of	**2.A.1:** All living systems require constant input of free energy. **2.A.2**: Organisms capture and store free energy for use in biological processes. **2.C.2**: Organisms respond to changes in their external environments. **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. **2.D.2**: Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments. **2.D.3**: Biological systems are affected by disruptions to their dynamic homeostasis. in their external environments. **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.	**4.5.10.D.** Research practices that impact biodiversity in specific ecosystems. Analyze the relationship Between habitat changes to plant and animal population fluctuations. **4.5.12.D.** Analyze the effects of new and emerging technologies on biodiversity in specific ecosystems. Evaluate the impact of laws and regulations on reducing the number of threatened and endangered species. **4.1.10.E.** Analyze how humans influence the pattern of natural changes in ecosystems over time. **4.1.12.E.** Research solutions addressing human impacts on ecosystems over time. **4.2.10.C.** Explain the relationship between	Biome Biogeographic regions Physical geography Biogeography Biotic Abiotic Ecology Population Community Biosphere Ecosystem Hadley cells Adiabatically Climate diagram Currents Topography Littoral zone Intertidal zone Photic zone Benthic zone Freshwater biomes Marine biome Habitats BD model Survivorship Fecundity Principle of allocation Doubling time Additive growth BIDE model Corridor Density dependent

Competition and cooperation are important aspects of biological systems. **Enduring understanding 4.C**: Naturally occurring diversity among and between components within biological systems affects interactions with the environment.	populations allow us to analyze them and make predictions? 10. What is the difference between exponential and logistic growth in populations? 11. What information can we obtain by analyzing survivorship curves and population age structure diagrams? 12. What are the ways in which populations interact in communities? Symbiosis and coevolution? 13. What is the structure of ecosystems? How does energy flow through ecosystems and how is matter cycled through them? 14. What are similarities and differences between the various biomes? 15. What is the human impact on the biosphere in terms of population growth and interference/influence with natural systems and cycles? 16. How do humans interact with other populations?	**3.E.1**: Individuals can act on information and communicate it to others. **3.E.2**: Animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce responses. **4.A.4**: Organisms exhibit complex properties due to interactions between their constituent parts. **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**: Cooperative interactions within organisms promote efficiency in the use of energy and matter. **4.B.3**: Interactions between and within populations influence patterns of species distribution and abundance. **4.B.4**: Distribution of local and global ecosystems changes over time. **4.C.3**: The level of variation in a population affects population dynamics. **4.C.4**: The diversity of species within an ecosystem may influence the stability of the ecosystem.	water quality and the diversity of life in a freshwater ecosystem. Explain how limiting factors affect the growth and reproduction of freshwater organisms. **4.5.12.E.** Analyze how consumer demands promote the production of pollutants that affect human health.	Interspecific interactions Limiting source Predation Herbivory Parasitism Mutualism Commensalism Amensalism Ecological transition Succession Niche NPP Species richness Fluxes Greenhouse gases Biogeochemical cycles Eutrophication