DELAWARE VALLEY SCHOOL DISTRICT

PLANNED INSTRUCTION

A PLANNED COURSE FOR:

Advanced Placement Biology

Curriculum writing committee:

Amanda M. Pope

Grade Level: 10, 11, 12

Date of Board Approval: _____2020_____

Planned Instruction

Title of Planned Instruction: Advanced Placement Biology

Subject Area: Biology Grade(s):10, 11, 12

Course Description: AP Biology is an introductory college-level biology course. Students cultivate their understanding of biology through inquiry-based investigations as they explore the following topics: evolution, cellular processes — energy and communication, genetics, information transfer, ecology, and interactions. This course requires that 25 percent of the instructional time will be spent in hands-on laboratory work, with an emphasis on inquiry-based investigations that provide students with opportunities to apply the science practices. The course is based on four Big Ideas, which encompass core scientific principles, theories, and processes that cut across traditional boundaries and provide a broad way of thinking about living organisms and biological systems. AP Biology focuses on four "Big Ideas":1. The process of evolution explains the diversity and unity of life. 2. Biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain dynamic homeostasis. 3. Living systems store, retrieve, transmit, and respond to information essential to life processes. 4. Biological systems interact, and these systems and their interactions possess complex properties. While students focus content on the Big Ideas, they will develop science practice skills. Students establish lines of evidence and use them to develop and refine testable explanations and predictions of natural phenomena. Focusing on these disciplinary practices enables teachers to use the principles of scientific inquiry to promote a more engaging and rigorous experience.

Time/Credit for the Course: 1 Full year, 144 hours, 36 hours dedicated to lab, 1 science credit

DELAWARE VALLEY SCHOOL DISTRICT

Advanced Placement Biology: Curricular Requirements

Curricular Requirement	One Example Evidence
CR1 Students and teachers use a recently published (within the last 10 years) college-level biology textbook.	**Text used: Campbell Biology AP 12th Edition**
CR2 The course is structured around the enduring understandings within the big ideas as described in the AP Biology Curriculum Framework.	**All units identify all Big Ideas and all Enduring Understandings addressed within each unit description.**
CR3a Students connect the enduring understandings within Big Idea 1 (the process of evolution drives the diversity and unity of life) to at least one other big idea.	**Students will analyze class-collected data on allele frequencies and perform a Hardy Weinberg analysis. They will then hypothesize scenarios that would cause shifts in allele frequencies. This laboratory experience connects Big Idea 1 (evolution) and EA 1.A (change over time) to Big Idea 4 (interactions).**
CR3b Students connect the enduring understandings within Big Idea 2 (biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain dynamic homeostasis) to at least one other big idea.	**Students will investigate the processes of cellular respiration, as performed in mitochondria and chloroplasts (Big idea 2 – biological systems utilize free energy to grow reproduce and maintain dynamic homeostasis). They will investigate the cellular structure of these organelles, and relate their features (size, shape, reproduction, presence of circular chromosome) to the endosymbiotic theory, an evidence of Big Idea 1 (evolution).**
CR3c Students connect the enduring understandings within Big Idea 3 (living systems store, retrieve, transmit, and respond to information essential to life processes) to at least one other big idea.	**Students will investigate the process of protein synthesis and shared mechanisms of transcription and translation amongst all living things (Big Idea 3 – living things store, retrieve, transmit and respond to information essential to all life processes). They will connect the continuity of these processes as an evidence for common ancestry (Big idea 1- evolution).**
CR3d Students connect the enduring understandings within Big Idea 4 (biological systems interact and these systems and their interactions possess complex properties) to at least one other big idea.	**Students will investigate how polymers, such as enzymes function in particular cellular processes, such as glycolysis, the Krebs Cycle and the Calvin Cycle. This assignment connects Big idea 4 to Big Idea 2.**
CR4a The course provides students with opportunities outside of the laboratory investigations to meet the learning objectives within Big Idea 1.	**Students will access data using the BLAST website to analyze genetic and protein sequences between different organisms.**
CR4b The course provides students with opportunities outside of the laboratory investigations to meet the learning objectives within Big Idea 2.	Big Idea #2: **Investigation 5: Photosynthesis: An inquiry lab where students will design and execute an experiment that investigates the effect of an environmental condition on the rate of photosynthesis. Students will use a mass spectrophotometer and the electron acceptor DPIP to determine rate of photosynthesis under effects of boiling and darkness. Students will**

	connect this lab to dissolved oxygen lab where similar variables were used to calculate primary productivity in an aquatic environment. OR **Photosynthesis Lab: Leaf Disc Floating Lab: Students will use plungers to remove air from the spongy mesophyll space in discs of leaves. They will apply different variables (temperature, light intensity or wavelength, pH of water etc) to determine the effect of the variable on photosynthesis rate, as indicated by the leaf filling with oxygen and floating to top of beaker.**
CR4c The course provides students with opportunities outside of the laboratory investigations to meet the learning objectives within Big Idea 3.	**Investigation 7: Mitosis and Meiosis: Students will use paper models of chromosomes to demonstrate stages of mitosis and meiosis. Students will use slides of onion root tips to determine amount of cells in each stage of mitosis and utilize Chi Square to analyze data. Students will observe karyotypes online at "The Biology Project" from University of Arizona to identify genetic disorders. Students will read about HeLa cells from article by Rebecca Skloot in NYTimes, "Who owns your cells?" to discuss ethical issues behind cell ownership and Henrietta Lack's cancer cells use. Students will use sordaria flashcards to determine amount of crossing over in meiosis.**
CR4d The course provides students with opportunities outside of the laboratory investigations to meet the learning objectives within Big Idea 4.	**Animal Behavior Lab: Students will generate a scientific hypothesis and create a controlled experiment to test behavior of isopods to observe taxis and kinesis. Students will communicate scientific inquiry by writing full lab report, including experimental design and analysis of results.**
CR5 The course provides students with opportunities to connect their biological and scientific knowledge to major social issues (e.g., concerns, technological advances, innovations) to help them become scientifically literate citizens.	**Students will investigate the ethical decision-making skills necessary in the realms of biotechnology. They will watch a TED talk on CRISPR, read current events articles and discuss possible ethical scenarios of treatment versus enhancement.**
CR6 The student-directed laboratory investigations used throughout the course allow students to apply the seven science practices defined in the AP Biology Curriculum Framework and include at least two lab experiences in each of the four big ideas.	**At least two lab experiences are offered to students in each of the four big ideas.**
CR7 Students are provided the opportunity to engage in investigative laboratory work integrated throughout the course for a minimum of 25 percent of instructional time.	**At least 36 hours, 25% of the total 144 hours are devoted to lab instruction.**
CR8 The course provides opportunities for students to develop and record evidence of their verbal, written and graphic communication skills through laboratory reports, summaries of literature or scientific investigations, and oral, written, or graphic presentations.	**Students summarize Survival of the Sickest, a novel demonstrating evolutionary trends in human illnesses. Students complete lap reports, poster presentations and do oral presentations of collected data.**

Course Weighting: Advanced Placement Biology

Major Assessments (Tests, Written Lab Reports)	45%
Skills Application (Quizzes, Short Labs)	30%
Skills Practice (Class Activities, Homework)	20%
Participation	5%
Total	100%

Curriculum Map

1. **Marking Period One**
   Unit 1: Biochemistry
   Unit 2: Cells, Cell Transport and Cell Communication
   Unit 3: Energy and Enzymes

   Marking Period One -Goals:
   Understanding of:
   -Basic Atomic structure
   -Types of bonds
   -Properties of water
   -Properties of acids and bases
   -Organic Molecules structure and function
   -Cell structures and functions
   -Cellular diversity
   -How cell membranes permit transport of molecules
   -Mechanisms of cellular communication
   -Immune system mechanisms
   -Nervous system mechanisms
   -Endocrine system mechanisms
   -ATP as cellular energy
   -Structure and function of enzymes
   -Comparison of endergonic and exergonic reactions
   -Enzymes as biological catalysts

2. **Marking Period Two**
   Unit 4: Cellular Respiration and Photosynthesis
   Unit 5: Cell Division: Mitosis and Meiosis
   Unit 6: DNA and Protein Synthesis

   Marking Period Two -Goals:
   Understanding of:
   -The reactants, products and location of each stage of cellular respiration
   -Alternative pathways for ATP production
   -The reactants, products and location of each stage of photosynthesis

-Alternative pathways/mechanisms for reduction of transpiration
-The stages of and products of mitosis
-The stages and products of meiosis
-Source for variation in prokaryotes
-Sources for variation in sexual reproduction
-Historical experiments leading to understanding of DNA structure and function
-Mechanism for DNA replication
-Mechanism for gene expression (protein synthesis)
-Methods of gene expression control in prokaryotes and eukaryotes

3. **Marking Period Three**
   Unit 7: Biotechnology
   Unit 8: Genetics
   Unit 9: Evolution
   Unit 10: Origins, Diversity and Classification

Marking Period Three –Goals:
Understanding of:
-Current uses and practices of biotechnology
-Ethical considerations for biotechnology
-Mendelian genetic inheritance (dominance, incomplete dominance, co-dominance)
-Sex linked traits, and linked genes
-Depiction of genetic inheritance in pedigrees
-Definition of evolution
-Natural selection as a mechanism of evolution
-Evidences that support and reinforce evolution
-The use of Hardy Weinberg to calculate allele frequencies
-Mechanisms leading to evolution
-Biological Species concept and isolating mechanisms
-Theories on origins of life
-Levels of classification of living things
-Prokaryotic diversity
-Viral diversity and mechanisms of infection

4. **Marking Period Four**
   Unit 11: Ecology and Behavior
   Unit 12: Animal Kingdom and Human Body Systems
   Unit 13: Plant Diversity and Structures

Marking Period Four -Goals:
Understanding of:
-The adaptive significance of behaviors
-How evolution influences behavior
-Specific examples of learned and innate behaviors

-Factors that affect population growth
-Interactions between different species at a community level
-Trophic Structure
-Interactions of biotic and abiotic factors at an ecosystem level
-Types of terrestrial and aquatic biomes
-Influences of human activity on the biosphere
-Animal development
-Animal Phyla diversity
-Digestive system structures and function
-Circulatory system structures and function
-Muscle contraction
-Comparative anatomy of different animals
-Basic divisions of plants
-Plant tissues and organs
-Plant reproduction with focus on angiosperms
-Plant hormones, behaviors and adaptations

Big Ideas

Big Idea #1: All organisms are made of cells and can be characterized by common aspects of their structure and functioning

Big Idea # 2: Organisms grow, reproduce, and perpetuate their species by obtaining necessary resources through interdependent relationships with other organisms and the physical environment.

Big Idea #3: Heredity refers to specific mechanisms by which characteristics or traits are passed from one generation to the next via genes, and explains why offspring resemble, but are not identical to, their parents.

Big Idea # 4: Biological evolution explains both the unity and diversity of species and provides a unifying principle for the history and diversity of life on Earth.

Textbooks and Supplemental Resources

Urry, Cain, Wasserman, Minorsky, Orr. (2020) AP Edition Campbell Biology 12th Ed. New York, NY. Pearson

College Board AP Classroom: https://apcentral.collegeboard.org/courses/ap-biology/course

HHMI Biointeractive: https://sites.google.com/site/biologydarkow/

Jon Darkow Laboratory Simulations: https://sites.google.com/site/biologydarkow/

Moalem, S. (2008) Survival of the Sickest: The Surprising Connections Between Disease and Longevity. New York, NY. Harper Perennial.

NOVA Evolution Lab: https://www.pbs.org/wgbh/nova/labs/lab/evolution/

Zedalis, J. and Eggebrecht, J. "OpenStax Instructor Resources for AP Biology". https://openstax.org/details/books/biology-ap-courses?Instructor%20resources

Zedalis, J. and Eggebrecht, J. "OpenStax Student Resources for AP Biology". https://openstax.org/details/books/biology-ap-courses?Student%20resources

UNIT: Biochemistry

Curriculum Plan

Unit: Biochemistry **Time Range in Days: 15 days**

Standard(s):
PA- Academic Standards: Science and Technology and Engineering Education
PACCS Reading and Writing for Science and Technology

Standards Addressed:
3.1.B.A2, 3.1.B.A5, 3.1.B.A7, 3.1.B.A8, 3.1.C.A1, 3.1.C.A2, 3.1.C.A7, 4.1.10.C

Anchor(s): Biology Keystone Anchors
BIO.A.3.1.1, BIO.A.3.2.1, BIO.A.3.2.2, BIO.A.2.1.1, BIO.A.2.2.1, BIO.A.2.2.2, BIO.A2.2.3, BIO.A.2.3.1, BIO.A.2.3.2

Standards Addressed:

http://www.pdesas.org/module/sas/curriculumframework/
http://www.pdesas.org/standard
https://www.pdesas.org/Standard/PACore

Overview: Students will identify the chemical basis of living things including the major molecules and elements that are present in living cells and tissues; distinguish between types of bonds that form molecules and compounds; describe properties of water and the significance of the molecule in living systems; distinguish between acids and basis and identify ways that pH affects the functioning of living systems; and identify and describe the structure and function of organic macromolecules, including carbohydrates, lipids, proteins, and nucleic acids.

Objectives:
(Students will be able to)

1. Identify and distinguish between the three subatomic particles found in atoms (DOK 1, 2)
2. Describe the properties of nonpolar and polar covalent bonds and ionic bonds (DOK 2)
3. Predict if a covalent bond is polar or nonpolar. (DOK3)
4. Evaluate why different bonds affect the properties of a molecule. (DOK3)
5. Identify patterns about the unique properties of water and explain the molecular basis behind the properties (DOK 2)
6. Describe how the emergent properties of water directly affect living things (DOK3)
7. Compare acidic solutions and basic solutions, evaluate the importance of buffers in biological systems (DOK 3)
8. Relate the properties of carbon to its significance in many different structural and functional characteristics of living things (DOK 2)
9. Identify and describe the properties of functional groups (DOK2)

10. Compare and contrast the structures and functions of each of the four groups of macromolecules (DOK 2)
11. Identify macromolecules based on structure or function (DOK4)
12. Identify the factors that can cause denaturing of enzymes. (DOK1)

Core Activities and Corresponding Instructional Methods (include, but are not limited to):

1. From *Practicing Biology,* 3rd Edition. Activity 4.1/5.1 "How can you identify organic macromolecules?"
2. Paper Lab: Dehydration synthesis/Hydrolysis of Protein, Carbohydrate and Nucleic Acid polymers: students use paper molecules to build polymers from monomers, demonstration removal of hydroxyl group and hydrogen to generate water molecule. Discussion of structure of monomers and polymers, hydrolysis and dehydration synthesis.
3. Protein Structure Tuber Lab: Students will be given bendable tubes to simulate a protein, must determine tertiary shape of protein based on supplied sequence of amino acid primary structure. Group discussion of protein folding- importance of structure and function. Demonstrate use of "fold.it" game online. **(SP 1)**
4. Class demonstration of protein denaturing using whole milk, heat and vinegar. Discussion of other examples of denaturing in food science will be discussed.
5. Students will use cards of biological models to find patterns in molecules. They will identify functional groups and organize the molecules based on size and structure. They will work in a Think, Pair, Share grouping to make conclusions on each molecule group.

Assessments:

Diagnostic:	Teacher Observation
	Pre-labs
	Discussion
	Chapter Outline
Formative:	Teacher Observation
	Discussion
	AP Free-Response Essay questions
	Quizzes
	Homework
	Projects
Summative:	Quizzes/Tests: Biochemistry

UNIT: Cells, Cell Transport and Cell Communication

Curriculum Plan

Unit: Cells, Cell Transport and Cell Communication **Time Range in Days: 15-25 days**

Standard(s):
PA- Academic Standards: Science and Technology and Engineering Education
PACCS Reading and Writing for Science and Technology

Standards Addressed:
3.3.4.B, 3.3.7.B, 3.3.10B, 3.1.B.A1, 3.1.B.A2, 3.1.B.A4, 3.1.A.B.A5, 3.1.B.A6, 3.1.B.A7, 3.1.C.A1, 3.1.B.C2, 4.1.3.A, 4.1.4.A

Anchor(s): Biology Keystone Anchors
BIO.A.1.1.1, BIO1.A.A, BIO.A.2.1.1, BIO.A.4.1.1, BIO.A.4.1.2, BIO.A.4.1.3

Standards Addressed:

http://www.pdesas.org/module/sas/curriculumframework/
http://www.pdesas.org/standard
https://www.pdesas.org/Standard/PACore

Overview:
Students will identify the three main components of the cell theory; compare and contrast prokaryotic and eukaryotic cells and provide examples of each type; identify examples of cell specialization and the formation of tissues; explain the significance of cell parts and how their structure relates to their function; and describe the mechanisms and the energy requirements that allow materials to move into and out of a cell. Mechanisms of cellular communication will be elaborated upon by applying information to human nervous, immune and endocrine systems.

Objectives:
1. State the three parts of the cell theory (All living things are made of cells; cells are the basic structure and function of living things; all cells come from pre-existing cells) and be able to apply each part to an example in nature (DOK 1, 4)
2. List and arrange the cellular organization of living things (cells→tissues→organs→organ systems→organism) (DOK 1)
3. Relate an example to the cellular organization of living things (DOK 2)
4. Make connections of diversity and specialization of cells to real-life examples (DOK 4)
5. Compare and contrast prokaryotic and eukaryotic cells (DOK 2)
6. List organelles found in eukaryotic cells (DOK 1)
7. Classify structural features of eukaryotic cell organelle and relate the structural features with the organelle's function (DOK 2)
8. Relate structures of chloroplasts and mitochondria to prokaryotic cells in support of the Endosymbiotic Theory (DOK 3)

9. Identify components of the cell membrane (DOK 1)
10. Apply knowledge of concentration gradients in order to explain the mechanisms by which materials move across the cell membrane (DOK 4)
11. Recall the energy requirements that apply to different types of cell transport (DOK 1)
12. Predict the mechanism of transport through the cell membrane of a molecule based on its properties (DOK 4)
13. Calculate water potential and use data to predict flow of water through cell membranes (DOK 4)
14. Evaluate the use of compartmentalization to increase cell efficiency (DOK 3)
15. Identify and describe the three stages of cellular communication, (DOK 1 and 3)
16. Discuss specific mechanisms of cell reception, transduction and response (DOK 3)
17. Predict and justify the location of reception for a protein and lipid hormone (DOK4)
18. Explain why similar signals can elicit different responses from cells and evaluate the use of signaling for multicellular organisms (DOK 2 and 4)
19. Apply concepts from entire unit to the human nervous, immune and endocrine systems. (DOK 3)
20. Predict outcomes of disruptions in normal cellular functions. (DOK 4)

Core Activities and Corresponding Instructional Methods (include, but are not limited to):

1. **Big Idea #2:** Investigation 4: Diffusion and Osmosis Lab: Students will investigate cell size and surface area's effect on rate of diffusion. Students will use dialysis tubing and process of osmosis to determine molarity of unknown sucrose solutions. Students will determine solute concentration of potato and use mathematical methods to determine solute potential and water potential of potato cells. **(SP 2, 4, 5)**
2. Cell membrane model: Students will create a model of the cell membrane using pasta and cereal. They must identify components of the cell membrane including phospholipid bi-layer, a variety of proteins, glycoproteins and glycolipids and cholesterol. Students must identify the purpose of each component. **(SP 1)**
3. Students will work in small groups to predict what is happening at a cellular level in different scenarios regarding osmosis. They will create before and after drawings to demonstrate understanding of water movement into and out of cells.
4. Students will consider relationship of structure and function of different illustrative examples of real cells that reduce surface area to volume ratio.
5. Students will access and evaluate supports for the evolution of cell compartmentalization and the Endosymbiotic Theory.
6. Students will watch Bonnie Bassler's TED talk on Quorum Sensing.
7. Light, Camera, Action Potential: students will create lab to simulate movements of sodium and potassium into and out of neuron as action potential is fired. **(SP1)**
8. Comparison and contrasting of innate and acquired immune responses. Students will analyze of primary and secondary response graph and discussion of memory cells and clonal selection for memory cells.
9. Rat Endocrine Pathways: Students will be given data on rats that have been given specific hormones and evaluate what endocrine pathway has been disrupted by comparing data to control rats. **(SP 2,5,7)**

Assessments:

Diagnostic:	Teacher Observation
	Pre-labs
	Discussion
	Chapter Outline
Formative:	Teacher Observation
	Discussion
	AP Free-Response Essay questions
	Quizzes
	Homework
	Projects
Summative:	Quizzes/Tests: Cells, Cell transport and Cell Communication

UNIT: Energy and Enzymes

Curriculum Plan

Unit: Energy and Enzymes **Time Range in Days: 7 days**

Standard(s):
PA- Academic Standards: Science and Technology and Engineering Education
PACCS Reading and Writing for Science and Technology

Standards Addressed:
3.1.B.A.7, 3.1.C.A2, 3.1.C.A2

Anchor(s): Biology Keystone Anchors
BIO.A.2.2.2, BIO. A. 2. 3.1, BIO.A.2.3.2

Standards Addressed:

http://www.pdesas.org/module/sas/curriculumframework/
http://www.pdesas.org/standard
https://www.pdesas.org/Standard/PACore

Overview:
Students will investigate the need for activation energy in reactions. Students will compare between endergonic and endergonic reactions. Students will gain the understanding that photosynthesis and cell respiration are examples of cell processes that transfer energy through an ecosystem. Students will distinguish between the reactants and products of each process and be able to identify the cell structures and specific steps that are responsible for carrying out the processes. Finally, students will describe the relationship that exists between photosynthesis and cell respiration for the overall success of an ecosystem.

Objectives:
(Students will be able to)

1. State and apply the effects of the first and second law of thermodynamics (DOK1, 4)
2. State the properties of endergonic and exergonic reactions. (DOK1)
3. Predict if a reaction is exergonic or endergonic (DOK4)
4. Identify the structure of ATP and explain its role in cellular work. (DOK2)
5. Explain the effect of enzymes in lowering activation energy to catalyze reactions. (DOK2)
6. Predictand justify enzyme efficiency based on environmental factors and presence of inhibitors or co-enzymes. (DOK 3)

Core Activities and Corresponding Instructional Methods (include, but are not limited to):

1. **Big Idea #4:** Investigation 13: Enzyme Catalysis (Modified): Students will investigate enzyme activity using liver catalase to decompose hydrogen peroxide into water and oxygen gas. Students will then investigate the effect of temperature or pH on enzyme activity by designing and executing an experiment of their own. They will communicate results of their experiment by creating a scientific poster of methods and data results. **(SP 4, 5)**
2. **Big Idea#4:** Toothpickase lab: Students will simulate enzyme dynamics in different conditions by breaking toothpicks with their hands. They will look at the effect of substrate concentration, enzyme concentration, the effect of temperature and collect data to analyze. They will create graphical representations of their data and relate the simulation to real enzyme activity. **(SP 1,2,5)**
3. **Big Idea #4:** Apple Browning lab: Students will design an experiment that explores the effect of student-determined variables on enzymatic browning in apples. They will collect quantitative and/or qualitative data and write a lab report on their findings. They will research current genetically modified apples that have mechanisms for reduction of browning. **(SP 2,3,4,5)**

Assessments:

Diagnostic: Teacher Observation
Pre-labs
Discussion
Chapter Outline

Formative: Teacher Observation
Discussion
AP Free-Response Essay questions
Quizzes
Homework
Projects

Summative: Quizzes/Quizzam: Enzymes and Energy

UNIT: Cellular Respiration and Photosynthesis

Curriculum Plan

Unit: Cellular Respiration and Photosynthesis **Time Range in Days: 15 days**

Standard(s):
PA- Academic Standards: Science and Technology and Engineering Education
PACCS Reading and Writing for Science and Technology

Standards Addressed:
3.3.10A, 3.1.C.A1, 3.3.10B, 3.4.10A, 3.1.B.A2, 3.1.B.A2, 3.1.B.A5, 3.1.B.A7, 4.1.10.C

Anchor(s): Biology Keystone Anchors
BIO.A.3.1.1, BIO.A.3.2.1, BIO.A.3.2.2., BIOA.2.3.1, BIO.A.2.3.2

Standards Addressed:

http://www.pdesas.org/module/sas/curriculumframework/
http://www.pdesas.org/standard
https://www.pdesas.org/Standard/PACore

Overview:
Students will investigate the need for activation energy in reactions. Students will compare between endergonic and endergonic reactions. Students will gain the understanding that photosynthesis and cell respiration are examples of cell processes that transfer energy through an ecosystem. Students will distinguish between the reactants and products of each process and be able to identify the cell structures and specific steps that are responsible for carrying out the processes. Finally, students will describe the relationship that exists between photosynthesis and cell respiration for the overall success of an ecosystem.

Objectives:
(Students will be able to)

1. Recognize that light and pigments are necessary components of photosynthesis (DOK1)
2. Identify and explain the role of electron carrier molecules in photosynthesis (DOK 1, 3)
3. Write the chemical equation for photosynthesis, including both reactants and products (DOK 1)
4. Distinguish between the light-dependent reactions and the light-independent reactions in photosynthesis (DOK 2)
5. Identify and be able to draw the general structure of a chloroplast (DOK 1)
6. Compare the different factors that affect the rate at which photosynthesis (DOK 3)
7. Label a cross-section of a leaf and be able to distinguish which tissues are involved in photosynthesis (DOK 1, 2)
8. Explain the use of evolutionary adaptations (CAM and C4) for reduction of transpiration. (DOK3)

9. Explain the general purpose of cell respiration (DOK 1)
10. Write the chemical equation for cellular respiration, including reactants and products (DOK 1)
11. Identify and be able to draw the general structure of a mitochondrion (DOK 1)
12. State what happens during glycolysis (DOK 1)
13. Summarize what happens during the Krebs cycle (DOK 2)
14. Recognize how high-energy electrons are used by the electron transport chain (DOK 1)
15. Discuss the functionality of ATP Synthase and its use of electrochemical proton gradient to generate ATP energy (DOK 4)
16. Compare and contrast aerobic and anaerobic respiration (DOK 2)
17. Describe different types of anaerobic respiration (alcohol fermentation and lactic acid fermentation) (DOK 1)
18. Analyze the net production of ATP that is generated by both anaerobic and aerobic respiration (DOK 4)
19. Assess the relationship that exists in ecosystems between the processes of photosynthesis and cellular respiration (DOK 3)
20. Identify which types of cells undergo photosynthesis and cell respiration (DOK 1)
21. Apply prior understanding of autotrophs and heterotrophs to the processes of photosynthesis and cell respiration (DOK 4)
22. Evaluate and compare the use of different variations of biological molecules that affect fitness of organisms (DOK 4)

Core Activities and Corresponding Instructional Methods (include, but are not limited to):

1. **Big idea #2:** Investigation 6: Pea Respiration: Using knowledge of the process of cellular respiration and of how to set timed experiments using the Vernier labquest software and carbon dioxide probes, students will engage in the process of inquiry as they conduct an experiment to measure the rate of cell respiration in germinating peas at room temperature. Next, students will design a controlled experiment to answer a question of their choice that they asked while conducting the experiment at room temperature. Students will collect and determine cellular respiration rates and demonstrate an understanding of concepts involved by preparing a report in their laboratory research**. (SP 2, 3, 4, 5)**

2. Fermentation lab: Students will investigate the effect of concentration of reactants, enzymes and different environmental variables (temperature and pH) on the rate of Fermentation by years, as measured by Vernier LabQuest CO2 sensors.

3. Students will analyze provided data on fermentation of wine to practice graph reading, and analysis the effects of reactants, products and genetic modification on rates of anaerobic respiration.

4. **Big Idea #2:** Investigation 5: Photosynthesis: An inquiry lab where students will design and execute an experiment that investigates the effect of an environmental condition on the rate of photosynthesis. Students will use a mass spectrophotometer and the electron acceptor DPIP to determine rate of photosynthesis under effects of boiling and darkness. Students will connect this lab to dissolved oxygen lab where similar variables were used to calculate primary productivity in an aquatic environment. **OR** Photosynthesis Lab: Leaf Disc Floating Lab: Students will use plungers to remove air from the spongy mesophyll space in discs of leaves. They will apply different variables (temperature, light intensity or wavelength, pH of water etc) to determine the

effect of the variable on photosynthesis rate, as indicated by the leaf filling with oxygen and floating to top of beaker. **(SP 1, 2, 5, 7)**
5. Students will evaluate the variation of phospholipids, hemogblobins and chlorophylls to determine how variations such s these can increase fitness of an organism.

Assessments:

Diagnostic:	Teacher Observation
	Pre-labs
	Discussion
	Chapter Outline
Formative:	Teacher Observation
	Discussion
	AP Free-Response Essay questions
	Quizzes
	Homework
	Projects
Summative:	Quizzes/Tests: Cellular Respiration, Photosynthesis

UNIT: Cell Division

Curriculum Plan

Unit: Cell Division **Time Range in Days: 8 days**

Standard(s):
PA- Academic Standards: Science and Technology and Engineering Education
PACCS Reading and Writing for Science and Technology

Standards Addressed:
3.1.B.A1, 3.1.B.B1, 3.1.B.B3, 3.1.B.A4, 3.1.B.A5, 3.1.B.B1, 3.1.B.B2, 3.1.B.B4, 3.1.B.B5, 3.1.B.C2, 3.1.C.C2, 4.4.10.A, 4.4.12, A, 4.4.10.B, 4.4.12.B

Anchor(s): Biology Keystone Anchors
BIO.B.1.1.1, BIO.B.1.1.2, BIO.B.1.2.1, BIO.B.2.1.2, BIO.B.2.3.1, BIO.B.2.4.1

Standards Addressed:

http://www.pdesas.org/module/sas/curriculumframework/
http://www.pdesas.org/standard
https://www.pdesas.org/Standard/PACore

Overview:
Students will discuss the differing types of cell reproduction and division in order to gain an understanding of how organisms develop, grow, repair tissues, and reproduce. Students will learn vocabulary essential for the understanding of both mitosis and meiosis and why each process is so important for the survival of an organism and the entire species.

Objectives:
(Students will be able to)

1. Recognize that cell size is limited because of growth (DOK 1)
2. Compare asexual and sexual reproduction (DOK 2)
3. Summarize the stages of the cell cycle (DOK 2)
4. Identify different forms of DNA and how it should appear at different stages of the cell cycle (molecular, chromatin, chromosome) (DOK 1)
5. Explain the role of DNA and chromosomes in cell division (DOK 1)
6. Differentiate between diploid and haploid cells (DOK 3)
7. Explain the role of interphase in preparation for cell division (DOK 1)
8. Describe what happens during the four phases of mitosis (DOK 1)
9. Describe the process of cytokinesis (DOK 1)
10. State how the cell cycle is regulated (DOK 1)
11. Distinguish between cancer cells and healthy cells
12. Relate the onset of cancer to the control of the cell cycle (DOK 2)

13. Compare and contrast a somatic cell and a gamete (DOK 2)
14. Summarize the events of meiosis (DOK 2)
15. Compare and contrast meiosis and mitosis (DOK 2)
16. Describe mechanisms to increase variation during meiosis (DOK 3)
17. Explain what a karyotype is and why it is used (DOK 1)
18. Create and analyze a karyotype (DOK 4)
19. Recognize chromosomal defects that may occur during meiosis (DOK 1)
20. Apply an understanding of cells to the processes of mitosis and meiosis (DOK 4)
21. Recognize that some traits (mitochondrial and chloroplast) are maternally inherited (DOK 2)
22. Compare the features and examples of positive and negative feedback (DOK 1-3)

Core Activities and Corresponding Instructional Methods (include, but are not limited to):

1. Big Idea #3: Investigation 7: Mitosis and Meiosis: Students will use paper models of chromosomes to demonstrate stages of mitosis and meiosis. Students will use slides of onion root tips to determine amount of cells in each stage of mitosis and utilize Chi Square to analyze data. Students will observe karyotypes online at "The Biology Project" from University of Arizona to identify genetic disorders. Students will read about HeLa cells from article by Rebecca Skloot in NYTimes, "Who owns your cells?" to discuss ethical issues behind cell ownership and Henrietta Lack's cancer cells use. Students will use sordaria flashcards to determine amount of crossing over in meiosis. **(SP 1, 2, 5, 7)**
2. Students will utilize selected readings from Survival of the Sickest to discuss genetic disorders **(SP 7)**
3. Students will investigate cell cycle control proteins and pathways. They will research a protein involved in a type of cancer and determine the role of the protein in stimulating cancer growth.

Assessments:

Diagnostic:	Teacher Observation
	Pre-labs
	Discussion
	Chapter Outline
Formative:	Teacher Observation
	Discussion
	AP Free-Response Essay questions
	Quizzes
	Homework
	Projects
Summative:	Quizzes/Tests: Cell Division

UNIT: DNA and Protein Synthesis

Curriculum Plan

Unit: DNA and Protein Synthesis **Time Range in Days: 10-15 days**

Standard(s):
PA- Academic Standards: Science and Technology and Engineering Education
PACCS Reading and Writing for Science and Technology

Standards Addressed:
3.1.B.A1, 3.1.B.A5,3.1.B.A6, 3.1.B.B1, 3.1.B.B2, 3.1.3B.B3, 3.1.B.B5,3.1.B.C2, 3.1.C.B3, 3.1.C.C2

Anchor(s): Biology Keystone Anchors
BIO.A.1.2.2, BIO.B.1.2.1, BIO.B.1.2.2, BIO.B.2.2.1, BIO.B.2.2.2, BIO.A.4.1.3

Standards Addressed:

http://www.pdesas.org/module/sas/curriculumframework/
http://www.pdesas.org/standard
https://www.pdesas.org/Standard/PACore

Overview:
Students will be exposed to a greater analysis of nucleic acids (first presented in Unit 2) by studying the structural and functional characteristics of deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). Students will learn about the mechanisms of DNA replication; DNA transcription and the formation of RNA; and the role of DNA and RNA in protein synthesis (translation). Students will also relate this new understanding of the molecular structure of DNA to their most recent topic of study—meiosis and the vital role of DNA in heredity. Moreover, students will analyze Mendelian patterns of inheritance and become acclimated with predicting genetic crosses through the use of tools such as Punnett Squares and Pedigree Charts. Lastly, students will site evidence of biotechnology and how it applies to the study of genetics.

Objectives:
(Students will be able to)

1. Identify the role of DNA in heredity (DOK 1)
2. Recall that nucleotides are the molecular subunits of DNA discussed in chapter 2 (DOK 1)
3. Label a subunit in DNA (DOK 1)
4. Illustrate the double helix structure of DNA (DOK 1)
5. Summarize the events and role of enzymes in DNA replication (DOK 2)

6. Identify DNA replication as a repeating pattern that occurs in an organism's lifetime (DOK 2)
7. Recognize that mutations may occur during DNA replication and may or may not have observable effects (DOK 2)
8. Compare DNA in prokaryotes with that of eukaryotes (DOK 2)
9. Compare and contrast the structure of DNA to that of RNA (DOK 2)
10. List the 3 major types of RNA (DOK 1)
11. Explain why DNA must make mRNA to successfully produce proteins (DOK 1)
12. Describe the mechanism of RNA splicing in eukaryotic cells (DOK 2)
13. Summarize the process of transcription (DOK 2)
14. Recall that amino acids are the subunits of proteins (DOK 1)
15. Make connections to show how mRNA codons, that were transcribed from a DNA blueprint, are then translated into a code of amino acids (DOK 4)
16. Summarize the process of protein synthesis (translation), including the role of DNA, mRNA, tRNA, and rRNA (DOK 2)
17. Describe different types of mutations (DOK 1)
18. Create an analogy for the process of protein synthesis (DOK 4)
19. Compare the process of protein synthesis in prokaryotic and eukaryotic cells (DOK 3)
20. Predict some of the difficulties in performing protein synthesis of eukaryotic genes in prokaryotic cells and explain methods used by scientists to overcome (DOK 4)
21. Investigate the multiple mechanisms of protein synthesis control, including, but not limited to: Epigenetic controls, transcription factors, activators, repressors, alternative mRNA splicing, miRNA, siRNA and epigenetic factors (DOK3)
22. Investigate the role and mechanisms of operon regulation in prokaryotic cells (DOK3)
23. Discuss the types of point mutations in DNA and the effect on amino acid sequences and protein structure and function (DOK 4)
24. Discuss the types, causes and impacts of chromosomal mutations (DOK 1,3)

Core Activities and Corresponding Instructional Methods (include, but are not limited to):

1. **Click and Learn Biointeractive: HHMI website: Lactase Persistence** Students will review an activity that explores the chemical mechanism of lactose digestion in humans as well as the adaptive significance of the trait. **(SP 5,6,7)**
2. Students will work in groups to create a model and presentation to depict how a cell could control expressing or not expressing a gene at each level of protein synthesis.
3. Students will read Rosalind Franklin "Work Another Look" in the AP classroom resources.
4. Students will use dnai.org to learn about the experiments and historical perspectives leading towards the determination of DNA as the genetic material.

Assessments:

Diagnostic:	Teacher Observation
	Pre-labs
	Discussion
	Chapter Outline
Formative:	Teacher Observation
	Discussion
	AP Free-Response Essay questions
	Quizzes
	Homework
	Projects
Summative:	Quizzes/Tests: DNA and Protein Synthesis

UNIT: Biotechnology and Ethics

Curriculum Plan

Unit: Biotechnology and Ethics **Time Range in Days: 10 days**

Standard(s):
PA- Academic Standards: Science and Technology and Engineering Education
PACCS Reading and Writing for Science and Technology

Standards Addressed:
3.1.B.B1, 3.1.B.B3, 3.1.B.B5, 3.1.C.B3, 3.1.C.C2

Anchor(s): Biology Keystone Anchors
BIO.B.2.2.1, BIO.B.1.2.2, BIO.B.2.4

Standards Addressed:

http://www.pdesas.org/module/sas/curriculumframework/
http://www.pdesas.org/standard
https://www.pdesas.org/Standard/PACore

Overview:
Genetic manipulation is a constantly developing field. Scientists are developing, applying and elaborating on methods to change DNA, clone cells and organisms and stimulate differentiation. Genetic analysis is used in multiple fields, including crime scene analysis and genetic relatedness studies. As the technology develops and changes, one must be mindful of the implications of these new advances: the potential power and harm they can cause must be evaluated in an ethical nature.

Objectives:
(Students will be able to)

1. Identify examples of biotechnology and genetic engineering (DOK 1)
2. Investigate the mechanism of plasmid-based genetic transformation in bacteria (DOK3)
3. Analyze DNA samples using gel electrophoresis (DOK4)
4. Evaluate the ethical viewpoints and considerations of biotechnological uses (DOK4)

Core Activities and Corresponding Instructional Methods (include, but are not limited to):
1. **Big idea #3:** Investigation 8 Biotechnology Transformation Lab: Students will perform a transformation experiment in which they transform a bacterial cell to contain a plasmid containing a gene which can be expressed so as to produce protein products which make the cell "glow". Students will then study the structure of the plasmid and make predictions regarding growth on various agar plates (LB plates, plates with ampicillin and arabinose added). **(SP 1, 3, 5, 6)**

2. **Big Idea #3:** Investigation 9 Biotechnology Gel Electrophoresis Lab: Students will use micro-techniques to restrict DNA, and using a marker DNA along with "crime scene" and "suspect" DNA, predict which suspect matches the crime scene. Students will understand the principles of gel electrophoresis. Students will collect quantitative data by using the marker DNA results to graph data. They will utilize band migration distances and extrapolate band sizes by extrapolating from their graphs. Students will extend this knowledge by investigating SNP DNA fingerprint analysis, using the Biointeractive Click and Learn.**(SP 3, 5, 6)**

Assessments:

Diagnostic:	Teacher Observation
	Pre-labs
	Discussion
	Chapter Outline
Formative:	Teacher Observation
	Discussion
	AP Free-Response Essay questions
	Quizzes
	Homework
	Projects
Summative:	Research Paper: Biotechnology and Ethical Considerations

UNIT: Genetics

Curriculum Plan

Unit: Genetics **Time Range in Days: 10 days**

Standard(s):
PA- Academic Standards: Science and Technology and Engineering Education
PACCS Reading and Writing for Science and Technology

Standards Addressed:
3.1.B.B1, 3.1.B.B2, 3.1.B.B3, 3.1.C.C2

Anchor(s):Biology Keystone Anchors
BIO.B.1.2, BIO.B.2.1

Standards Addressed:

http://www.pdesas.org/module/sas/curriculumframework/
http://www.pdesas.org/standard
https://www.pdesas.org/Standard/PACore

Overview:
Students will analyze Mendelian patterns of inheritance and become acclimated with predicting genetic crosses through the use of tools such as Punnett Squares and Pedigree Charts. Lastly, students will site evidence of biotechnology and how it applies to the study of genetics.

Objectives:
(Students will be able to)

1. Describe Gregor Mendel's studies and conclusions about inheritance (DOK 1)
2. Recall what happens during segregation in meiosis (DOK 1)
3. Recognize patterns of inheritance of human traits (DOK 1)
4. Display how geneticists use the principles of probability to predict genetic crosses by setting up and analyzing Punnett Squares (DOK 2, 4)
5. Recall the principle of independent assortment as it applies to meiosis (DOK 1)
6. Explain how Mendel's principles apply to all organisms (DOK 1)
7. Define codominance and apply the ABO blood typing system as a model of codominance (DOK 1, 4)
8. Show the cause and effect relationship between gene expression and the environment (DOK 2)
9. Analyze a pedigree chart to better understand how geneticists can study inheritance patterns (DOK 4)

10. Cite evidence for the causes of genetic disorders—distinguish between small changes in DNA; errors occurring in meiosis; and chromosomal abnormalities (DOK 2, 3)

Core Activities and Corresponding Instructional Methods (include, but are not limited to):

1. Students will collect data from the offspring of different matings of fruit flies. They will then apply chi squared analysis to investigate of predicted ratios of offspring are close to collected data. **(SP 2, 7)**

2. Students will research and present on a specific human genetic disorder, including examples such as Tay Sachs, Red Green Colorblindiness, Huntington's Disease, sickle cell anemia and Down's Syndrome.

Assessments:

Diagnostic: Teacher Observation
Pre-labs
Discussion
Chapter Outline

Formative: Teacher Observation
Discussion
AP Free-Response Essay questions
Quizzes
Homework
Projects

Summative: Quizzes/Tests: Genetics

UNIT: Evolution

Curriculum Plan

Unit: Evolution **Time Range in Days: 15 days**

Standard(s):
PA- Academic Standards: Science and Technology and Engineering Education
PACCS Reading and Writing for Science and Technology

Standards Addressed:
3.1.B.A9, 3.1.B.B3, 3.1.B.C1, 3.1.B.C3, 3.3.10.C, 3.3.10.D, 4.7.10.C, 4.8.10.A, 4.8.10.C, 4.8.10.D

Anchor(s): Biology Keystone Anchors
BIO.B.3.1.1, BIO.B.3.1.2, BIO.B.3.1.3, BIO.B.3.2.1, BIO.B.3.3.1

Standards Addressed:

http://www.pdesas.org/module/sas/curriculumframework/
http://www.pdesas.org/standard
https://www.pdesas.org/Standard/PACore

Overview:
In this unit, students will learn that evolution is one of the foundations of biology and is a scientific explanation for the diversity of life on Earth. Students will read about and discuss historical events that have occurred to shape the current scientific principles of evolution and how it applies to species diversity, population changes, advancements in medicine, extinction of organisms, selective breeding, and more. Three main ideas will be addressed: 1. Evolution is the process by which the diversity of life on earth developed over time from common ancestors 2. Over time, the genetic makeup of a population changes, resulting in changes in the distribution of characteristics in that population 3. These changes result in differences within species (microevolution) as well as the emergence of new species (macroevolution).

Objectives:
(Students will be able to)

1. Define evolution (DOK 1)
2. Summarize Charles Darwin's journey on the *HMS Beagle* (DOK 2)
3. Explain Darwin's theory of natural selection and how it has affected changes in populations over time, or how it may affect future changes in populations (DOK 3)
4. Identify the patterns of biodiversity that were observed by Darwin (DOK 2)
5. Distinguish between the conclusions drawn by James Hutton and Charles Lyell about the Earth's history (DOK 2)

6. Compare Jean-Baptiste Lamarck's hypothesis of evolution with that of Darwin's (DOK 2)
7. Report on Thomas Malthus' view of human population growth (DOK 1)
8. Explain how the research of Hutton, Lyell, Lamarck, Malthus, Wallace and about artificial selection influenced Darwin's research (DOK 1)
9. Explain the role of inherited variation in artificial selection (DOK 1)
10. Identify the conditions under which natural selection occur (DOK 1)
11. Cite evidence of adaptions in nature (DOK 3)
12. Describe how an organism's fitness can affect its ability to survive (DOK 2)
13. Explain the principle of common descent (DOK 1)
14. Compare how geologic distribution of species relates to their evolutionary history (DOK 2)
15. Explain how fossils and the fossil record provide evidence of the descent of modern species from ancient ancestors (DOK 1)
16. Describe what homologous structures, analogous structures, vestigial structures, and embryology suggest about the process of evolutionary change (DOK 1)
17. Apply the idea that DNA is molecular evidence that can be used to trace the process of evolution (DOK 4)
18. Describe how genetics plays a role in evolutionary change (DOK 1)
19. Make connections about mutations and genetic variation in a population (DOK 4)
20. Identify ways in which genetic recombination in sexual reproduction plays a role in evolution (DOK 1)
21. Describe genetic drift (DOK 1)
22. Describe genetic equilibrium and state what types of factors may affect it (DOK 1)
23. Calculate allele frequencies and apply the Wardy Weinberg Theorem to determine if evolution has occurred based on changes (DOK 4)
24. Determine the likely sources for changes in allele frequencies (DOK 3)
25. Identify the types of isolation that can lead to the formation of new species (DOK 1)
26. Summarize the processes that influenced survival or extinction of a species (DOK 2)
27. Identify some of the hypotheses about early Earth and the origin of life (DOK 1)
28. Explain the endosymbiotic theory for the evolution of eukaryotes from prokaryotes (DOK 1)
29. Create and assess phylogenic trees based on available types of data (DOK 3, 4)

Core Activities and Corresponding Instructional Methods (include, but are not limited to):

1. **Big Idea #1:** NOVA: Evolution Lab: Students will perform Missions 1-3 (and may also do 4-5) to practice the creation of phylogenic trees based on different types of data. They will learn how to interpret trees and evaluate the significance of different types of data on how a tree is created**. (SP 1, 7)**

2. **Big Idea#1:** Investigation 3: BLAST LAB: Students will learn how to analyze cladograms and understand evolutionary relationships using the Basic Local Alignment Sequencing Tool. First students will practice interpreting cladograms. Then students will use ALIGN and BLAST programs to determine relatedness of reptiles and birds. Students will design a hypothesis to investigate relatedness of organisms of their choice and create a poster to share results with class. **(SP 1, 2, 3, 6, 7)**

3. **Big idea #1:** Investigation 2: Hardy Weinberg Theorem: Students will simulate a mating population and calculate allelic and genotypic frequencies using the Hardy Weinberg equations. Students will then create a hypothesis to predict what will happen to the allelic frequency of a trait that is selected against in a population. Class discussion will allow students to understand value of heterozygote advantage and allele variety. Students will connect these data to readings Survival of the Sickest. **(SP 1, 2, 4, 5, 6, 7)**
4. Students will investigate different illustrative examples of evolution, such as Hawaiian *Drosophila*, Caribbean *Anolis*, Apple Maggot *Rhagoletis*.
5. Students will analyze data collected by Peter and Rosemary Grant to practice standard deviation practice and determine the characteristics that drove evolution in the finches after an extreme draught.

Assessments:

Diagnostic:	Teacher Observation
	Pre-labs
	Discussion
	Chapter Outline
Formative:	Teacher Observation
	Discussion
	AP Free-Response Essay questions
	Quizzes
	Homework
	Projects
Summative:	Quizzes/Tests: Evolution

UNIT: Origins, Diversity and Classification

Curriculum Plan

Unit: Origins, Diversity and Classification **Time Range in Days: up to 10 days**

Standard(s):
PA- Academic Standards: Science and Technology and Engineering Education
PACCS Reading and Writing for Science and Technology

Standards Addressed:
4.7.10.C, 3.3.10.D

Anchor(s): Biology Keystone Anchors
BIO.B.3.1.1, BIO.B.3.2.1, BIO.B.3.3.1

Standards Addressed:

http://www.pdesas.org/module/sas/curriculumframework/
http://www.pdesas.org/standard
https://www.pdesas.org/Standard/PACore

Overview
There are multiple hypothesis that have supporting evidence as to how live originated on earth. One of the more compelling theories is Abiotic Synthesis: that life came from a synthesis of inorganic molecules. Other theories include Panspermia and Deep-Sea origins. All living things on Earth that have been observed have been classified based on specific set of criteria and evolutionary history. Students will explore traditional classification of organisms, modern evolutionary classification, and the tree of life that highlights common descent. Students will recall information from the evolution unit to make connections that the diversity of life on Earth is the result of ongoing evolutionary change and that species alive today have evolved from ancient common ancestors.

Objectives:
(Students will be able to)

1. Compare the different theories on life origins and evaluate the data that supports them. (DOK 3)
2. Use data to demonstrate the five global extinctions and provide evidence and sources for the current global extinction. (DOK 2)
3. Describe the goals of binomial nomenclature and systematics (DOK 1)
4. Identify the taxa in the classification system devised by Linnaeus (DOK 1)
5. Compare evolutionary classification and Linnaean classification (DOK 2)
6. Interpret a cladogram (DOK 2)
7. Analyze the use of DNA sequences in classification (DOK 4)

8. Name the six kingdoms of life as they are currently identified (DOK 1)
9. Explain what the tree of life represents (DOK 1)
10. Summarize some major characteristics of viruses (DOK 2)
11. Explain why viruses are not classified as living organisms (DOK 1)
12. Summarize some major characteristics of eubacteria (DOK 2)
13. Summarize some major characteristics of archaebacteria (DOK 2)
14. Compare and contrast eubacteria and archaebacteria (DOK 2)
15. Explain the role of bacteria in the living world (DOK 1)
16. Identify ways by which bacteria cause disease (DOK 2)
17. Identify ways by which viruses cause disease (DOK 2)
18. Summarize some major characteristics of protists (DOK 2)
19. Summarize some major characteristics of fungi (DOK 2)
20. Summarize some major characteristics of plants (DOK 2)
21. Summarize some major characteristics of animals (DOK 2)
22. Develop and support with evidences a logical argument that all organisms share common characteristics (DOK 3)

Core Activities and Corresponding Instructional Methods (include, but are not limited to):

1. Students will research the signs, symptoms, infection mechanisms and treatment of a specific type of virus. Students will use each other's research to identify a viral infection based on provided case studies.
2. Students will collect data using surveys to determine understanding of viruses and bacterial treatments of students in the school. Students will relate their graphed data to common misconceptions. Students will create a PSA to educate classmates on credible scientific fact.

Assessments:

Diagnostic:	Teacher Observation
	Pre-labs
	Discussion
	Chapter Outline
Formative:	Teacher Observation
	Discussion
	AP Free-Response Essay questions
	Quizzes
	Homework
	Projects
Summative:	Quizzes/Tests: Classification and Origins

UNIT: Behavior and Ecology

Curriculum Plan

Unit: Behavior and Ecology **Time Range in Days: 10-15 days**

Standard(s):
PA- Academic Standards: Science and Technology and Engineering Education
PACCS Reading and Writing for Science and Technology

Standards Addressed:
3.1.B.A2, 3.1.B.A4, 3.1.B.A5, 3.1.B.A7, 3.1.B.A8, 3.2.B.B.6,
3.2.C.A1, 4.1.5.C, 4.1.10.1, 4.1.10.B, 4.1.10.C, 4.1.10 E, 4.1.12.A, 4.1.12.C, 4.2.10.A, 4.2.10.B, 4.2.10.C,4.1.12.A, 4.2.12.B, 4.3.10B, 4.3.12.A, 4.5.10B, 4.5.12.B

Anchor(s): Biology Keystone Anchors
BIO.B. 4.1.1, BIO.B.4.1.2, BIO.4.2.1, BIO.4.2.2, BIO 4.2.3, BIO.4.2.4, BIO.4.2.5

Standards Addressed:

http://www.pdesas.org/module/sas/curriculumframework/
http://www.pdesas.org/standard
https://www.pdesas.org/Standard/PACore

Overview: Ecology is the study of interactions of living things and their environment. Ecology can be studied at multiple levels: population, community, ecosystem, biome and biosphere. Students will complete summer work to investigate the different levels of ecological study and how human activity impacts the ecosystem. At an organismal level, the adaptive behaviors of organisms will be reviewed and evaluated in terms of evolutionary fitness. The unit will also allow students to practice the scientific method and develop experiments.

Goals:

For students to better understand how scientific research and investigation applies to real-world situations and to identify patterns in nature by identifying the many factors that help to define ecology and the ways in which living things interact with each other and their environment.

Objectives:
1. State the goals of science. (DOK1)
2. Describe the steps used in scientific methodology. (DOK2)
3. List the characteristics of living things. (DOK1)
4. Explain how scientific attitudes generate new ideas. (DOK2)
5. Describe the importance of peer review. (DOK2)

6. Explain what a scientific theory is. (DOK1)
7. Explain the relationship between science and society. (DOK2)
8. Identify the central themes of biology. (DOK1)
9. Explain how life can be studied at different levels. (DOK1)
10. Describe the difference between learned and innate behaviors. (DOK2)
11. Identify and explain specific learned and innate behaviors. (DOK2)
12. Evaluate the adaptiveness of different examples of learned and innate behaviors. (DOK3)
13. Predict how the use of behaviors will affect organism interaction. (DOK4)
14. Investigate altruism in Kin Selection for increasing fitness. (DOK3)
15. Describe the study of ecology. (DOK2)
16. Explain how biotic and abiotic factors influence an ecosystem. (DOK3)
17. Describe the methods used to study ecology. (DOK2)
18. Define primary producers. (DOK1)
19. Predict how the loss of primary producers will affect the ecosystem. (DOK2)
20 Describe how consumers obtain energy and nutrients. (DOK1)
21. Trace the flow of energy through living systems. (DOK2)
22. Define niche. (DOK1)
23. Describe the role competition plays in shaping communities. (DOK2)
24. Describe the role predation and herbivory play in shaping communities. (DOK2)
25. Identify the three types of symbiotic relationships in nature. (DOK1)
26. Describe how ecosystems recover from a disturbance. (DOK2)
27. Compare succession after a natural disturbance with succession after a human-caused disturbance. (DOK3)
28. Describe and compare the characteristics of the major land biomes. (DOK3)
29. Discuss the factors that affect aquatic ecosystems. (DOK3)
30. Identify the major categories of freshwater ecosystems. (DOK1)
31. Describe and compare the distinct ocean zones that make up marine ecosystems. (DOK1)
32. List the characteristics used to describe a population. (DOK1)
33. Identify factors that affect population growth.(DOK2)
34. Describe exponential growth. (DOK1)
35. Describe logistic growth. (DOK1)
36. Analyze data to determine the type of population growth. (DOK4)
37. Identify factors that determine carrying capacity. (DOK1)
38. Identify the limiting factors that depend on population density. (DOK1)
39. Identify the limiting factors that do not depend on population density. (DOK1)
40. Discuss the trend of human population growth. (DOK2)
41. Describe human activities that can affect the biosphere. (DOK2)
42. Describe the relationship between resource use and sustainable development. (DOK2)
43. Describe how human activities affect soil and land. (DOK2)
44. Describe how human activities affect water resources. (DOK2)
45. Describe how human activities affect air resources.(DOK2)
46. Define biodiversity and explain its value. (DOK1)
47. Identify current threats to biodiversity. (DOK2)
48. Describe how biodiversity can be preserved. (DOK2)
49. Explain the concept of ecological footprint.(DOK1)
50. Identify the role of ecology in a sustainable future (DOK1)

Core Activities and Corresponding Instructional Methods (include, but are not limited to):

1. **Big Idea# 4:** Investigation 12: Animal Behavior Lab: Students will generate a scientific hypothesis and create a controlled experiment to test behavior of isopods to observe taxis and kinesis. Students will communicate scientific inquiry by writing full lab report, including experimental design and analysis of results. **(SP1, 3, 4, 5)**
2. **Big Idea #4 and Big Idea #2:** Dissolved Oxygen and Primary Aquatic Productivity: Students will use Vernier Lab tool to measure dissolved oxygen and investigate effect of different variables on primary productivity. Students will investigate effect of light, turbidity and temperature on dissolved oxygen. Students will extend these data to identify effect of variables on primary productivity. Students will use light and dark bottle method to determine the different between gross and net primary productivity and use mathematical methods to calculate. **(SP 1, 2, 3,5)**
3. Boom and Bust Activity: students will perform activity to determine how dynamic populations of prey and predators affect each other. Students will use inquiry to determine how not only density, but also dispersion patterns may affect predator/prey interactions.
4. Discussion of selected passages from Survival of the Sickest **(SP 7)**
5. Students will investigate energy dynamics in the AP Lab manual. They will consider seasonal reproduction in plants and animals and life history strategies, such as biennial plants and reproductive diapause).
6. Students will apply equations for population growth to predict population changes over time.
7. Students will practice using the Simpson's Diversity Index equation to compare diversity and make predictions of an ecosystem's resistance to environmental changes.
8. Students will investigate an example of human activity, such as global warming, logging or introduced species and its impacts on ecosystems. Students will propose solutions or strategies to mitigate human impact.
9. Students will connect one ecological phenomenon to global warming and predict how increasing global temperatures will affect the phenomenon in the future.

Assessments:

Diagnostic:	Teacher Observation
	Pre-labs
	Discussion
	Chapter Outline
Formative:	Teacher Observation
	Discussion
	AP Free-Response Essay questions
	Quizzes
	Homework
	Projects
Summative:	Quizzes/Tests: Ecology and Behavior:

UNIT: Animal Kingdom and Physiology

Curriculum Plan

Unit: Animal Kingdom and Body Systems **Time Range in Days: up to 10 days**

Standard(s):
PA- Academic Standards: Science and Technology and Engineering Education
PACCS Reading and Writing for Science and Technology

Standards Addressed:
3.1.B.A1, 3.1.B.A2, 3.1.B.A.4, 3.1.B.A5, 3.1.B.A6, 3.1.B.A7, 3.1.B.A8, 3.2.B.B6, 3.2.C.A1

Anchor(s):Biology Keystone Anchors
BIO.A.4.2.1, BIO.A.4.1.1, BIO.A.4.1.2, BIO.A.1.2.2

Standards Addressed:

http://www.pdesas.org/module/sas/curriculumframework/
http://www.pdesas.org/standard
https://www.pdesas.org/Standard/PACore

Overview:
All animals have four major features in common: they are eukaryotic, multicellular, heterotrophic, and their cells lack cell walls. All animals demonstrate similar mechanisms of development, but some there are some significant differences between protostomes and deuterostomes. All animals have multiple and diverse mechanisms to maintain homeostasis. There is great diversity in the multiple phyla within the animal kingdom. Students will have the opportunity to investigate the systems of the human body, including the digestive, immune, nervous, muscular, and endocrine systems.

Goals:
Students will understand the similarities and differences within the animal kingdom. They will learn about how the different systems within the human body work independently and together to maintain homeostasis.

Objectives:
1. List the features of all animals. (DOK 1)
2. Distinguish between the different animal phyla. (DOK 2)
3. Compare different regulatory mechanisms for maintenance of homeostasis. (DOK 3)
4. Define the functions of the organs of the digestive, immune, nervous, endocrine and muscular systems. (DOK 1)
5. Evaluate different mechanisms of structure and function in the digestive, immune, nervous, endocrine and muscular systems. (DOK 3)

6. Predict the responses of a feedback loop in an endocrine pathway when changes occur. (DOK 4)

Core Activities and Corresponding Instructional Methods (include, but are not limited to):

1. Students will create paper depiction of each part of human digestive system and identify function of each organ.
2. Students will use online textbook Bioflix animation to observe the functioning of the lungs and gas exchange.
3. Students will use online textbook activity to measure Q10 for ectothermic animals. Students will also measure blood pressure and heart rate of humans. Class discussion about why endothermic animals do not exhibit Q10 and energy demands of endothermy. Connect to structure of 4 chambered heart for efficiency in endothermic organisms. **(SP7)**
4. Animal Dissections: Students will dissect a variety of organisms within the animal kingdom to investigate anatomy and compare and contrast structures.

Assessments:

Diagnostic:	Teacher Observation
	Pre-labs
	Discussion
	Chapter Outline
Formative:	Teacher Observation
	Discussion
	AP Free-Response Essay questions
	Quizzes
	Homework
	Projects
Summative:	Quizzes/Tests: Animal Kingdom and Human Body Systems

UNIT: Plant Diversity and Structures

Curriculum Plan

Unit: Plant Diversity and Structures **Time Range in Days: up to 10 days**

Standard(s):
PA- Academic Standards: Science and Technology and Engineering Education
PACCS Reading and Writing for Science and Technology

Standards Addressed:
3.1.B.A1, 3.1.B.A2, 3.1.B.A.4, 3.1.B.A5, 3.1.B.A6, 3.1.B.A7, 3.1.B.A8, 3.2.B.B6, 3.2.C.A1

Anchor(s): Biology Keystone Anchors
BIO.A.4.2.1, BIO.A.4.1.1, BIO.A.4.1.2, BIO.A.1.2.2

Standards Addressed:

http://www.pdesas.org/module/sas/curriculumframework/
http://www.pdesas.org/standard
https://www.pdesas.org/Standard/PACore

Overview:
The plant kingdom has the following characteristics in common: multicellular, cell walls made of cellulose, photosynthetic, eukaryotic, apical meristems and alternation of generations. Plants perform photosynthesis and have multiple mechanisms for resource acquisition, communication and maintenance of homeostasis.

Goals:
The students will develop a greater understanding of the mechanisms for homeostasis and communication in plants. They will learn about different methods for reproduction.

Objectives:
1. State the common characteristics of all plants. (DOK1)
2. Compare and contrast the different groups of plants. (DOK 3)
3. Investigate the effects that hormones, light duration, gravity and other variables have on plant behavior. (DOK3)
4. Design an experiment to explore the effect of variables on plant transpiration. (DOK4)

Core Activities and Corresponding Instructional Methods
1. Big Idea #4: Investigation 11: Transpiration: Student-directed inquiry will allow students will place small plants in sealed bags and measure changes in mass over a period of time under different environmental conditions. Students will hypothesize the effect that variables including wind, light and humidity will have on transpiration rate. Students will calculate percent change in mass to determine rate and effect of each variable. Students will write formal lab report to describe method and depict data and analysis. **(SP 1, 2, 4, 5)**

2. Flower dissection: students will dissect an angiosperm's reproductive organ to identify structure and function of each anatomical part.

Assessments:

Diagnostic:	Teacher Observation
	Pre-labs
	Discussion
	Chapter Outline
Formative:	Teacher Observation
	Discussion
	AP Free-Response Essay questions
	Quizzes
	Homework
	Projects
Summative:	Quizzes/Tests: Plants