Pre-AP Biology
Curriculum

Board Approved:

June 4th, 2015

Francis Howell School District
Mission Statement

Francis Howell School District is a learning community where all students reach their full potential.

Vision Statement

Francis Howell School District is an educational leader that builds excellence through a collaborative culture that values students, parents, employees, and the community as partners in learning.

Values

Francis Howell School District is committed to:

- Providing a consistent and comprehensive education that fosters high levels of academic achievement for all
- Operating safe and well-maintained schools
- Promoting parent, community, student, and business involvement in support of the school district
- Ensuring fiscal responsibility
- Developing character and leadership

Francis Howell School District Graduate Goals

Upon completion of their academic study in the Francis Howell School District, students will be able to:

1. Gather, analyze and apply information and ideas.
2. Communicate effectively within and beyond the classroom.
3. Recognize and solve problems.
4. Make decisions and act as responsible members of society.

Science Graduate Goals

The students in the Francis Howell School District will graduate with the knowledge, skills, and attitudes essential to leading a productive, meaningful life. Graduates will:

· Understand and apply principles of scientific investigation.
· Utilize the key concepts and principles of life, earth, and physical science to solve problems.
· Recognize that science is an ongoing human endeavor that helps us understand our world.

- Realize science, math, and technology are interdependent, each with strengths and limits that impact the environment and society.
- Use scientific knowledge and scientific ways of thinking for individual and social purposes.

Course Rationale

Science education develops science literacy. Scientific literacy is the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity. A sound grounding in science strengthens many of the skills that people use every day, like solving problems creatively, thinking critically, working cooperatively in teams, using technology effectively, and valuing life-long learning. Scientific literacy has become a necessity for everyone.

To accomplish this literacy, science courses will reflect the following:

- Develop scientific reasoning and critical thinking skills.
- Extend problem-solving skills using scientific methods.
- Include lab-based experiences.
- Incorporate the use of new technologies.
- Provide relevant connections to personal and societal issues and events.

Course Description

In this course the student will engage in scientific inquiry, biochemistry, the cell, bio-energy, mechanisms of genetics, biotechnology, change in organisms over time, classification, and ecosystems. Lab experiences are an integral part of the course. This course will emphasize critical thinking, as well as, advanced reading, writing, and problem solving skills. This class will provide a foundation for advanced science courses. This course requires a high degree of independent initiative.

Curriculum Committee

Laura Montgomery	Francis Howell North
Luanne Scott	Francis Howell Central
Janet Eubanks	Francis Howell
Secondary Content Leader	Stephen Moorman
Director of Student Learning	Dr. Chris Greiner
Chief Academic Officer	Dr. Mary Hendricks-Harris
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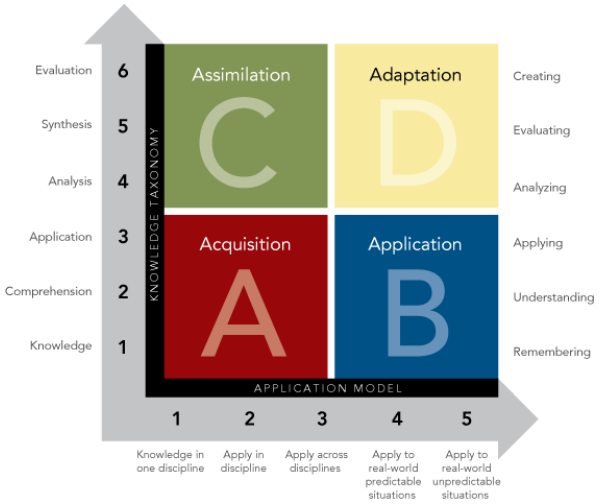
Curriculum Notes

All FHSD performance tasks and sample learning activities are aligned not only to understandings and standards, but also the Rigor and Relevance Framework and 21st Century Skills. Information on these two things is provided below or by clicking on the hyperlinks.

Rigor and Relevance Framework



The Rigor/Relevance Framework is a tool developed by the International Center to examine curriculum, instruction, and assessment along the two dimensions of higher standards and student achievement.

The Rigor/Relevance Framework has four quadrants.
Quadrant A represents simple recall and basic understanding of knowledge for its own sake. Examples of Quadrant A knowledge are knowing that the world is round and that Shakespeare wrote Hamlet.

A	B	C	D
Students gather and store bits of knowledge and information. Students are primarily expected to remember or understand this knowledge.	Students use acquired knowledge to solve problems, design solutions, and complete work. The highest level of application is to apply knowledge to new and unpredictable situations.	Students extend and refine their acquired knowledge to be able to use that knowledge automatically and routinely to analyze and solve problems and create solutions.	Students have the competence to think in complex ways.

Quadrant C represents more complex thinking but still knowledge for its own sake. Quadrant C embraces higher levels of knowledge, such as knowing how the U.S. political system works and analyzing the benefits and challenges of the cultural diversity of this nation versus other nations.

Quadrants B and D represent action or high degrees of application. Quadrant B would include knowing how to use math skills to make purchases and count change. The ability to access information in wide-area network systems and the ability to gather knowledge from a variety of sources to solve a complex problem in the workplace are types of Quadrant D knowledge.

21st Century Skills

These skills have been pared down from 18 skills to what are now called the 4Cs. The components include critical thinking, communication, collaboration, and creativity. Critical thinking is focused, careful analysis of something to better understand and includes skills such as arguing, classifying, comparing, and problem solving. Communication is the process of transferring a thought from one mind to others and receiving thoughts back and includes skills such as choosing a medium (and/or technology tool), speaking, listening, reading, writing, evaluating messages. Collaboration is working together with others to achieve a common goal and includes skills such as delegating, goal setting, resolving conflicts, team building, decision-making, and managing time. Creativity is expansive, open-ended invention and discovery of possibilities and includes skills such as brainstorming, creating, designing, imagining, improvising, and problem-solving.

Standards

Standards aligned to this course can be found:

Biology Standards
https://dese.mo.gov/sites/default/files/cle-biology-science.pdf

Missouri Learning Standards for Literacy
http://www.corestandards.org/ELA-Literacy/

National Educational Technology Standards
http://www.iste.org/STANDARDS

Units & Standards Overview
Semester 1 Semester 2

Unit 1: Semester 1	Unit 2: Semester 1	Unit 3: Semester 1 & 2	Unit 4: Semester 2	Unit 5: Semester 2
Ecology	**Cells (energy & reproduction)**	**Molecular Biology (DNA & Genetics)**	**Change of Organisms over Time**	**Classification**
PE Assessment:	PE Assessment:	PE Assessment:	PE Assessment:	PE Assessment:
"Habitat: The Choice is Yours" Students will plan a community in which 10,000 people will live, work, shop, and meet recreational needs. They will map out their community, assigning parcels of land to specific aspects of the community(housing, agriculture, industry, etc) design. They will validate their design choices with a claim, evidence, justification format.	"Leaf Pattern" Students will carry out an investigation regarding the relationship between the architecture of a leaf and its photosynthetic efficiency. Students will gather leaves from various trees, calculate the sinus area and weight/cm2. They will use evidence and appropriate data to justify claims regarding a trees photosynthetic efficiency.	"Genetic Case Study" Students will work through a case study involving parents with a family history of a genetic disorder. Students must complete a pedigree, Punnett squares, and do online research. Students will explain, using evidence from the case study and research how the parents could have a child with the genetic disorder.	"Fishie Frequencies" Students will simulate natural selection and calculate allele frequencies in a population of fish, producing a graph of their results. Using their data, they will justify a claim about how natural selection affects allele frequencies in a population.	"Taxonomy Project:" Students will develop a food web based upon organisms that are designed by the students in a fictitious ecosystem. The students will develop appropriate scientific names and design a dichotomous key for the classification of the organisms. Students will predict the effects of the introduction of new species and the elimination of a species in this ecosystem.

Francis Howell School District Pre-AP Biology Course Map

*****Recommended that teachers embed released ACT items and ACT like items within each unit to better prepare students for AP Biology and AP tests.**

	Unit Description	Unit Timeline/Standards	PE Summary	PE Standards
Semester 1	**Ecology (with inquiry):** **<u>Inquiry</u>** (IN1, ST3) ● Experimental Design ● Scientific Tools & Techniques ● Graphing **<u>Ecological Principles</u>** (EC1, EC2, EC3, ST3) ● Cycles ● Populations ● Man's Impact ● Species Interactions ● Energy Transfer	6 weeks **7.1.A.a, 7.1.A.b, 7.1.A.c.** 7.1.A.g, **7.1.B.a**, 7.1.B.b, 7.1.B.c 7.1.B.d, 7.1.B.e, **7.1.C.a** **7.1.C.b**, 7.1.C.c, **7.1.D.a** 7.1.D.c 4.1.A.a, 4.1.A.b, 4.1.A.c, 4.1.B.a, 4.1.B.b, 4.1.C.a, 4.1.C.b, 4.1.D.a, 4.1.D.b, 4.2.A.a, 4.2.A.b, 4.2.A.c, 4.2.B.a, 4.2.B.b, 4.3.C.d 8.3.B.c, 8.3.C.b, 8.3.C.c 8.3.D.a, 8.3.D.b RST1, RST2, RST4, RST8 WHST4, WHST5, WHST 9	Students will plan a community in which 10,000 people will live, work, shop, and meet recreational needs. They will validate their design choices with a claim, evidence, justification format.	**7.1 A.a,** **7.1 A.b,** **7.1 A.c,** **7.1 B.a,** **7.1 C.a,** **7.1 C.b,** **7.1 D.a**
Semester 1	**Cells (biochem., cell structure and function, energy, cell division & development)** **(LO1, LO2, LO3)** ● Organelles-Interrelationships ● Cell theory ● Cell transport ● Tonicity ● Endosymbiotic hypothesis ● Plant vs. animal cell	9 weeks: 3.1.B.a, 3.1.B.b, 3.1.C.a, 3.1.C.b, 3.2.A.a 3.2.A.b, 3.2.A.c, 3.2.B.a 3.2.B.b, 3.2.D.a, 3.2.D.b, 3.2Dc, 3.2.D.d, 3.2.D.e 3.2.E.b, 3.2.F.a, 3.2.F.b 3.2.F.c, 3.3.A.a, 3.3.B.e, 3.3.C.a,	Students will carry out an investigation determining the relationship between the architecture of a leaf and photosynthetic efficiency. They will use evidence and appropriate data to support their claim	**7.1 A.a,** **7.1 A.b,** **7.1 A.c,** **7.1 B.a,** **7.1 C.a,** **7.1 C.b,** **7.1 D.a**

	● Prokaryotic vs. Eukaryotic ● Photosynthesis and Cellular respiration as reverse reactions ● effect of environmental conditions on photosynthesis and cellular ● mitosis ● meiosis ● development ● respiration ● anaerobic vs. aerobic ● asexual reproduction	3.3.C.b, 3.3.C.c, 3.3.D.a, **7.1.A.a,7.1.A.b, 7.1.A.c**, **7.1.B.a, 7.1.C.a**, **7.1.C.b.**, **7.1.D.a,** 7.1.D.b, RST.3, RST.4, RST.8 WHST.1,WHST.4, WHST.5, WHST.6 WHST.10, ITSE1, ITSE2		
Semester 2	**Molecular Biology (reproduction, DNA & Genetics)** ● DNA/Chromosomes/genes ● protein synthesis ● Cell cycle ● genetics/ heredity ● mutations ● biotechnology	8 weeks: 3.2 E.a, 3.2.E.1, 3.3 B.a, 3.3.B.a.1, 3.3.B.b.1, 3.3 B.b.2, 3.3.C.d, 3.3.C.d.1 3.3.D.b, 3.3.D.c 3.3.E.a, 3.3.E.b 3.3.E.b.1, 3.3.E.b.2 3.3.E.b.3, 3.3.E.c **7.1Aa, 7.1.Ab, 7.1A.c, 7.1B.a, 7.1.C.a, 7.1C.b,** 7.1.C.d, **7.1.D.a** 8.3.B.c.1, 8.3.B.c.2 8.3.B.c.3 RST.1, RST.3, RST.4 RST.8 WHST.1, WHST.2, WHST.4, WHST.6 ISTE.3, ISTE.4, ISTE.6	Students will work through a case study involving parents with a family history of a genetic disorder. Students must complete a pedigree, Punnett squares, and do online research. Students will explain, using evidence from the case study and research how the parents could have a child with the genetic disorder.	**7.1 A.a, 7.1 A.b, 7.1 A.c, 7.1 B.a, 7.1 C.a, 7.1 C.b, 7.1 D.a**
Semester 2	**Change of Organisms Over time** ● evidence supporting the changes ● mechanisms	4 weeks 3.3.B.c, 3.3.D.a, 4.1.D.b,	Students will simulate natural selection and calculate allele frequencies in a population of	**7.1 A.a, 7.1 A.b, 7.1 A.c,**

	• Hardy-Weinberg equilibrium	4.3.A.a, 4.3.A.b, 4.3.B.a, 4.3.B.b, 4.3.C.a, 4.3.C.b, 4.3.C.c, 4.3.C.d RST 1, RST 2, RST4 RST 8 WHST 4, WHST 5 WHST 9	fish, producing a graph of their results. Using their data, they will justify a claim about how natural selection affects allele frequencies in a population.	**7.1 B.a,** **7.1 C.a,** **7.1 C.b,** **7.1 D.a**
Semester 2	**Classification** • taxonomy • dichotomous key • survey of kingdoms	2 weeks or the period of time left between EOC exams and the end of the school year: 3.1.E.a, 3.1.E.b, 3.1.C.a, 3.3.B.c, 4.1.B.a, 4.1.B.b, 4.1.D.a, 4.2.A.a, 4.3.B.a, 4.3.B.b, 4.3.C.a, 8.1.B.a, RST.1, RST.2, RST.4, WHST.1, WHST.4, WHST.6, ISTE.3	Students will develop a food web based upon organisms that are designed by the students in a fictitious ecosystem. The students will develop appropriate scientific names and design a dichotomous key for the classification of the organisms. Students will predict the effects of the introduction of new species and the elimination of a species in this ecosystem.	**7.1 A.a,** **7.1 A.b,** **7.1 A.c,** **7.1 B.a,** **7.1 C.a,** **7.1 C.b,** **7.1 D.a**

Content Area: Science	Course: Pre-AP Biology	UNIT 1: Ecology

Unit Description: **Students will understand that:** ● Matter is recycled and energy flows through an ecosystem. ● Earth's materials are limited and organisms, including humans, and their activities can cause changes in the environment that affects the ecosystem. ● The diversity of species within an ecosystem is affected by changes in the environment, which can be caused by other organisms or outside processes. ● Living organisms have the capacity to produce populations of infinite size, but environments and resources are finite.	**Unit Timeline: 6 weeks** Inquiry: 2 weeks Ecological Principles:4

DESIRED Results Ecology
Transfer Goal - ***Students will be able to independently use their learning to……*** · Students will be able to plan and conduct an investigation. · Students will be able to develop and use models to illustrate the organization of interacting systems. · Students will be able to construct an argument based on evidence.

Understandings – *Students will understand that… (Big Ideas)*

1. In a balanced ecosystem populations within a community interact.
2. Resources within an ecosystem affect growth and reproduction of a population.
3. All organisms, including humans can cause changes that affect the ecosystem.
4. Changes in the environment affect the diversity of the ecosystem.
5. Energy flows, matter is recycled in an ecosystem.
6. Science is a process used to answer a question with evidence.
7. Interactions of organisms in an ecosystem can be represented mathematically.
8. Scientists plan and carry out investigations in the field or laboratory working collaboratively as well as individually.

<u>Essential Questions</u>: *Students will keep considering…*

1. How can I help to maintain a balanced ecosystem in my local environment?
2. What resources in my community limit natural populations?
3. How do my actions impact my local environment?
4. How do environmental changes affect biodiversity?
5. How do essential resources flow through an ecosystem?
6. What is appropriate evidence to validate a question?
7. How does population growth affect carrying capacity?
8. How does the scientific community ensure commonality in the data?

Students will know…..	Standard	Students Will Be Able to…..	Standard
● Abiotic factors are the non-living parts of an ecosystem and biotic factors are the living parts. ● Symbiosis is any relationship between organisms living close together including mutualism, commensalism, and parasitism. ● Habitat is the place where an organism lives while a niche is how an organism impacts where it lives. ● There are levels of organization within an ecosystem. ● Exponential and logistic growth patterns occur in populations. ● Limiting factors affect carrying capacity. ● Trophic levels are steps on a food chain or web. ● An autotroph/producer is an organism that produces its own energy, while a	4.1.B.a 4.1.A.a 4.1.A.c 4.1.B.a 4.1.B.a 4.1.B.a 4.2.A.a 4.2.A.b	● Explain the nature of interactions between organisms in predator/prey relationships and different symbiotic relationships (i.e., mutualism, commensalism, parasitism) ● Explain how cooperative (e.g., symbiotic) and competitive (e.g., predator/prey) relationships help maintain balance within an ecosystem ● Explain why no two species can occupy the same niche in a community (The functional role of a species is not limited to its placement along a food pyramid; it also includes the interactions of a species with other organisms while obtaining food. For example, the methods used to tolerate the physical factors of its environment, such as climate, water, nutrients, soils, and parasites, are all part of its functional role. In other words, the ecological niche of an organism is its natural history: <u>all the interactions</u>	4.1.A.a 4.1.A.b 4.1.A.c

heterotroph/consumer cannot. ● Biogeochemical cycles are used to recycle matter. ● There is a finite availability of fresh water for use by living organisms. ● Natural resources are limited and affected by human activity. ● The sun is the ultimate source of all energy on Earth.	4.2.B.a 4.2.B.b 4.1.C.a 3.2.B.b	<u>and interrelationships of the species with other organisms and the environment.)</u> ● Identify and explain the limiting factors (biotic and abiotic) that may affect the carrying capacity of a population within an ecosystem ● Predict how populations within an ecosystem may change in number and/or structure in response to hypothesized changes in biotic and/or abiotic factors ● Devise a multi-step plan to restore the stability and/or biodiversity of an ecosystem when given a scenario describing the possible adverse effects of human interactions with that ecosystem (e.g., destruction caused by direct harvesting, pollution, atmospheric changes) ● Predict and explain how natural or human caused changes (biological, chemical and/or physical) in one ecosystem may affect other ecosystems due to natural mechanisms (e.g., global wind patterns, water cycle, ocean currents) ● Predict the impact (beneficial or harmful) a natural environmental event (e.g., forest fire, flood, volcanic eruption, avalanche) or human caused change (e.g., acid rain, global warming, pollution, deforestation, introduction of an exotic species) may have on the diversity of different species in an ecosystem ● Describe possible causes of extinction of a population ● Illustrate and describe the flow of energy within a food web ● Explain why there are generally more producers than consumers in an energy pyramid ● Predict how the use and flow of energy will be altered due to changes in a food web	4.1.B.a 4.1.B.b 4.1.C.a 4.1.C.b 4.1.D.a 4.1.D.b 4.2.A.a 4.2.A.b

		● Explain the processes involved in the recycling of nitrogen, oxygen, and carbon through an ecosystem ● Explain the importance of the recycling of nitrogen, oxygen, and carbon within an ecosystem ● Given a scenario describing an environmental change, hypothesize why a given species was unable to survive ● Analyze and evaluate the drawbacks (e.g., design constraints, unintended consequences, risks), benefits, and factors (i.e., social, political, economic, ethical, and environmental) affecting progress toward meeting major scientific and technological challenges (e.g., limitations placed on stem-cell research or genetic engineering, introduction of alien species, deforestation, bioterrorism, nuclear energy, genetic counseling, use of alternative energies for carbon fuels, use of pesticides) ● Identify and evaluate the role of models as an ethical alternative to direct experimentation (e.g., using a model for a stream rather than pouring oil in an existing stream when studying the effects of oil pollution on aquatic plants) ● Write arguments focused on *discipline-specific content*. ● Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. ● Demonstrate command of technology, including the Internet, to produce, publish, and update work in response to ongoing feedback, including fresh arguments or new information.	4.2.A.c 4.2.B.a 4.2.B.b 4.3.C.d 8.3.B.c 8.3.C.c WHST.1 WHST.4 WHST.6

		● Gather relevant information from multiple print and digital sources. Assess its credibility and accuracy and its usefulness in terms of purpose task, and audience. Integrate selected information into the text, avoiding over reliance on any one source, avoiding plagiarism, and following a standard format for citations.	WHST.8
		● Write response to informational sources, drawing on textual evidence to support analysis and reflection as well as to describe what they have learned.	WHST.9
		● Write routinely over extended time frames and shorter time frames for a range of tasks, purposes, and audiences.	WHST.10
		● Summarize complex information or ideas presented in a text, paraphrasing it in simpler but still accurate terms.	RST.2
		● Determine the meaning of key terms, symbols, and domain-specific vocabulary used in a text, attending to the precise meaning of terms as they are used in particular scientific or technical contexts.	RST.4
		● Analyze hierarchical or categorical relationships of concepts or information presented in a text.	
		● Synthesize information in different formats by representing complex information in a text in graphical form (i.e. table or chart) or translating a graphic or equation into words	RST.5 RST.7
		● Evaluate the hypotheses, data, and conclusions in a scientific text, corroborating or undercutting them with other sources of information.	RST.8
		● Integrate information from diverse sources into a coherent understanding of a concept process, or phenomenon, noting discrepancies among sources.	RST.9

		● Read informational text independently, proficiently, and fluently in grades 11-CCR text complexity band; read “stretch” texts with scaffolding as needed ● Creativity and Innovation: students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. ● Research and Information Fluency: Students apply digital tools to gather, evaluate, and use information. ● Critical Thinking, Problem Solving, and Decision Making: students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools.	RST.10 ISTE.1 ISTE.3 ISTE.4

EVIDENCE of LEARNING	Ecology

Understanding	**Standards**	**Unit Performance Assessment**:	**R/R Quadrant**
1, 2, 3, 4, 7	**4.1.B.a** **4.1.B.b** 4.1.C.a 4.1.C.b **4.1.D.a** 4.1.D.b 7.1.A.e 7.1.D.a 7.1.D.b WHST - 9 WHST - 10 RST - 4 RST - 9 RST - 10	**Description of Assessment Performance Task(s):** Habitat Performance Assessment Students will complete an activity titled “Habitat: The Choice is Yours”. The initial instructions to the students are as follows: Your planning team will be given a map of an area. Your job is to plan a community in which 10,000 people will live, work, shop, and will meet their recreational needs. At the same time, students will have to consider how to balance the biodiversity in the planning zone so people can co-exist and maintain the present ecosystem. When you have marked your plan on your map, you will compare it to another planning team in your class. You should be able to explain why you chose to use the land as you did. **Teacher will assess:** Each team will establish a claim backed by evidence from their community design, and support it with justification on how their ecological protection and use priorities were different and similar to other groups. They also have to provide a claim backed by evidence supported with justification on how they would maintain economic stability in their community design. **Performance:** ***Mastery:*** Students will show that they really understand when they… *Score 8/11 for each of the three questions* **Scoring Guide:** *See Appendix _1B_____* *https://docs.google.com/document/d/1KpUqIz-mvQGVZeVTcLA1aRqlyDtcvK2686TMGC_jaj4/edit?usp=sharing*	D **21 Century** Communication Creativity Critical Thinking Collaboration

SAMPLE LEARNING PLAN
Pre-assessment: 10 Question Multiple Choice Pre-Test Titled “Ecology Pre-Test” in appendix. All questions are based on state CLEs in this unit, and modeled after the End of Course Exam.

Understanding	**Standards**	**Major Learning Activities:**	**Instructional Strategy:**	**R/R Quadrant:** **21 Century**
1, 3, 6	**4.1.B.b**, 4.1.C.a, 7.1.B.f, 7.1.D.b WHST -1 WHST - 4	1. Activity: Students will be asked to respond to the following on an exit card: The planning committee for your neighborhood would like your input on something they could do as a group to help migrating songbirds. Give them one suggestion. Be sure to justify your suggestion with an explanation of how and why your suggestion would help migrating songbirds. Students will have an opportunity to provide peer feedback and defend claims. **Scoring:** 1- answer not complete enough to determine understanding 2-student answered completely, but with minor flaws 3-student made a reasonable suggestion, and supported it with valid reasons **Possible acceptable answers:** ● Plant native plants that provide food and shelter for migrating songbirds ● Remove exotic, nonnative plants like honeysuckle to encourage growth of native plants ● Add one or more small water features with flowing or dripping	Argumentative writing	C Communication Critical Thinking

		water. Small shrubs should be located about 5 feet away. No hiding areas should be available for cats. ● Objective: Objective states students will evaluate the needs of migrating songbirds and be able to provide reasonable suggestions for an environmental scenario designed to help them in a local setting during their migratory path; providing support (a defense) for the reasoning behind the suggestion. Appendix Documents: None needed - this is an exit slip activity.		
1, 2, 4, 6, 7, 8	4.1.A.a 4.1.A.b **4.1.B.a** **4.1.B.b** 7.1.A.f 7.1.B.d 7.1.C.a 7.1.C.b 7.1.C.c 7.1.D.a WHST - 4	2. Activity: Students will use a biology case study about the relationship between Predator/Prey (wolf/deer) to identify and evaluate how predators can be used to manage populations. Working in pairs, they will graph and analyze data through written response, of deer and wolf populations over a 10 year period. Once they have analyzed the data, they will switch partners with another team, compare results, and formally defend their results if necessary. ● Objective: Students will be able to evaluate predatory/ prey relationships to understand that their relationship not only manages their balance in an ecosystem, but also helps manage and create a balance in their overall ecosystem.. Students will be able to diagram the rise and fall of the populations through a graphic display. Appendix Documents: Biology Case Study - *Using Predators to Manage Populations*	Providing Practice, Nonlinguistic Representation Cooperative Learning Feedback	C Critical Thinking Communication Collaboration
1, 2, 3, 5	4.2.A.a, 4.2.A.b, 4.2.A.c	3. Activity: Students will use a pond community key to identify producers, consumers, and decomposers in an ecosystem. They will also develop a food chain and complete food web using all the organisms in the pond community. Then they will create an energy pyramid formulated	Providing Practice, Nonlinguistic	C

	7.1.C.a ISTE.1	from the same pond community. They will also determine the potential impact humans may have on the ecosystem. Students may use Popplet or Google Sketch technology to assist in this activity. Finally, students will formally provide peer feedback and defend claims. ● Objective: Working with a partner, students will be able to develop a food web and energy pyramid for an ecosystem by analyzing a pond community key. They will be able to sequence a food chain and apply that to an energy pyramid based on their food chain, diagraming the flow of energy. They will also determine possible human impact to the ecosystem based on a specific scenario. Appendix Documents: How is a Pond System Organized?	Representation Cooperative Learning	Critical Thinking Communication Collaboration Creativity
2, 6, 7, 8	**4.1.B.b** 7.1.A.f 7.1.B.e 7.1.C.a 7.1.C.b 7.1.D.a RST - 2 RST - 4 WHST - 4	4. Activity: Students will work in groups to examine data from the Hanover Green Cemetery near Scranton, Pennsylvania. The birthdates on the headstones span three centuries. The student's study of this Pennsylvania population will reveal information about its age-structure and death-rate patterns during certain time periods. In the process they will explore how data can be used to make various inferences about a population. In the extension part of the activity they will have the opportunity to evaluate the historical, social, and economic issues that could affect populations, providing justification for their research, defending their claim and conclusions. ● Objective: Working in collaborative groups, students will collect data on birthdates and ages of death of members of a population during a specific time period. Using the data, students will be able to construct and analyze two types of graphs – a survivorship curve and an age-structure graph. Then, they will compare data with other groups and be able to make inferences about the patterns that they observe.	Nonlinguistic representation Providing Practice Identifying Similarities & Differences Cooperative Learning Feedback	B Collaboration Communication Critical Thinking

		Appendix Documents: Populations (Population Patterns – Analysis of a Human Population)		
1, 2, 3, 6 ,8	**4.1.B.b**, 4.1.C.a, 4.1.C.b 7.1.A.a 7.1.A.f 7.1.B.f 7.1.D.b ISTE - 3 ISTE - 4 RST - 7 WHST - 1 WHST - 4	5. Activity: *supports the performance event In this activity, students will act as a public health officer and track the incidence of a waterborne disease. They will also look at demographics and determine where to build a new sewage treatment plant for a community. They will also consider different methods for the disposal of sewage and hazardous wastes and suggest proper processes for each. They will then present and formally defend their proposal to the class for acceptance or rejection through peer feedback. Students will also use a website to view a video on the importance of our water infrastructure and public health protection. http://liquidassets.psu.edu/#trailer ● Objective: Students will be able to make a connection between disease and water sources in a community and then identify where a new treatment plant should hypothetically be built for future use, based on demographics and geographies of an area. Students will also be able to suggest possible disposal methods for a variety of sewage and hazardous waste products by analyzing various methods for disposal of hazardous wastes. Appendix Documents: Waste Disposal and the Environment http://liquidassets.psu.edu/#trailer	Providing Practice Nonlinguistic Representation Feedback	D Critical Thinking Creativity Communication
1, 2, 4, 6, 7	4.1.A.a 4.1.A.b 4.1.A.c **4.1.B.a** **4.1.B.b** 7.1.A.f 7.1.B.e	6. Activity: Working with a partner (could use Rally Table strategy), students will examine graphs which show the relationships between rainfall, the length of the grasses, and the populations of zebra, wildebeests, and Thomson's gazelles on the Serengeti Plain during one year (1989). They will use this data to answer questions and make predictions as a result of monthly abiotic factors (rainfall) and biotic factors (living	Cues & Questions Nonlinguistic Representation Providing Practice	C Collaboration

	7.1.C.a 7.1.C.b. 7.1.D.a RST - 7 WHST - 4	organisms in this scenario). Students will have an opportunity to justify claims and allow for peer feedback ● Objective: Students will be able to determine how specific abiotic and biotic relationships in an ecosystem affect feeding and population patterns for three different organisms. They will then compare their predictions with other groups. Appendix Documents: Analyzing Ecological Relationships	Cooperative Learning Identifying Similarities & Differences Feedback	Communication Critical Thinking
2, 5, 6, 8	**4.1.B.a** 4.1.C.b 4.2.B.a 4.2.B.b 7.1.D.a ISTE - 1 ISTE - 3 ISTE - 4 RST - 2 RST - 4 RST - 8 WHST - 4 WHST - 8	7. Activity: Students will research the biogeochemical cycles (carbon, water, etc,) and create a cartoon depicting one of the cycles, with a written explanation of the cartoon. Students will use Internet research to assist in the creation of the cartoon and in synthesizing the written explanation. ● Objective: The student will be able to demonstrate comprehension of the energy sources of various biochemical cycles by completing mini stories and deriving definitions from prefixes and suffixes from the the terminology students find within the research. Then they will apply it to the written explanation and cartoon. Appendix Documents: **Biogeochemical Cycles Cartoon Project** **Biogeochemical Cycles**	Nonlinguistic representation, Providing Practice	B Critical Thinking Creativity
1, 3, 4, 6, 8	4.1.C.a 4.1.C.b	8. Activity: Students will use BrainPOP to practice crafting reasoned arguments and explore water ecology and the effect of humans on the	Argumentative writing	D

	4.1.D.a 4.1.D.b ISTE - 3 ISTE - 4 RST - 1 RST - 2 RST - 4 RST - 8 WHST - 1 WHST - 4 WHST - 8	environment. Through an online game, students will learn about the causes of water pollution in a lake and pose a question about the local water supply to community residents. Students then compile the residents' opinions during game play and have a choice to compose a persuasive letter to their congressional representative, song, or public service announcement asking for support in improving water conditions. ● Objective: Students will work with a partner to identify the causes of water pollution and what humans can do to combat the problem. They will pose a question about the local water supply to community residents during game play and compile their opinions. Students will craft reasoned, evidence-based arguments to persuade others using established facts and compose a persuasive letter to their congressional representative asking for his or her support in improving water conditions. Appendix: Lesson is at the website below: http://www.brainpop.com/educators/community/lesson-plan/citizen-science-game/	Nonlinguistic representations Providing Practice Cooperative Learning	Critical Thinking Communication Collaboration Creativity
1, 2, 3, 4, 6, 8	4.1.A.c **4.1.B.b** 4.1.C.b **4.1.D.a** 4.1.D.b 4.3.C.d 7.1.B.f 7.1.C.a 7.1.C.d 7.1.D.a 7.1.D.c	9. Activity Working with a partner, students will be part of a hypothetical global campaign which has been chosen to create posters of endangered species to promote greater environmental awareness worldwide. Students will research the plight of endangered species; create a poster of a selected animal; and present their poster, research, and advertising approach for the "Save Our Animals" project for this lesson to the class. Students will use at least 2 websites for this project (included in the lesson). When finished, there will be a Gallery Walk to drive class discussion over the presentations. Students will have an opportunity to create an online presentation through social media or Google Drive to present to an authentic audience while asking for their feedback including peer feedback.	Nonlinguistic representation Cooperative learning Feedback	D Critical Thinking Communication Collaboration Creativity

	ISTE - 1 ISTE - 3 ISTE - 4 RST - 4 RST - 5 RST - 7 WHST - 8	● Objective: Students will be able to identify the nature and causes (human) of species endangerment; the kinds of present and future threats that species endangerment and extinction is causing; the virtually unstoppable impending danger of human population growth and its seemingly unavoidable impact on the environment; the ongoing problem of informing or connecting with the public about the danger it is causing to the environment; and the kinds of resources available and solutions needed to begin leading a life of informed environmental responsibility Appendix: Lesson is at website below http://sciencenetlinks.com/lessons/endangered-species-1/		

UNIT RESOURCES Ecology
Teacher Resources: This may include: ● Modern Biology, Holt 2006 ● Teachers' Domain is an extensive library of free digital media resources produced by public television, designed for classroom use and professional development. Users must register, but content is free. Available online at http://www.teachersdomain.org/ ● The Missouri Department of Conservation available online at http://mdc.mo.gov/ ● Missouri Department of Natural Resources available online at http://www.dnr.mo.gov/kids.htm ● Global Learning and Observations for the Benefit of the Environment maintains a searchable online teacher's guide of activities at all levels. Available online at http://globe.gov/tctg/globetg.jsp?rg=n&lang=en ● http://liquidassets.psu.edu/#trailer
Student Resources: This may include: ● Modern Biology, Holt 2006 ● http://liquidassets.psu.edu/#trailer

- Missouri Department of Natural Resources available online at http://www.dnr.mo.gov/kids.htm

Vocabulary:

These are words and definitions students will need to be familiar with to complete the objectives for the unit.

Word – definition

- **age structure** - the classification of members of a population into groups according to age or the distribution of members of a population in terms of age
- **biodiversity** - the variety of organisms considered at all levels, from populations to ecosystems
- **biological magnification** - the accumulation of increasingly large amounts of toxic substances within each successive link of the food chain
- **biotic factor** - an environmental factor that is associated with or results from the activities of living organisms
- **carrying capacity** - the largest population that an environment can support at any given time
- **climax community** - a community that, after a process of ecological succession, has reached a generally stable state
- **commensalism** - a relationship between two organisms in which one organism benefits and the other is unaffected
- **community** - a group of various species that live in the same habitat and interact with each other
- **density-dependent factor** - a variable affected by the number of organisms present in a given area
- **density-independent factor** - a variable that affects a population regardless of the population density, such as climate
- **diversity/biodiversity** - the variety of organisms considered at all levels, from populations to ecosystems
- **ecological succession** - a gradual process of change and replacement in a community
- **exponential model** - a model of population growth in which a constant and unlimited growth rate results in geometric increases in population size
- **extinction** - the death of every member of a species
- **habitat** - the place where an organism usually lives
- **herbivore/primary consumer** - an organism that eats only plants
- **interdependence** - the dependence of every organism on its connections with other living and nonliving parts of its environment
- **interspecific competition** - a relationship between two species in which both species compete for limited resources such that both species are negatively affected by the relationship
- **limiting factor** - an environmental factor that prevents an organism or population from reaching its full potential of distribution or activity
- **logistic model** - a model of population growth that assumes that finite resource levels limit population growth
- **mutualism** - a relationship between two species in which both species benefit
- **niche** - the unique position occupied by a species, both in terms of its physical use of its habitat and its function within an ecological community
- **nitrogen fixation** - the process by which gaseous nitrogen is converted into nitrates, compounds that organisms can use to make amino acids and other nitrogen-containing organic molecules

- **parasitism** - a relationship between two species in which one species, the parasite, benefits from the other species, the host, which is harmed
- **pioneer species** - a species that colonizes an uninhabited area and that starts an ecological cycle in which many other species become established
- **polygenic** - describes a characteristic that is influenced by many genes
- **population** - a group of organisms of the same species that live in a specific geographical area and interbreed
- **predation** - a relationship between two species in which one species, the predator , feeds on the other species, the prey
- **primary succession** - succession that begins in an area that previously did not support life
- **secondary succession** - the process by which one community replaces another community that has been partially or totally destroyed
- **survivorship curves** - a graph of the mortality data of a population; indicates the probability that individuals will survive to any given age
- **symbiosis** - a relationship in which two different organisms live in close association with each other

Content Area: Science	Course: Pre-AP Biology	UNIT 2: Cells (biochemistry, cell structure and function, energy, cell division and development)

Unit Description:	Unit Timeline: 9 weeks
Students will understand that: ● Cells carry out chemical transformations that use energy for the synthesis or breakdown of organic compounds. ● Cellular activities and responses can maintain stability internally while external conditions are changing (homeostasis). ● Cells are the fundamental units of structure and function of all living things. ● The cell contains a set of structures called organelles that interact to carry out life processes through physical and chemical means. ● Photosynthesis and cellular respiration are complementary processes necessary to the survival of most organisms on Earth. ● Cell reproduce and organisms develop through cell differentiation.	Biochemistry Cell structure and function Energy Cell Division and Development

DESIRED Results
<u>Transfer Goal</u> - ***Students will be able to independently use their learning to……*** · Students will be able to plan and conduct an investigation. · Students will be able to develop and use models to illustrate the organization of interacting systems. · Students will be able to construct an argument based on evidence.

Understandings – ***Students will understand that… (Big Ideas)***

1. Cells are the fundamental units of structure and function.
2. Cellular organelles are interdependent, but interact to maintain homeostasis and carry out life processes.
3. Biological systems use molecular building blocks to grow, reproduce and maintain homeostasis.
4. Life processes are affected by environmental conditions.
5. All organisms require energy through the processes of cellular respiration and photosynthesis.
6. Scientists plan and carry out investigations in the field or laboratory working collaboratively as well as individually.
7. Meiosis produces haploid gametes which combine to form diploid zygotes with a combination of traits from two parents.
8. Mitosis produces diploid cells identical to the parent cells; this process is used for growth, repair, and development of multicellular organisms.

Essential Questions: ***Students will keep considering…***

- How can you predict the function of a cell by the way it looks?
- How do I maintain homeostasis?
- What role do carbohydrates, proteins, nucleic acids, and lipids play in the growth, reproduction, and maintenance of homeostasis in our bodies?
- How are life processes affected by changing environmental conditions?
- How is energy transferred through an organism and their environment?
- How do scientists carry out investigations for cell biology?

Students will know…..	Standard	Students Will Be Able to…..	Standard
● An organic compound is a chemical synthesized in living things that contains the element carbon; while inorganic compounds do not. ● Energy is either absorbed or released in a chemical reaction. ● Energy is absorbed or released in the breakdown and/or synthesis or organic compounds	3.2.Db 3.2.Dc 3.2.Dc	● Relate the structure of organic compounds (e.g., proteins, nucleic acids, lipids, carbohydrates) to their role in living systems ● Explain how protein enzymes affect chemical reactions(e.g., the breakdown of food molecules, growth and repair, regulation) ● Interpret a data table showing the effects of an enzyme on a biochemical reaction ● Describe the function of protein in cell structure and function (i.e., enzyme action,	3.2.Db 3.2.Dd 3.2.De 3.2.Eb

● Organic compounds are chemicals containing carbon, synthesized in living things; inorganic compounds do not contain carbon.	3.2.Db	growth and repair of body parts, regulation of cell division and differentiation)	
● Enzymes affect the activation energy of a chemical reaction.	3.2.Dd	● Explain how water is important to cells (e.g., is a buffer for body temperature, provides soluble environment for chemical reactions, serves as a reactant in chemical reactions, provides hydration that maintains cell turgidity, maintains protein shape)	3.2.Fc
● Different types of bonds are broken and remade during chemical reactions.	3.2Dc		
● The four major macromolecules are proteins, nucleic acids, lipids, and carbohydrates.	3.2.Db	● Build representative models of macromolecules and show how monomers combine by dehydration synthesis and are broken down by hydrolysis.	3.2.Db
● Water is a universal solvent which makes transfer across membranes possible.	3.2.Fc		
● Potential energy is stored in molecular bonds and is released as kinetic energy when bonds are broken.	3.2.Dc	● Identify factors (e.g., biochemical, temperature) that may affect the differentiation of cells and the development of an organism	3.1.Bb
● Functional groups (hydroxyl, amino, carboxyl, phosphate) are small groups of molecules that change the characteristics of the macromolecule to which they are bonded.	3.2.Dc	● Describe the structure of cell parts (e.g., cell wall, cell membrane, cytoplasm, nucleus, chloroplast, mitochondrion, ribosome, vacuole) found in different types of cells (e.g., bacterial, plant, skin, nerve, blood, muscle) and the functions they perform (e.g., structural support, transport of materials, storage of genetic information, photosynthesis and respiration, synthesis of new molecules, waste disposal) that are necessary to the survival of the cell and organism	3.1.Cb
● pH is described as the relative concentration of hydronium and hydroxide ions in solution.	3.2.Fc		
● Changes in pH cause specific changes in living organisms.	3.2.Fc		
● Cells are the structural and functional units of all organisms.	3.1.Ca		
● Organelles carry out specific functions inside the cell.	3.1.Cb		
● Eukaryotic cells contain a nucleus, and prokaryotic cells do not.	3.1.Cb	● Compare and contrast the structure and function of mitochondria and chloroplasts	3.2.Aa
● Cells both increase in number and differentiate, becoming specialized in structure and function, during and after embryonic development.	3.1.Ba	● Compare and contrast the structure and function of cell wall and cell membranes	3.2.Ab
		● Explain physical and chemical interactions that occur between organelles (e.g., nucleus, cell membrane, chloroplast, mitochondrion, ribosome) as they carry out life processes	3.2.Ac
● All cell membranes are selectively permeable.	3.2.Fa		
● Energy is absorbed or released in the	3.2.Dc		

breakdown and/or synthesis or organic compounds ● Photosynthesis and respiration recycle oxygen and carbon dioxide in the environment. ● Chloroplasts are the organelles of photosynthesis; mitochondria are the organelles of cellular respiration. ● Various environmental factors affect the rate of photosynthesis and respiration. ● The sun is the ultimate source of all energy on Earth. ● Cells have cycles of growth and division. ● Meiosis is the production of gametes/sex cells; mitosis is the division of somatic cells. ● Chromatin (DNA) condenses into chromosomes for cell division. ● The chromosomes of daughter cells, formed through the processes of asexual reproduction and mitosis, the formation of somatic (body) cells in multicellular organisms, are identical to the chromosomes of the parent cell ● During meiosis, the formation of sex cells, chromosomes are reduced to half the number present in the parent cell	3.2.Ba 3.2.Aa 3.2.Bb 3.2.Da 3.3.Aa 3.3.Aa 3.3.C.a 3.3.C.a 3.3.Cb	● Describe the function of protein in cell structure and function (i.e., enzyme action, growth and repair of body parts, regulation of cell division and differentiation) ● Explain the significance of the selectively permeable membrane to the transport of molecules ● Predict the movement of molecules across a selectively permeable membrane (i.e., diffusion, osmosis, active transport) needed for a cell to maintain homeostasis given concentration gradients and different sizes of molecules ● Explain the significance of the surface area to volume ratio as it applies to the life cycle of a cell. ● Explain the endosymbiotic hypothesis/theory. ● Compare and contrast isotonic, hypotonic and hypertonic solutions. ● Compare and contrast the structure and function of mitochondria and chloroplasts ● Explain physical and chemical interactions that occur between organelles (e.g., nucleus, cell membrane, chloroplast, mitochondrion, ribosome) as they carry out life processes ● Explain the interrelationship between the processes of photosynthesis and cellular respiration (e.g., recycling of oxygen and carbon dioxide), comparing and contrasting photosynthesis and cellular respiration reactions (do NOT assess intermediate reactions) ● **Determine what factors affect the processes of photosynthesis and cellular respiration (i.e., light intensity, availability of reactants, temperature)**	3.2.Eb 3.2.Fa 3.2.Fb 3.1Ba 3.1.Ca 3.2.Fa 3.2.Aa 3.2.Ac 3.2.Ba **3.2.Bb**

		● **Summarize how energy transfer occurs during photosynthesis and cellular respiration as energy is stored in and released from the bonds of chemical compounds (i.e., ATP**)	**3.2.Da**
		● Explain the steps of the Light Reactions and the Dark Reactions in photosynthesis.	3.2.Dc
		● Briefly describe the events that occur in glycolysis, the Kreb's cycle and the Electron Transport Chain.	3.2.D.c
		● Compare/contrast aerobic and anaerobic respiration, including the two types of anaerobic respiration.	3.3.C.c
		● Distinguish between asexual (i.e., binary fission, budding, cloning) and sexual reproduction	3.3.A.a
		● Explain how fertilization restores the diploid number of chromosomes	3.3.C.c
		● Describe the events that take place in the phases of mitosis and meiosis.	3.3.C.a
		● Distinguish between chromatids, sister chromatids and centromeres.	3.3.B.e
		● Describe a normal cell cycle versus a cancerous cell cycle.	3.1.B.a
		● Differentiate between the results of spermatogenesis and oogenesis.	
		● Formulate testable questions and hypotheses.	7.1.A.a
		● Analyzing an experiment, identify the components (i.e., independent variable, dependent variables, control of constants, multiple trials) and explain their importance to the design of a valid experiment.	7.1.A.b
		● Design and conduct a valid experiment	7.1.A.c
		● Make qualitative and quantitative observations using the appropriate senses,	7.1.B.a

		tools and equipment to gather data (e.g., microscopes, thermometers, analog and digital meters, computers, spring scales, balances, metric rulers, graduated cylinders)	
		● Use quantitative and qualitative data as support for reasonable explanations (conclusions)	7.1.C.a
		● Analyze experimental data to determine patterns, relationships, perspectives, and credibility of explanations (e.g., predict/extrapolate data, explain the relationship between the independent and dependent variable)	7.1.C.b
		● Analyze whether evidence (data) and scientific principles support proposed explanations (laws/principles, theories/models)	7.1.C.d
		● Communicate the procedures and results of investigations and explanations through: oral presentations, drawings and maps, data tables, graphs, equations and writings	7.1.D.a
		● Communicate and defend a scientific argument	7.1.D.b
		● Write arguments focused on *discipline-specific content*.	WHST.1
		● Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.	WHST.4
		● Strengthen writing as needed by planning, revising, editing, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.	WHST.5
		● Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of	WHST.6

		technology's capacity to link to other information and to display information flexibly and dynamically. ● Write routinely over extended time frames and shorter time frames for a range of tasks, purposes, and audiences. ● Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks;analyze the causes of specific results based on information from the text. ● Determine the meaning of key terms, symbols, and domain-specific vocabulary used in a text, attending to the precise meaning of terms as they are used in particular scientific or technical contexts. ● Evaluate the hypotheses, data, and conclusions in a scientific text, corroborating or undercutting them with other sources of information ● Creativity and Innovation: students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. ● Communication and Collaboration: students use digital media and environment to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. ● Technology Operations and Concepts: students demonstrate a sound understanding of technology concepts, system, and operations	WHST.10 RST.3, RST.4 RST.8 ISTE.1 ISTE.2 ISTE.6

EVIDENCE of LEARNING			
Understanding 1-5	**Standards** **3.2.B.b** **3.2.D.a** 7.1.A.a 7.1.A.c 7.1.B.a 7.1.C.a 7.1.C.b 7.1.D.b RST.3, RST.4, RST.8, WHST.10	**Unit Performance Assessment**: **Description of Assessment Performance Task(s):** This exercise illustrates the concept of micro-environments and how each leaf of a large tree is living in its own micro-environment with its own set of environmental factors. The reason leaves on the interior of a tree can still be efficient in conducting photosynthesis is that the rate of photosynthesis is not linear with respect to light intensity. Above a certain light intensity the effect of increased intensity on total photosynthetic activity becomes diminished. Thus leaves in the interior of the canopy - if allowed reasonable light can also be efficient in conducting photosynthesis. With a multiple-layered canopy, the amount of total surface area of light-absorbing leaf surface area is greatly increased. In this exercise students will collect leaves from the "outside" and "inside" canopy of trees that have a large canopy. The students will calculate leaf area, sinus area, sinus area to leaf area ratio, leaf weight, and weight to area and determine advantages to having a certain leaf size. The data generated will be used to justify their claim. **Teacher will assess:** The evidence and justification must be used to support 3 claims made at the end of the investigation. 1. A higher sinus area/leaf ratio indicates a leaf with deeper, larger lobes. This might be an advantage to each leaf or to the entire tree. 2. Is there any advantage to a tree to have leaves with a higher weight/cm2 ratio? 3. How might leaf growth/shape be affected for plants low to the ground in a dense forest? **Performance:** **Mastery:** Students will show that they really understand when they… Are able to complete the tasks with a level of proficiency of 80% or higher **Scoring Guide:** *See Appendix __Unit 2___LeafPattern* *Leaf Performance Assessment and Scoring Guide*	**R/R Quadrant** C **21 Century** critical thinking communication

SAMPLE LEARNING PLAN
Pre-assessment: 10 Question Multiple Choice Pre-Test Titled “Cell Pre-Test” in appendix. All questions are based on state CLEs in this unit, and modeled after the End of Course Exam.

Understanding	**Standards**	**Major Learning Activities:**	**Instructional Strategy:**	**R/R Quadrant:** **21 Century**
3	3.2.Db 3.2 Dc 3.2 Eb 3.3 Ba 3.3 Bb WHST.1	1. Activity: Organic Molecule Graphic Organizer: In Find Someone Who, students are given vocabulary words to place in a graphic organizer. Upon completion they will write a summary on how they organized the words and what criteria they used to separate them. They will swap their graphic organizer with another pair and each will evaluate and comment on each others justification. ● Objective: Students will be able to classify related words and summarize the relationship that exists between those words. Appendix Documents: Organic Concept Map	Nonlinguistic representation Graphic organizer Summarizing and Note Taking Cooperative Learning	C Critical thinking Communication Collaboration
4	3.22.D.d 3.2.D.e 3.2.E.b	2. Activity: Exit Ticket: pH and Enzyme Activity The purpose of this activity is to check the students understanding of the effect of pH on enzyme activity. ● Objective: Students will interpret a graph that compares the activity and efficiency of two enzymes in environments that vary in their pH. Appendix Documents: pH and Enzyme Activity	Similarities & differences	A Critical thinking

4,6	3.2.D.c 3.2.D.d 3.2.D.e 7.1..A.a 7.1.A.b 7.1.A.c 7.1.B.a 7.1.C.a 7.1.C.b 7.1.D.a 7.1.D.b WHST.1 WHST.4 WHST.5 WHST.10 RST.8 ISTE.2 ISTE.6	3. Activity: Lab: Students will test the effects of enzyme activity in different environments by monitoring gas production from the breakdown of hydrogen peroxide. Students will generate data to defend the claim that they have made. Students will write their justification, peer edit, and rewrite their final draft. This lab will be conducted using the LabQuest2 with the Oxygen probe sensor technology. Students will present and justify their data while receiving formal peer feedback. ● Objective: The students predict, test, analyze, and use argumentative writing to justify the effects of changing environmental conditions on enzyme activity(the claim). Appendix Documents: Catalase lab	Generating and testing hypotheses Feedback Cooperative Learning	B Collaboration Critical thinking Creativity Communication
#8	3.3.C.a 7.1.B.a 7.1.C.a 7.1.C.b WHST.1 WHST.4 WHST.6 RST.3 RST.4	4. Activity: Effect of Environmental Stimuli on Cell Division ● Objective: Students will be able to use prepared onion root tip slides and a microscope to determine baseline data for cell division in this species. They will then compare their baseline data to data collected for onion tips soaked in a lectin solution. Students will perform a Chi Square test and use argumentative writing to justify a claim with evidence and receive peer feedback on the data. ● Appendix Documents: Effect of Environmental Stimuli on Cell Division	Argumentative Writing Cues and Questions Generating and Testing Hypotheses	C Critical Thinking
#7	3.3.C.a 3.3.C.b 3.3.C.c	5. Activity: Simulating Meiosis Using Chromosome Models Students will use pop beads to simulate each step of meiosis. Each stage will be sketched or students will create a vine for the steps and	Nonlinguistic Representation	B Collaboration Creativity

	RST.3 RST.4 ITSE-6	questions answered. The models provided and created by students will show how chromosomes come together at the end of Meiosis to determine an organism's traits. There will be in opportunity for Pairs to Share strategy here. ● Objective: Student will be able to manipulate and create individual models to demonstrate the steps of meiosis. Students will understand that Meiosis relates directly to student's traits and individual characteristics. Appendix Documents: Simulating Meiosis Using Chromosome Models	Kinesthetic learning Practice and Homework	
#8	3.3.A.a	6. Activity: Students will address the following question as an exit card or bell ringer: Describe the benefits and disadvantages of sexual and asexual reproduction. ● Objective: Students will compare and understand the pros and cons to sexual and asexual reproduction. Students should include in their answer the following points: ● <u>Asexual Reproduction:</u> more offspring and shorter generation time ● <u>Sexual Reproduction:</u> greater time and energy invested, greater chance for sexually transmitted disease, and genetic variation	Identifying Similarities and Differences	A Communication

1,2,4	3.2.F.a 3.2.F.b 3.2.F.c	7. Activity: Homeostasis Questioning and Importance ● Students will work collaboratively (Fan 'n Pick) on question related to homeostasis. They will determine the necessity of homeostasis such blood pressure, body temperature, etc., as it relates to survival of an organism and to humans. Students will have the opportunity to share their work in a class discuss where peer feedback and justification of claims will take place ● Objective: Students will be able to answer challenging questions on homeostasis together with their shoulder partner to demonstrate and justify the significance of homeostasis as it relates to the survival of an organism including humans. Appendix Documents: Homeostasis Transport Fan 'n Pick	Cooperative learning Feedback	B Communication Collaboration Critical thinking
1	3.1.C.b 3.2.A.b	8. Activity: Cell Organelle Analogy ● Students will describe the function of each cell organelle. Then they will state a person that serves a similar function in their school and justify the similarities between the organelle and selected individual. Students will justify their selection and other students will have the opportunity to express opinion/feedback on analogies ● Objective: Students will be able to define the cell organelles of a plant cell along with their functions and make a real world analogy for each organelle. Appendix documents: Cell Organelle Analogy	Similarities and differences Feedback	C Critical thinking Creativity

2,4,5,6	3.2.A.a 3.2.A.c 3.2.B.a 3.2.B.b 3.2.D.a 7.1..A.a 7.1.A.b 7.1.A.c 7.1.A.e 7.1.B.a 7.1.B.b 7.1.B.c 7.1.B.d 7.1.B.e 7.1.C.a 7.1.C.b 7.1.C.c 7.1.C.d 7.1.D.a 7.1.D.b WHST-1 WHST-2	9. Activity: Leaf Disk Photosynthesis ● Students will choose roles based upon pre-determined cooperative learning groups, design and conduct their own laboratory investigation on the factors that affect photosynthetic rate. Students will gather evidence, make a claim, and justify their claim both in writing and to their colleagues along with receive peer feedback. Students will have the opportunity to formally defend their claim and peer critique their work. There may be an opportunity to share the results with the regular biology classes to help them gain a greater understanding on Photosynthesis. ● Objective: Students will be able to design, synthesize, and evaluate their own lab to address what affects the rate of photosynthesis and prepare an argument to support their claim. Appendix documents: Leaf Disk Photosynthesis	Generating and testing hypothesis Argumentative Writing Cooperative Learning Feedback	D Communication Collaboration Critical thinking Creativity
1,8	3.1.B.a 3.1.B.b. ITSE.1 ITSE.2	10. Activity: Embryology ● Students will model the stages of embryological development using play dough and create a Voicethread that depicts each stage with an explanation. Students will peer edit another groups Voicethread. This activity could also be used with Google Slides, PowerPoint, or Prezi technologies. ● Objective: Students will be able to differentiate the stages of embryological development, identify the types of stem cells at each stage, and predict what will happen if a mutation would occur during development.	Nonlinguistic representation Feedback	B Collaboration Critical thinking

		Appendix document: Embryology 2		

UNIT RESOURCES
Teacher Resources: This may include: ● Modern Biology, Holt ©2006Teachers' ● Reece, J. B. (2015). Campbell biology: Concepts and connections. ● http://www.bozemanscience.com/biology-main-page/ ● http://www.hhmi.org/biointeractive/ ● http://www.dnaftb.org/ ● http://www.dnai.org/ ● Appendix Documents
Student Resources: ● Modern Biology, Holt ©2006Teachers' ● Reece, J. B. (2015). Campbell biology: Concepts and connections. ● http://www.bozemanscience.com/biology-main-page/ ● http://www.bubbabrain.com/ ● Vocabulary Central from Pearson Education, Inc. (for iPad and iPod touch)—for each grade from 6–12, an app with engaging flash cards, songs, and trivia games to help students learn vocabulary words
Vocabulary: . ● **Organic Compound:** A compound containing hydrocarbon groups. ● **pH**: in gram atoms per liter, used to express the acidity or alkalinity of a solution on a scale of 0 to 14, where less than 7 represents acidity, 7 neutrality, and more than 7 alkalinity. ● **Macromolecule:** a very large molecule, as a colloidal particle, protein, or especially a polymer, composed of hundreds or thousands of atoms.

- **Activation Energy:** the least amount of energy required to activate atoms or molecules to a state in which they can undergo a chemical reaction.
- **Polar Molecule**: a molecule in which the centroid of the positive charges is different from the centroid of the negative charges.
- **Inorganic Molecule:** A molecule not consisting of carbon atoms.
- **Protein:** any of numerous, highly varied organic molecules constituting a large portion of the mass of every life form and necessary in the diet of all animals and other nonphotosynthesizing organisms, composed of 20 or more amino acids linked in a genetically controlled linear sequence into one or more long polypeptide chains
- **Nucleic Acid:** any of a group of long, linear macromolecules, either DNA or various types of RNA, that carry genetic information directing all cellular functions: composed of linked nucleotides.
- **Lipid:** any of a group of organic compounds that are greasy to the touch, insoluble in water, and soluble in alcohol and ether: lipids comprise the fats and other esters with analogous properties and constitute, with proteins and carbohydrates, the chief structural components of living cells.
- **Carbohydrate:** any of a class of organic compounds that are polyhydroxy aldehydes or polyhydroxy ketones, or change to such substances on simple chemical transformations, as hydrolysis, oxidation, or reduction, and that form the supporting tissues of plants and are important food for animals and people.
- **Enzyme:** any of various proteins, as pepsin, originating from living cells and capable of producing certain chemical changes in organic substances by catalytic action, as in digestion
- **Energy:** The ability to do work, or produce change. In biology, energy is often stored by cells in biomolecules, like carbohydrates (sugars) and lipids. The energy is released when these molecules have been oxidized during cellular respiration. The energy released from them when they are oxidized during cellular respiration is carried and transported by an energy-carrier molecule called ATP.
- **Autotroph:** any organism capable of self-nourishment by using inorganic materials as a source of nutrients and using photosynthesis or chemosynthesis as a source of energy, as most plants and certain bacteria and protists
- **Heterotroph:** an organism requiring organic compounds for its principal source of food.
- **Photosynthesis:** the complex process by which carbon dioxide, water, and certain inorganic salts are converted into carbohydrates by green plants, algae, and certain bacteria, using energy from the sun and chlorophyll
- **Respiration:** the sum total of the physical and chemical processes in an organism by which oxygen is conveyed to tissues and cells, and the oxidation products, carbon dioxide and water, are given off. It is an analogous chemical process, as in muscle cells or in anaerobic bacteria, occurring in the absence of oxygen.
- **Electromagnetic Spectrum:** the entire spectrum, considered as a continuum, of all kinds of electric, magnetic, and visible radiation, from gamma rays having a wavelength of 0.001 angstrom to long waves having a wavelength of more than 1 million km.
- **Pigment:** any substance whose presence in the tissues or cells of animals or plants colors them.
- **Electron Transport Chain:** An electron transport chain (ETC) is a series of compounds that transfer electrons from electron donors to electron acceptors via redox reactions, and couples this electron transfer with the transfer of protons (H^+ ions) across a membrane.
- **Chemiosmosis:** a chemical reaction between two compounds after osmosis through an intervening semipermeable membrane

- **C_4 Pathway:** Instead of the direct carbon fixation in the Calvin cycle like in C_3 carbon fixation, the C_4 pathway involves steps that first converts pyruvate to phosphoenolpyruvate (PEP) to bind with the CO_2 forming a four-carbon compound (hence the name C_4). As a result, the photorespiration pathway is bypassed, and the wasteful loss of CO_2 common in C_3 carbon fixation pathway is minimized.
- **CAM Pathway:** A type of photosynthesis exhibited by many succulent plants in which carbon dioxide is taken up and stored during the night to allow the stomata to remain closed during the daytime, decreasing water loss. Abbreviated CAM.
- **ATP (Adenine triphosphate):** Adenosine triphosphate; an adenosine-derived nucleotide that supplies large amounts of energy to cells for various biochemical processes, including muscle contraction and sugar metabolism, through its hydrolysis to ADP.
- **Aerobic cellular respiration**: The process in which our cells break down food and turn it into energy that cells need to perform their life functions.
- **Lactic Acid Fermentation:** Lactic acid fermentation is a biological process by which glucose and other six-carbon sugars (also, disaccharides of six-carbon sugars, e.g. sucrose or lactose) are converted into cellular energy and the metabolite lactate.
- **Alcoholic Fermentation:** The process by which yeast turns sugar into carbon dioxide (CO_2) and alcohol.
- **Cell:** the smallest structural and functional unit of an organism, typically microscopic and consisting of cytoplasm and a nucleus enclosed in a membrane. Microscopic organisms typically consist of a single cell, which is either eukaryotic or prokaryotic.
- **Cell Theory:** In biology, cell theory is a scientific theory which describes the properties of cells. These cells are the basic unit of structure in all organisms and also the basic unit of reproduction.
- **Organelle:** a specialized part of a cell having some specific function; a cell organ.
- **Prokaryote:** any cellular organism that has no nuclear membrane, no organelles in the cytoplasm except ribosomes, and has its genetic material in the form of single continuous strands forming coils or loops
- **Eukaryote:** any organism having as its fundamental structural unit a cell type that contains specialized organelles in the cytoplasm, a membrane-bound nucleus enclosing genetic material organized into chromosomes, and an elaborate system of division by mitosis or meiosis
- **Nuclear Envelope:** the double membrane surrounding the nucleus within a cell.
- **Nucleolus:** a conspicuous, rounded body within the nucleus of a cell.
- **Ribosome:** a minute particle consisting of RNA and associated proteins, found in large numbers in the cytoplasm of living cells. They bind messenger RNA and transfer RNA to synthesize polypeptides and proteins.
- **Mitochondria:** an organelle found in large numbers in most cells, in which the biochemical processes of respiration and energy production occur. It has a double membrane, the inner layer being folded inward to form layers (cristae).
- **Lysosome:** an organelle in the cytoplasm of eukaryotic cells containing degradative enzymes enclosed in a membrane.
- **Cytoskeleton:** a microscopic network of protein filaments and tubules in the cytoplasm of many living cells, giving them shape and coherence.
- **Centriole:** a minute cylindrical organelle near the nucleus in animal cells, occurring in pairs and involved in the development of spindle fibers in cell division.
- **Golgi apparatus:** a complex of vesicles and folded membranes within the cytoplasm of most eukaryotic cells, involved in secretion and intracellular transport.

- **Endoplasmic reticulum:** a network of membranous tubules within the cytoplasm of a eukaryotic cell, continuous with the nuclear membrane. It usually has ribosomes attached and is involved in protein and lipid synthesis.
- **Plasma membrane:** biological membrane that separates the interior of all cells from the outside environment. The cell membrane is selectively permeable to ions and organic molecules and controls the movement of substances in and out of cells. The basic function of the cell membrane is to protect the cell from its surroundings. It consists of the phospholipid bilayer with embedded proteins.
- **Permeability:** the state or quality of a material or membrane that causes it to allow liquids or gases to pass through it.
- **Semi permeable/Selectively permeable:** A semipermeable membrane, also termed a selectively permeable membrane, a partially permeable membrane or a differentially permeable membrane, is a type of biological membrane that will allow certain molecules or ions to pass through it by diffusion and occasionally specialized "facilitated diffusion".
- **Central vacuole:** a membrane-bound organelle containing water and other enzymes that function during the life of the plant. Structurally, the central vacuole is surrounded by a phospholipid bilayer.
- **Chloroplast:** organelles, specialized subunits, in plant and algal cells. Their main role is to conduct photosynthesis, where the photosynthetic pigment chlorophyll captures the energy from sunlight, and stores it in the energy storage molecules ATP and NADPH while freeing oxygen from water.
- **Chlorophyll:** Chlorophyll is a green pigment found in cyanobacteria and the chloroplasts of algae and plants.
- **Osmosis:** is the spontaneous net movement of solvent molecules through a partially permeable membrane into a region of higher solute concentration, in the direction that tends to equalize the solute concentrations on the two sides.
- **Diffusion:** The passive movement of molecules or particles along a concentration gradient, or from regions of higher to regions of lower concentration. The spontaneous net movement of particles down their concentration gradient (i.e. difference in the concentrations of substances or molecules between two areas).
- **Osmotic pressure:** the pressure that would have to be applied to a pure solvent to prevent it from passing into a given solution by osmosis, often used to express the concentration of the solution.
- **Turgor/turgidity:** being in a state of distension: swollen, tumid as applied to cells
- **Endocytosis:** the taking in of matter by a living cell by invagination of its membrane to form a vacuole.
- **Exocytosis:** a process by which the contents of a cell vacuole are released to the exterior through fusion of the vacuole membrane with the cell membrane.
- **Chromatin** - The complex of DNA and proteins that makes up a eukaryotic chromosome. When the cell is not dividing, chromatin exists as a mass of very long, thin fibers that are not visible with a light microscope.
- **Chromosome** - A threadlike, gene-carrying structure found in the nucleus. Each chromosome consists of one very long DNA molecule and associated proteins.
- **Centromere** - The centralized region joining two sister chromatids.
- **Homologous chromosome/ homolog** - Chromosome pairs of the same length, centromere position, and staining pattern that possess genes for the same characters at corresponding loci. One homologous chromosome is inherited from the organism's father, the other from the mother.

- **Diploid** - A cell containing two sets of chromosomes (2n), one set inherited from each parent.
- **Haploid** - A cell containing only one set of chromosomes (n).
- **Autosome** - A chromosome that is not directly involved in determining sex, as opposed to the sex chromosomes.
- **Sex chromosome** - The pair of chromosomes responsible for determining the sex of an individual.
- **Asexual reproduction** - A type of reproduction involving only one parent that produces genetically identical offspring by budding or by the division of a single cell or the entire organism into two or more parts.
- **Sexual reproduction** - A type of reproduction in which two parents give rise to offspring that have unique combinations of genes inherited from the gametes of the two parents.
- **Mitosis** - A process of nuclear division in eukaryotic cells conventionally divided into five stages: prophase, prometaphase, metaphase, anaphase, and telophase. Mitosis conserves chromosome number by equally allocating replicated chromosomes to each of the daughter nuclei.
- **Meiosis** - A two-stage type of cell division in sexually reproducing organisms that results in gametes with half the chromosome number of the original cell.
- **Somatic cell** - Any cell in a multicellular organism except a sperm or egg cell.
- **Cytokinesis** - The division of the cytoplasm to form two separate daughter cells immediately after mitosis.
- **Binary fission** - The type of cell division by which prokaryotes reproduce; each dividing daughter cell receives a copy of the single parental chromosome.
- **Interphase** - The period in the cell cycle when the cell is not dividing. During interphase, cellular metabolic activity is high, chromosomes and organelles are duplicated, and cell size may increase. Interphase accounts for 90% of the time of each cell cycle.
- **Crossing-over** - The reciprocal exchange of genetic material between nonsister chromatids during synapsis of meiosis I.
- **Genetic recombination** - The general term for the production of offspring that combine traits of the two parents.
- **Independent assortment** - the random distribution of the pairs of genes on different chromosomes to the gametes
- **differentiation** - The structural and functional divergence of cells as they become specialized during a multicellular organism's development; dependent on the control of gene expression.
- **Specialization** - the evolutionary adaptation of a cell, organ, organism, or population for a particular function or environment
- **Spermatogenesis** - The continuous and prolific production of mature sperm cells in the testis.
- **Oogenesis** - The process in the ovary that results in the production of female gametes.
- **Cleavage furrow** - The first sign of cleavage in an animal cell; a shallow groove in the cell surface near the old metaphase plate.
- **Cell plate** - A double membrane across the midline of a dividing plant cell, between which the new cell wall forms during cytokinesis.

Content Area: Science	Course: Pre-AP Biology	UNIT 3: Molecular Biology (DNA, Cellular Reproduction, Biotechnology, & Genetics)

Unit Description:	Unit Timeline:
There is a genetic basis for the transfer of biological characteristics from one generation to the next through reproductive processes.	8 weeks

DESIRED Results

Transfer Goal - ***Students will be able to independently use their learning to……***

- Students will be able to plan and conduct an investigation.
- Students will be able to develop and use models to illustrate the organization of interacting systems.
- Students will be able to construct an argument based on evidence.

Understandings – *Students will understand that… (Big Ideas)*

1. DNA, the hereditary material, codes for proteins which determine traits in living organisms.
2. Genetic variation is generated by mutations in DNA. New combinations of traits are generated through crossing over and independent assortment in meiosis through sexual reproduction.
3. Bioinformatics tools aid in the comparison of genetic and genomic data and more generally in the understanding of evolutionary aspects of molecular biology.
4. Genetic engineering is the process of manually adding new DNA to an organism.
5. DNA technologies are used for many commercial, medical, and judicial applications.
6. Scientists plan and carry out investigations in the field or laboratory working collaboratively as well as individually.

Essential Questions: *Students will keep considering…*

1. How does DNA code for the characteristics of living organisms?
2. How does meiosis result in organisms with unique combinations of traits from two parents?
3. What general processes produce variation in living organisms?
4. What general processes produce new cells in an organism?
5. How do scientists use genetic data to compare organisms?
6. How are genetically modified organisms engineered?
7. What are some practical applications of DNA technology?
8. In what ways do scientists investigate molecular biology?

Students will know…..	Standard	Students Will Be Able to…..	Standard
● Certain chromosomes are called the sex chromosomes because they determine the sex of the individual.	3.3.C.d	● Distinguish sex chromosomes from autosomes.	3.3.C.d
		● Describe how genes can be altered and combined to create genetic variation within a species (e.g., mutation, recombination of genes)	3.3.D.b
● DNA codes for proteins which are expressed as the heritable characteristics of an organism.	3.3.B.b		
● **New heritable characteristics can only result from new combinations of existing genes or from mutations of genes in an organism's sex cells.**	**3.3.D.c**	● **Explain how genotypes (heterozygous and homozygous) contribute to phenotypic variation within a species**	**3.3.E.a**
		● **Predict the probability of the occurrence of specific traits, including sex-linked traits, in an offspring by using a monohybrid cross**	**3.3.E.b**
● Not all traits are passed to offspring in a Mendelian inheritance pattern. (i.e. incomplete dominance, codominance).	3.3.E.b.2		
		● Predict the probability of the occurrence of specific traits using a dihybrid cross. (independent assortment)	3.3.E.b.1
● Chromosomal mutations are caused by a change in chromosome number and by a change in chromosomal structure.	8.3.B.c.2		
		● Predict the probability of the occurrence of traits that are inherited as non-Mendelian traits, such as codominance or incomplete dominance, or sex linked traits.	3.3.E.b.2
● Explain how DNA electrophoresis and the polymerase chain reaction has changed the nature of criminal investigations and the understanding of genetics at the molecular level.	8.3.B.c.1		
		● Analyze a pedigree to determine the mode of inheritance**.**	3.3.E.b.3
● DNA can be transferred between organisms by genetic engineering.	8.3.B.c.4	● Identify the implications of human sex chromosomes for sex determination	3.3.C.d
		● Analyze various karyotypes to determine	3.3.C.d.1

		chromosomal mutations that indicate a chromosomal disorder and gender. Identify karyotypes of Down Syndrome, Turner Syndrome, and Klinefelter Syndrome.	
		● Explain how sex-linked traits may or may not result in the expression of a genetic disorder (e.g., hemophilia, muscular dystrophy, color blindness) depending on gender.	3.3.E.c
		● Explain how the process of electrophoresis works to separate mixes of DNA fragments.	8.3.B.c.1
		● Describe how bioinformatics, proteomics, and microarrays are changing the medical field	8.3.B.c.2
		● Explain the process of PCR. Include the ingredients necessary and the machine involved.	8.3.B.c.3
		● Explain how the DNA code determines the sequence of amino acids necessary for protein synthesis	3.2.E.a
		● Diagram the sequence of events of protein synthesis from transcription in the nucleus to translation on a ribosome.	3.2.E.a.1
		● Describe the chemical and structural properties of DNA (e.g., DNA is a large polymer formed from linked subunits of four kinds of nitrogen bases; genetic information is encoded in genes based on the sequence of subunits; each DNA molecule in a cell forms a single chromosome)	3.3.B.a
		● Explain how an error in the DNA molecule (mutation) can be transferred during replication	3.3.B.d
		● Identify different types of mutations (frameshift/point) and how these mutations will affect the protein synthesized.	3.3.B.d.1
		● Identify possible external causes (e.g., heat, radiation, certain chemicals) and effects of DNA mutations (e.g., altered proteins which may	3.3.B.e

		affect chemical reactions and structural development)	
		● Identify the role of the enzymes used in DNA synthesis. (i.e. helicase, DNA polymerase, DNA ligase)	3.3.B.d.2
		● Compare and contrast the structure and function of DNA and RNA.	3.3.B.a.1
		● Make qualitative and quantitative observations using the appropriate senses, tools and equipment to gather data (e.g., microscopes, thermometers, analog and digital meters, computers, spring scales, balances, metric rulers, graduated cylinders)	7.1.B.a
		● Use quantitative and qualitative data as support for reasonable explanations (conclusions)	7.1.C.a
		● Analyze experimental data to determine patterns, relationships, perspectives, and credibility of explanations (e.g., predict/extrapolate data, explain the relationship between the independent and dependent variable)	7.1.C.b
		● Analyze whether evidence (data) and scientific principles support proposed explanations (laws/principles, theories/models)	7.1.C.d
		● Write arguments focused on *discipline-specific content*.	WHST.1
		● Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.	WHST.4
		● Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.	WHST.6

		● Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.	WHST.8
		● Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.	RST.1
		● Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.	RST.3
		● Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9-10 texts and topics*.	RST.4
		● Students apply digital tools to gather, evaluate, and use information.	ISTE 3
		● Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources.	ISTE 4
		● Students demonstrate a sound understanding of technology concepts, systems, and operations.	ISTE 6

EVIDENCE of LEARNING

Understanding	**Standards**	**Unit Performance Assessment**:	**R/R Quadrant & 21st Century**
1 - 6	**3.3.D.c** **3.3.E.b.3** **3.3.E.b** **3.3.E.a** ISTE S-3 ISTE S-4 RST.1 RST.4 RST.8 WHST.1 WHST.2 WHST.9	**Description of Assessment Performance Task(s):** Case Study Performance Assessment This case study follows a young couple that is consulting with a genetic counselor about their plans to have a child. Because of their family history with cystic fibrosis, they are concerned about their chances of having a child with this genetic disease. The case study reviews the basics of Mendelian and molecular genetics in humans, briefly examines the possibilities and limitations of genetic testing, and introduces students to online databases, including OMIM, a catalog of human genetic traits. The case also requires students to practice the scientific method, including hypothesis development, experimental design, and the analysis of primary research articles. Students will construct an argument in which they justify their claim from evidence. **Teacher will assess:** What criteria will be used in each assessment to evaluate attainment of the desired results? ● Construct and analyze a human pedigree and a Punnett square. ● Predict the effect of a mutation on the expression of a gene, specifically whether the mutation will alter the amount of the gene's mRNA, the structure of the gene's mRNA, the amount of the encoded protein, or the structure of the encoded protein. ● Explain why a gene can have many alleles within a population. ● Explain how a mutation outside of the coding region of a gene can cause a genetic disease. ● Access OMIM, a commonly used online database of human genetic diseases and other traits. What are those elements assessed for? What qualities are most important? ● The claim made is BOTH accurate and sufficient to answer the question. ● The evidence includes valid and appropriate data, an analysis of the data, and an interpretation of data.	D Critical Thinking

		● The justification thoroughly explains why the evidence is important or relevant, AND links to an important concept or principle. **Performance:** **Mastery:** *Students will show that they really understand when they…* Write an explanation that includes a claim concerning the inheritance patterns of parents with two different mutations for cystic fibrosis, support of the claim with evidence, and a justification of how their evidence supports the claim. **Scoring Guide:** *See Appendix : Cystic Fibrosis Case Study PE*	

SAMPLE LEARNING PLAN
Pre-assessment: 10 Question Multiple Choice Pre-Test Titled “Molecular Biology Pre-Test” in appendix. All questions are based on state CLEs in this unit, and modeled after the End of Course Exam.

Understanding	**Standards**	**Major Learning Activities:**	**Instructional Strategy:**	**R/R Quadrant: & 21st Century**
#1	3.3.B.d.2 3.3.B.a RST.1 RST.3 RST.4	1. Activity: Modeling DNA ● Students will be provided with explicit instruction about the components of a DNA model. Students will be guided through the instruction on how to create a DNA Model while students begin to understand how DNA forms the double	Modeling Nonlinguistic Representation Kinesthetic	A Collaboration

		helix, replicates, and its structural importance. ● Objective: Students will construct a model of DNA following the rules of complementary base pairing, and then demonstrate how DNA is replicated. ● Appendix Documents: Modeling DNA	learning Cooperative Learning	
#1, #2, #3, #5, #6	**3.2.E.a** 3.2.E.a.1 3.3.B.d **3.3.D.c** 3.3.D.b 7.1.C.d 7.1.C.a 8.3.B.c.2 WHST.1 WHST.4 WHST.6 WHST.8 RST.1 RST.3 RST.4 ISTE S-3 ISTE S-4	2. Activity: Why Do I Need a Flu Shot Every Year? ● Students will use the National Institute of Health's national database of influenza amino acid sequence data to explore mutations in influenza and evaluate the need for a new Flu Shot every year. They will collect data to gain an understanding why the Flu Shot is recommended to be taken yearly. There may be an opportunity to share the claims when the third PLTW Biomedical course begins as this relates to its curriculum. This could also be shared with some of our Social Studies courses because the spread of virus and disease has played a huge role in history. An other option would be to have students create a public service announcement for their peers on the topic. ● Objective: Students will be able to use bioinformatics, which is the confluence of computer science, biology, and mathematics to construct an argument in which they justify their claim from evidence while defending their claim regarding the need or no need to get the Flu Shot every year. ● Appendix Documents: Flu Pre-Lab Why Do I Need a Flu Shot Every Year?	Problem Solve Argumentative Writing Generating and Testing Hypotheses Feedback	D Critical Thinking
#1, #2, #3, #5,	3.3.B.d.1	3. Activity: Detection of Duchenne Muscular Dystrophy by		D

#6	3.3.C.d **3.3.E.a** **3.3.E.b** 3.3.E.b.2 3.3.E.c 7.1.B.a 7.1.C.a 7.1.C.b 8.3.B.c.3 8.3.B.c.2 8.3.B.c.1 WHST.1 WHST.4 RST.1 RST.3 RST.4 ISTE-6	electrophoresis ● Students will be able to use the tools of DNA gel electrophoresis as they pour their own gels and load them with simulated DNA samples from a family with Duchenne Muscular Dystrophy. The mutant allele has a deletion, so it will run farther in the gel than the wild type, thus allowing students to diagnose each member of the family. After making a diagnosis, students will work in Mix-Pair-Share to justify their diagnosis and get other perspectives from peers. ● Objective: Students will evaluate how gel electrophoresis technology is used to produce visual DNA results that can be analyzed and used in diagnosing disorders in the real world while understanding the importance of understanding family genetic history. ● Appendix Documents: Detection of Duchenne Muscular Dystrophy by electrophoresis	Problem Solving Cooperative Learning	Critical Thinking Collaboration
#4	3.3.B.d.2 3.3.B.a **3.3.E.a** WHST.4 RST.3 RST.4	4. Activity: A paper activity involving cutting and pasting DNA fragments using Jurassic Park as a theme ● Students will read to understand a section from the book Jurassic Park by Michael Crichton that details the technology of how restriction enzymes were used to cut and paste DNA to create ”dinosaurs.” Students can utilize a “Jot Thoughts strategy to brainstorm the next step in this activity. Then they will be able to choose a simulated gene and corresponding restriction enzymes to genetically engineer their own dinosaur. The class will share their results and discuss how genetic engineering is occurring every day through the creation of new products. ● Objective: Students will be able to genetically engineer an	Nonlinguistic Representation Generating and Testing Hypothesis Identifying similarities and differences Cooperative learning	C Critical Thinking Creativity Collaboration

		organism by understanding the functionality of restriction enzymes while relating genetic engineering to changes in many products created today through a follow up class discussion. ● Appendix Documents:Jurassic Park Day 1 and Jurassic Park Student		
#2	3.3.C.d **3.3.E.a** **3.3.E.b** 3.3.E.b.2 **3.3.E.b.3**	5. Activity: Human Sex-Linked Pedigree ● Students will work through a paper activity involving a Human Sex-Linked Pedigree in which students will be able to follow the pedigree to determine the genotype and phenotype involved in a sex-linked trait. Students can utilize a Rally Table strategy in problem solving ● Objective: Students will learn how to analyze and interpret a sex-linked pedigree to determine individual genotypes and phenotypes. ● Appendix Documents: A Human Sex-Linked Pedigree	Problem Solving Cooperative Learning	A Critical Thinking Collaboration
#5	3.3.C.d 3.3.C.d.1 8.3.B.c.2 WHST.1 RST.1 ISTE-3 ISTE - 6	6. Activity: Completing a web based karyotyping activity ● Students will work through an online resource where they will evaluate the genetic information of 3 patients. From their prior knowledge and frontloading activities, students will synthesize a diagnosis of each patient that also includes genetic research to justify student claims. To follow up, students will utilize a Round Table strategy to discuss, analyze and provide peer feedback on the diagnosis related to the data researched. ● Objective: Students will be able to use genetic data to	Generating and testing hypothesis Cooperative Learning	B Critical Thinking Collaboration

		complete karyotypes and diagnose any missing or extra chromosomes based on their research. Students will be able to justify their claims through the research too. ● Appendix Documents: none; entire activity available online at http://bit.ly/18pLMjj		
#1, #2	**3.3.E.a** **3.3.E.b** 3.3.E.b.1 7.1.C.a	7. Activity: Punnett Square Packet ● Students will practice predicting the outcomes of monohybrid and dihybrid crosses. They will learn to appropriately use and interpret Punnett Squares, genotypes, and phenotypes to determine organism traits including human traits. ● Objective: Students will be able to manipulate Punnett Squares to determine genetic characteristics such as genotypes, phenotypes, dominance, recessive, probability, and relate to traits found in organisms including humans. ● Appendix Documents: Punnett Square Packet	Providing Practice and Homework Summarizing and Note Taking	B Critical Thinking

UNIT RESOURCES
Teacher Resources: ● Postlethwait, J. H., Hopson, J. L., & Holt, Rinehart, and Winston, inc. (2006). *Modern biology*. Orlando: Holt, Rinehart and Winston. ● Reece, J. B. (2015). *Campbell biology: Concepts and connections*. ● *http://www.bozemanscience.com/biology-main-page/* ● *http://www.hhmi.org/biointeractive/* ● *http://www.dnaftb.org/* ● *http://www.dnai.org/* ● *Appendix Documents*
Student Resources:

- Postlethwait, J. H., Hopson, J. L., & Holt, Rinehart, and Winston, inc. (2006). *Modern biology*. Orlando: Holt, Rinehart and Winston.
- Reece, J. B. (2015). *Campbell biology: Concepts and connections*.
- *http://www.bozemanscience.com/biology-main-page/ (Cannot use at school; videos are on YouTube)*
- *http://www.bubbabrain.com/*
- *http://www.dnaftb.org/*
- *Apps:*
    - *Vocabulary Central from Pearson Education, Inc. (for iPad and iPod touch)—for each grade from 6–12, an app with engaging flashcards, songs, and trivia games to help students learn vocabulary words*
    - *Lizard Evolution Virtual Lab App*
    - *Stickleback Evolution Virtual Lab App*
    - *Click and Learn App*
    - *Bacterial ID Virtual Lab App*

Vocabulary:

Ribonucleic acid - A type of nucleic acid consisting of nucleotide monomers with a ribose sugar and the nitrogenous bases adenine (A), cytosine (C), guanine (G), and uracil (U); usually single-stranded; functions in protein synthesis and as the genome of some viruses.
Transcription - The synthesis of RNA on a DNA template.
Translation - The synthesis of a polypeptide using the genetic information encoded in an mRNA molecule. There is a change of "language" from nucleotides to amino acids.
Protein synthesis -the formation of proteins by using information contained in DNA and carried by mRNA
Codon - A three-nucleotide sequence of DNA or mRNA that specifies a particular amino acid or termination signal; the basic unit of the genetic code.
Anticodon - A specialized base triplet on one end of a tRNA molecule that recognizes a particular complementary codon on an mRNA molecule.
Genome - The complete complement of an organism's genes; an organism's genetic material.
Sex-linked traits - An inherited trait, such as color discrimination, determined by a gene located on a sex chromosome and that therefore shows a different pattern of inheritance in males and females.
Multiple alleles - more than two alleles (versions of the gene) for a genetic trait
Incomplete dominance - A type of inheritance in which F_1 hybrids have an appearance that is intermediate between the phenotypes of the parental varieties.
Intron - A noncoding, intervening sequence within a eukaryotic gene.
Exon - The coding region of a eukaryotic gene that is expressed. Exons are separated from each other by introns.
Polygenic inheritance - An additive effect of two or more gene loci on a single phenotypic character.
Translocation - An aberration in chromosome structure resulting from an error in meiosis or from mutagens; attachment of a chromosomal

fragment to a nonhomologous chromosome.
Nondisjunction - An accident of meiosis or mitosis, in which both members of a pair of homologous chromosomes or both sister chromatids fail to move apart properly.
Frameshift mutation - A mutation occurring when the number of nucleotides inserted or deleted is not a multiple of 3, thus resulting in improper grouping into codons.
Pedigree - A family tree describing the occurrence of heritable characters in parents and offspring across as many generations as possible.
Point mutation - A change in a gene at a single nucleotide pair.
Chromatin - The complex of DNA and proteins that makes up a eukaryotic chromosome. When the cell is not dividing, chromatin exists as a mass of very long, thin fibers that are not visible with a light microscope.
Chromosome - A threadlike, gene-carrying structure found in the nucleus. Each chromosome consists of one very long DNA molecule and associated proteins.
Centromere - The centralized region joining two sister chromatids.
Homologous chromosome/ homolog - Chromosome pairs of the same length, centromere position, and staining pattern that possess genes for the same characters at corresponding loci. One homologous chromosome is inherited from the organism's father, the other from the mother.
Diploid - A cell containing two sets of chromosomes (2n), one set inherited from each parent.
Haploid - A cell containing only one set of chromosomes (n).
Autosome - A chromosome that is not directly involved in determining sex, as opposed to the sex chromosomes.
Sex chromosome - The pair of chromosomes responsible for determining the sex of an individual.
Asexual reproduction - A type of reproduction involving only one parent that produces genetically identical offspring by budding or by the division of a single cell or the entire organism into two or more parts.
Sexual reproduction - A type of reproduction in which two parents give rise to offspring that have unique combinations of genes inherited from the gametes of the two parents.
Mitosis - A process of nuclear division in eukaryotic cells conventionally divided into five stages: prophase, prometaphase, metaphase, anaphase, and telophase. Mitosis conserves chromosome number by equally allocating replicated chromosomes to each of the daughter nuclei.
Meiosis - A two-stage type of cell division in sexually reproducing organisms that results in gametes with half the chromosome number of the original cell.
Somatic cell - Any cell in a multicellular organism except a sperm or egg cell.
Cytokinesis - The division of the cytoplasm to form two separate daughter cells immediately after mitosis.
Specialization - the evolutionary adaptation of a cell, organ, organism, or population for a particular function or environment
Spermatogenesis - The continuous and prolific production of mature sperm cells in the testis.
Oogenesis - The process in the ovary that results in the production of female gametes.
Cleavage furrow - The first sign of cleavage in an animal cell; a shallow groove in the cell surface near the old metaphase plate.
Cell plate - A double membrane across the midline of a dividing plant cell, between which the new cell wall forms during cytokinesis.

Cancer - a tumor in which the cells begin dividing at an uncontrolled rate and become invasive
Nitrogenous base - An**Binary fission** - The type of cell division by which prokaryotes reproduce; each dividing daughter cell receives a copy of the single parental chromosome.
Interphase - The period in the cell cycle when the cell is not dividing. During interphase, cellular metabolic activity is high, chromosomes and organelles are duplicated, and cell size may increase. Interphase accounts for 90% of the time of each cell cycle.
Crossing-over - The reciprocal exchange of genetic material between nonsister chromatids during synapsis of meiosis I.
Genetic recombination - The general term for the production of offspring that combine traits of the two parents.
Independent assortment - the random distribution of the pairs of genes on different chromosomes to the gametes
Differentiation - The structural and functional divergence of cells as they become specialized during a multicellular organism's development; dependent on the control of gene expression.
organic base that contains the element nitrogen.
DNA replication - the process of making a copy of DNA
RNA - A type of nucleic acid consisting of nucleotide monomers with a ribose sugar and the nitrogenous bases adenine (A), cytosine (C), guanine (G), and uracil (U); usually single-stranded; functions in protein synthesis and as the genome of some viruses.
RNA polymerase - An enzyme that links together the growing chain of ribonucleotides during transcription.
Transformation - A phenomenon in which external DNA is assimilated by a cell.
Semi-conservative replication - in each new DNA double helix, one strand is from the original molecule, and one strand is new
nucleotide - The building block of a nucleic acid, consisting of a five-carbon sugar covalently bonded to a nitrogenous base and a phosphate group.
DNA polymerase - An enzyme that catalyzes the elongation of new DNA at a replication fork by the addition of nucleotides to the existing chain.
Helicase - an enzyme that separates DNA strands
Genetic engineering - a technology in which the genome of a living cell is modified for medical or industrial use
Polymerase chain reaction - A technique for amplifying DNA in vitro by incubating with special primers, DNA polymerase molecules and nucleotides.
Bioinformatics - the collection, classification, storage, and analysis of biochemical and biological information using computers especially as applied to molecular genetics and genomics
DNA fingerprinting - the pattern of bands that results when an individual's DNA sample is fragmented, replicated, and separated
Genetic counseling - the process of testing and informing potential parents about their genetic makeup and the likelihood that they will have offspring with genetic defects or hereditary diseases
Restriction enzyme - A degradative enzyme that recognizes and cuts up DNA (including that of certain phages) that is foreign to a bacterium.
Plasmid - A small ring of DNA that carries accessory genes separate from those of a bacterial chromosome. Also found in some eukaryotes, such as yeast.
Clone - A lineage of genetically identical individuals or cells.
Recombinant DNA - A DNA molecule made in vitro with segments from different sources.

Gene therapy - a technique that places a gene into a cell to correct a hereditary disease or to improve the genome
Single Nucleotide Polymorphism - in DNA, a single base site that differs in at least 1% of the population
DNA microarray - a set of target DNA sequences embedded in a glass chip, to which sample DNA fragments bind and fluoresce; used to show patterns of gene expression

Content Area: Science	Course: Pre-AP Biology	UNIT 4: Change of Organisms over Time

Unit Description:	Unit Timeline: 4 weeks
There is heritable variation within every species of organism. The diversity of species within an ecosystem is affected by changes in the environment, which can be caused by other organisms or outside processes. Evidence for the nature and rates of evolution can be found in anatomical and molecular characteristics of organisms and in the fossil record. Reproduction is essential to the continuation of every species. Natural selection is the process of sorting individuals based on their ability to survive and reproduce within their ecosystem.	

DESIRED Results

Transfer Goal - ***Students will be able to independently use their learning to……***

- Students will be able to plan and conduct an investigation.
- Students will be able to develop and use models to illustrate the organization of interacting systems.
- Students will be able to construct an argument based on evidence.

Understandings – *Students will understand that… (Big Ideas)*

1. Natural selection is the driving force for organisms changing over time.
2. Evidence for the nature and rates of evolution can be found in anatomical and molecular characteristics of organisms and in the fossil record.
3. All species have descended with modifications from a common ancestor.
4. Scientists plan and carry out investigations in the field or laboratory working collaboratively as well as individually.

Essential Questions: *Students will keep considering…*

1. How does natural selection impact organisms changing over time?
2. What evidences can you analyze supporting changes in organisms?
3. How have species changed over time?
4. What scientific investigations have lent credibility to organisms changing over time to survive and adapt throughout history?

Students will know…..	Standard	Students Will Be Able to…..	Standard
● The degree of relatedness can be determined by comparing DNA sequences.	3.3.B.c	● **Describe the advantages and disadvantages of asexual and sexual reproduction with regard to variation within a population.**	**3.3.D.a**
● Extinction is the permanent loss of a species.	4.3.B.b	● Describe possible causes of extinction of a population.	4.1.D.b
● Evolution is biological change over time.	4.3.A.a	● Interpret fossil evidence to explain the relatedness of organisms using the principles of superposition and fossil correlation.	4.3.A.a
● Half life can be used as evidence in determining the age of a fossil.	4.3.A.b	● **Evaluate the evidence that supports the theory of biological evolution (e.g., fossil records, similarities between DNA and protein structures, similarities between developmental stages of organisms, homologous and vestigial structures)**	**4.3.A.b**
● Anatomical structures can be used as evidence for evolution.	4.3.C.a	● Define a species in terms of the ability to mate and produce fertile offspring.	4.3.B.a
● Natural selection can be used as evidence for evolution of a species.	3.3.D.b	● **Explain the importance of reproduction to the survival of a species (i.e., the failure of a species to reproduce will lead to extinction of that species)**	**4.3.B.b**
● Genetic variations in allele frequency can account for changes in a population.	4.1.B.b	● **Identify examples of adaptations that may have resulted from variations favored by natural selection (e.g., long-necked giraffes, long-eared jack rabbits) and describe how that variation may have provided populations an advantage for survival.**	**4.3.C.a**
● Individuals move into and out of populations.	4.3.B.a	● Explain how genetic homogeneity may cause a population to be more susceptible to extinction (e.g., succumbing to a disease for which there is no natural resistance)	4.3.C.b
● A species is a group of organisms that can mate and produce fertile offspring.	4.3.A.b.1		
● Changes in gene frequencies can be caused by natural selection, genetic drift, nonrandom mating, gene flow and mutations.	4.3.A.b.1		
● Genetic drift can be caused by the founder effect or a bottleneck effect	4.3.A.b.1		
● Patterns of natural selection include disruptive, directional, and stabilizing			

		• **Explain how environmental factors (e.g., habitat loss, climate change, pollution, introduction of non-native species) can be agents of natural selection.**	**4.3.C.c**
		• Calculate the gene frequencies in a population using the Hardy Weinberg equations.	4.3.A.b.1
		• Determine whether a population is in Hardy Weinberg equilibrium.	4.3.A.b.1
		• Given a nonfiction account of a change in gene frequencies, propose the type of selective pressure affecting the population.	4.3.A.b.1
		• Write arguments focused on *discipline-specific content*.	WHST.1
		• Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience	WHST.4
		• Gather relevant information from multiple print and digital sources; assess its credibility and accuracy and its usefulness in terms of purpose task, and audience; and integrate selected information into the text, avoiding over reliance on any one source, avoiding plagiarism, and following a standard format for citations.	WHST.8
		• Write response to informational sources, drawing on textual evidence to support analysis and reflection as well as to describe what they have learned.	WHST.9
		• Write routinely over extended time frames and shorter time frames for a range of tasks, purposes, and audiences.	WHST.10
		• Summarize complex information or ideas presented in a text, paraphrasing it in simpler but still accurate terms.	RST.2
		• Follow precisely a complex multistep procedure when carrying out experiments, taking	RST.3

		measurements, or performing technical tasks; analyze the causes of the specific results based on information from the text	
		● Determine the meaning of key terms, symbols, and domain-specific vocabulary used in a text, attending to the precise meaning of terms as they are used in particular scientific or technical contexts.	RST.4
		● Analyze the scope and purpose of an experiment or explanation and determine which related issues remain unresolved and uncertain.	RST.6
		● Synthesize information in different formats by representing complex information in a text in graphical form (i.e. table or chart) or translating a graphic or equation into words	RST.7
		● Evaluate the hypotheses, data, and conclusions in a scientific text, corroborating or undercutting them with other sources of information.	RST.8
		● Creativity and Innovation: students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology.	ISTE 1
		● Students apply digital tools to gather, evaluate, and use information.	ISTE 3
		● Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources.	ISTE 4
		● Students demonstrate a sound understanding of technology concepts, systems, and operations.	ISTE 6

EVIDENCE of LEARNING			
Understanding 1, 2, 4	Standards **3.3.D.a,** **4.3.A.b,** 4.3.B.a, **4.3.B.b,** **4.3.C.a,** **4.3.C.c** WHST - 1 WHST - 4 WHST - 10 RST- 2 RST - 3 RST - 4 RST - 6 RST - 7 ISTE.4	**Unit Performance Assessment**: **Description of Assessment Performance Task(s):** Fish Frequency Performance Assessment and Scoring Guide Students will complete an activity titled "Fishy Frequencies". The initial instructions to the students are as follows: **Introduction:** Understanding natural selection can be confusing and difficult. People often think that animals consciously adapt to their environments --- that the peppered moth can change its color, the giraffe can permanently stretch its neck, the polar bear can turn itself white - allowing them to better survive in their environments. As a follow up, they have the opportunity to investigate and report a claim about a "real world" organism and how that organism was able to adapt to it's changing environment. In this, lab you will use fish crackers to help further your understanding of natural selection and the role of genetics and gene frequencies to provide evidence why and how organisms change over time. The fish crackers will be assigned multiple genetic traits. Based on the instruction, data will be collected regarding what traits will either be passed on or eliminated from the environment. The steps are all random following Hardy-Weinberg principles. **Teacher will assess:** Students will develop a graph of their data and the class data. Students will then establish a claim backed by evidence from their data, and support it with justification on how natural selection affects the frequencies of alleles in a population along with providing real world examples that appear to follow changes based on environmental changes. Students will use their data to provide evidence and justification for their claim. **Performance:** **Mastery:** *Students will show that they really understand when they…Receive a score of 2 for each of the graded categories for the graph and a score of 8-11 on the claim question.***Scoring Guide:** *See Appendix Fishy Frequencies and scoring guide*	**R/R Quadrant** C **21 Century** Critical Thinking Communication Collaboration

SAMPLE LEARNING PLAN
Pre-assessment: 10 Question Multiple Choice Pre-Test Titled “Change of Organisms over time Pre-Test” in appendix. All questions are based on state CLEs in this unit, and modeled after the End of Course Exam.

Understanding	**Standards**	**Major Learning Activities:**	**Instructional Strategy:**	**R/R Quadrant:** **21 Century**
1, 3, 4	**4.3.C.a**	1. Activity: Origami Birds **Modeling Selection** - In this “selection” lab students will model and test fly “birds” which experience mutations that are passed down through the generations. Working in groups, they will then analyze how those mutations affected the change in an organism’s characteristics. A Round Robin or Jot Thoughts strategy may be beneficial for the collaboration portion of this activity. ● Objective: Students will simulate the generation of variation in a population of birds. They will then model the selection of favorable traits in new generations. Students will have the opportunity to compare and contrast their birds with those of neighboring groups and make predictions as to how the birds may change over time, based on the results of their activity. Appendix Documents: **Modeling Selection - Origami Birds** (Word Document)	Non-linguistic Representation Generating & Testing Hypothesis Cooperative Learning Feedback	C Collaboration Communication Critical Thinking

1, 2, 3, 4	4.3.B.a, **4.3.B.b,** **4.3.C.a,** 4.3.C.b, **4.3.C.c** WHST - 4 WHST - 10 RST - 2 RST - 3 RST - 4 RST - 6 RST - 7 ISTE.1 ISTE.3	2. Activity: Online Simulation **Change of Organisms by Natural Selection -** This simulation activity demonstrates principles of natural selection. Students will have the opportunity to work in groups, with particular roles. Numbered Heads strategy may be a good way to start the introductory questions and follow up the additional questions.The activity includes: ● introductory questions and explanations to help students understand how natural selection works (pages 1-2 of the Student Handout) ● a simulation of natural selection using different colored pompoms as inhabitants of a forest or grassland, and students as hunters in the varied environments (pages 2-4) ● data analysis and graphs (pages 4-5) ● additional questions that guide students in interpreting the results and understanding how the results demonstrate the principles of natural selection (pages 6-8). ● Objectives: Students will gain understanding of two Disciplinary Core Ideas, LS4.B *Natural Selection* and LS4.C *Adaptation* (NGSS & A Framework for K-12 Science Education) . ● Students will engage in several Scientific Practices, developing and using models; using mathematics; analyzing and interpreting data; and constructing explanations. Students will have the opportunity to synthesize the results and apply to hypothetical scenarios not acted out. ● Students will have the opportunity to discuss in groups the Crosscutting Concepts, "cause and effect: mechanism and explanation", "systems and system models", and "stability and change". Appendix Documents:	Cues & questions Nonlinguistic Representations Identifying Similarities & Differences Generating & Testing Hypothesis Cooperative Learning Frontloading	C Critical Thinking Communication Collaboration

		Natural Selection Protocol (Word Document) **Natural Selection Teach Prep** http://serendip.brynmawr.edu/sci_edu/waldron/#evolution		
1, 3, 4	**3.3.D.a,** 4.3.B.a, **4.3.B.b** WHST - 4 WHST - 10 RST - 3 RST - 4 RST - 6 RST - 7	3. Activity: * *supports the performance assessment* **Predicting Allele Frequency** ● Students will use black and white beads to represent a population of hypothetical animals, recording offspring genotype and phenotype from "reproductive" events. Students will simulate random and non-random mating and compare the allele frequencies produced for both types of mating procedures. Using vocabulary and prior knowledge, they will read and answer a series of questions pertaining to their results, including the opportunity to produce an argumentative report for their claim/conclusion. ● Objective: Students will use process skills such as modeling, predicting, calculating and analyzing to demonstrate the effect of natural selection on genotype frequencies in a population. Working in groups, they will be able to compare the results of random and nonrandom mating in relationship to phenotypic expression through writing an argumentative report for their claim/conclusion. Appendix Documents: **Predicting Allele Frequencies**	Nonlinguistic Representation Identifying Similarities & Differences Generating & Testing Hypothesis Cooperative Learning Argumentative Writing	B Critical Thinking Communication Collaboration
1, 2, 3, 4	4.3.A.b, 4.3.B.A, **4.3.B.b,** **4.3.C.a,** 4.3.C.b, **4.3.C.c,**	4. Activity: Pocket Mouse!!! A multiple layered biointeractive activity based on the Rock Pocket Mouse Population of the Sonoran Desert in the Southwest. From the Howard Hughes Medical Institute http://www.hhmi.org/biointeractive/ **Introductory activity - Pocket Mouse Film With Quiz** Embedded quiz modules test students' understanding as they	Non-linguistic Representation Cues & Questions Summarizing & Note taking Argumentative	D Critical Thinking Communication

	4.3.C.d WHST - 4 WHST - 9 WHST - 10 RST - 4 RST - 6 RST - 8 ISTE-1 ISTE-3 ISTE - 4 ISTE - 6	watch the short film on the rock pocket mouse—a living example of Darwin's process of natural selection. The film features Dr. Michael Nachman, whose work in the field and in the lab has quantified the selective pressure of predators on rock pocket mouse evolution and identified the genes involved in adaptation. Use the website below to access the film. (Can be ordered through Howard Hughes Medical Institute) http://www.hhmi.org/biointeractive/pocket-mouse-film-quiz ● Objective: Students will be able to determine how the rock pocket mouse has evolved as well as identifying the genes involved by watching a short video and answering quiz questions. Appendix Documents: none; an online site **Part 2: Natural Selection and Evolution of Rock Pocket Mouse** **Populations** This lesson serves as an extension to the short film *The Making of the Fittest: Natural Selection and Adaptation* (http://www.hhmi.org/biointeractive/making-fittest-natural-selection-and-adaptation). It provides an opportunity for students to analyze amino acid data and draw conclusions about the evolution of coat-color phenotypes in the rock pocket mouse. ● Objective: Students will be able to review key concepts and mechanisms of evolution, including mutation, gene flow (or migration), genetic drift, and natural selection. Students should come to understand that evolution can and does repeat itself by doing the lab. Appendix Documents: **Rock Pocket Mouse Student Page** **Rock Pocket Mouse Teacher Page**	Writing Feedback Generating and testing Hypothesis Collaboration	Collaboration

		Part 3:Color Variation Over Time in Rock Pocket Mouse Populations Populations of rock pocket mice are found all over the Sonoran Desert in the southwestern United States. There are two common varieties—a light-colored variety and a dark-colored variety. Similarly, there are two major colors of substrate, or surface materials, that make up the desert floor. Most of the landscape consists of light-colored sand and rock. Here and there, however, separated by several kilometers of light-colored substrate, are patches of dark volcanic rocks that formed from cooling lava flows. Using colored illustrations of the Sonoran Desert, students will collect data about color frequencies in rock pocket mice. This would be an opportunity for students to look at peer analysis in a Roundtable Consensus strategy to check to make sure students can justify claims and are in agreement about the data. ● Objective: Students will be able to analyze data collected and examine how selection has impacted coat color in rock pocket mouse populations on different color substrates over time, by doing this data and analysis activity. Appendix Documents: **Mouse Color Variation Over Time Student Page** **Mouse Color Variation Over Time Teacher Page** **Part 4: Molecular Genetics of Color Mutations in Rock Pocket Mice** A lesson that requires students to transcribe and translate portions of the wild-type and mutant rock pocket mouse *Mc1r* genes and compare sequences to identify the locations and types of mutations responsible for the coat color variation described in the film. ● Objective: By comparing DNA sequences, students will identify the locations and types of mutations responsible for		

		the coat-color change described in the film. Students will form a hypothesis to explain how a change in amino acid sequence affects the functionality of the MC1R protein, and how that change might directly affect the coat color of the rock pocket mouse populations. Appendix Documents: **Molecular Genetics of Color Mutations in Rock Pocket Mice Student Page** **Molecular Genetics of Color Mutations in Rock Pocket Mice Teacher Page** **Part 5: Allele and Phenotype Frequencies in Rock Pocket Mouse Populations (supports the Performance Activity)** This activity serves as a means of reinforcing the concepts of variation and natural selection. This lesson uses real rock pocket mouse data collected by Dr. Michael Nachman and his colleagues to illustrate the Hardy-Weinberg principle. Students will apply the Hardy-Weinberg formula to the data to determine if the pocket mouse population is evolving. They will utilize a website for further application and evaluation of the data. ● Objective: Students will be able to formally write a claim supported by evidence how variation, selection, and time can fuel the change of an organism's characteristics over time and manipulate and analyze data. They will have the opportunity to defend their argument as to whether the population is evolving using the results of their calculated formula. Appendix Documents: **Allele and Phenotype Frequencies in Rock Pocket Mouse Populations Student Page** **Allele and Phenotype Frequencies in Rock Pocket Mouse Populations Teacher Page**		

		http://www.hhmi.org/biointeractive/classroom-activities-battling-beetles.		
	4.3.B.b, 4.3.C.a	5. Activity: * *supports the performance assessment* **The Hardy-Weinberg Equation Problem Practice Set** ● Students will work with a partner to determine estimated allele frequencies in a population. Students will then work with their partner through two sample problems for the Hardy-Weinberg Equation using Rallytable strategy then to a Mix-Pair-Share, with step by step instructions. Students will then exchange one partner with another group and discuss their outcomes with a new partner, comparing solutions to the problems. Students will then check for correctness of answers with the instructor key. ● Objective: Students will calculate allelic frequencies when there are two different alleles and then use the *Hardy-Weinberg equation* to determine the percent of a pig population that is heterozygous for white coat. By using the equation, they will also determine how many individuals would be expected to be homozygous for red eye color in a fly population. Appendix Documents: **Hardy Weinberg Problems**	Cooperative learning Practice and Homework Feedback	B Critical Thinking Collaboration
1, 4	**4.3.C.a,** **4.3.C.c,** 7.1.A.a WHST - 4 WHST - 10	6. Activity: *sixth activity* **Sex and the Single Guppy** This activity uses an online PBS simulation of the same name to allow students to manipulate predator and prey populations and collect data on changes in populations of guppies over several generations. They will justify their claim with the data they collect in the simulation. Students can work alone or in pairs. The activity usually takes 2 class periods. If in pairs, a Rallytable or Rally coach	Generating and testing hypotheses	C Critical Thinking Collaboration

	RST - 4 RST - 6 RST - 7 RST - 10 ISTE - 3	would be appropriate strategies to utilize. ● Objective: Students will be able to develop a hypothesis and evaluate guppy coloration patterns in three different stream situations and make predictions about their survival in these habitats and how predators play a role in that survival. http://www.pbs.org/wgbh/evolution/sex/guppy/index.html Appendix Documents: **Sex and the Single Guppy Word Document**		

UNIT RESOURCES

Teacher Resources:

This may include: Books, Magazines, Journals, Websites, Appendix Documents

- Modern Biology, Holt Ó2006
- Howard Hughes Medical Institute's BioInteractive site has a series of short videos and animations. Available online at http://www.hhmi.org/biointeractive/evolution/video.html
- Teachers' Domain is a extensive library of free digital media resources produced by public television, designed for classroom use and professional development. Users must register, but content is free. Available online at http://www.teachersdomain.org/
- Understanding Evolution Website from the University of California Museum of Paleontology with support provided by the National Science Foundation and the Howard Hughes Medical Institute. Available online at http://evolution.berkeley.edu/
- Antibiotic resistance animation/tutorial available online at http://www.sumanasinc.com/scienceinfocus/sif_antibiotics.html (Click to view animation)
- Sex and the Single Guppy is an interactive simulation. Students pick attributes of the environment, predators, etc. Available online at http://www.pbs.org/wgbh/evolution/sex/guppy/index.html
- DNA From the Beginning produced by the Dolan Learning Center, Cold Spring Harbor, Concept 40: Living things share common genes. Discusses the use of the ras gene in yeast to study human cancer. Available online at http://www.dnaftb.org/dnaftb/40/concept/index.html
- http://serendip.brynmawr.edu/sci_edu/waldron/.

- http://www.phschool.com/science/biology_place/labbench/lab8/samprob2.html
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Student Resources:

This may include: Books, Magazines, Journals, Websites, Apps

- Modern Biology, Holt 2006
- Howard Hughes Medical Institute's BioInteractive site has a series of short videos and animations. Available online at http://www.hhmi.org/biointeractive/evolution/video.html
- Sex and the Single Guppy is an interactive simulation. Students pick attributes of the environment, predators, etc. Available online at http://www.pbs.org/wgbh/evolution/sex/guppy/index.html
- *Apps:*
  - *Vocabulary Central from Pearson Education, Inc. (for iPad and iPod touch)—for each grade from 6–12, an app with engaging flashcards, songs, and trivia games to help students learn vocabulary words*
  - *Lizard Evolution Virtual Lab App*
  - *Stickleback Evolution Virtual Lab App*
  - *Click and Learn App*
  - *Bacterial ID Virtual Lab App*

Vocabulary:

These are words and definitions students will need to be familiar with to complete the objectives for the unit.

Word – definition

- **Absolute age** - the numeric age of an object or event, often stated in years before the present, as established by an absolute dating process, such as radiometric dating
- **Adaptation** - the process of becoming adapted to an environment; an anatomical, physiological, or behavioral trait that improves an organism's ability to survive and reproduce
- **Adaptive radiation** - an evolutionary pattern in which many species evolve from a single ancestral species
- **Allele frequency** - the proportion of gene copies in a population that are a given allele, expressed as a percentage
- **Allopatric speciation** - when species arise as a result of geographic isolation
- **Analogous structure** - an anatomical structure in one species that is similar in function and appearance, but not in evolutionary origin, to another anatomical structure in another species
- **Artificial selection** - the selective breeding of organisms (by humans) for specific desirable characteristics
- **Biogenesis** - the scientific principle that living organisms came only from other living organisms
- **Biogeography** - the study of the geographical distribution of living organisms and fossils on earth
- **Chemosynthesis** - the production of carbohydrates through the use of energy from inorganic molecules instead of light
- **Coacervate** - a mass of droplets of colloidal substances, such as lipids, amino acids, and sugars, that are held together by electrostatic

attraction

- **Coevolution** - the evolution of of two or more species that is due to mutual influence, often in a way that makes the relationship more mutually beneficial
- **Convergent evolution** - the process by which unrelated species become more similar as they adapt to the same kind of environment
- **Cyanobacteria** - a group of bacteria that can carry out photosynthesis (singular, *cyanobacterium*); formerly called blue-green algae
- **Directional selection** - a type of natural selection in which the most extreme form of a trait is favored and becomes more common
- **Disruptive selection** - a type of natural selection in which two extreme forms of a trait are selected
- **Divergent evolution** - the process by which two or more related but reproductively isolated populations become more and more dissimilar
- **Emigration** - the movement of an individual or group out of an area
- **Endosymbiosis** - a mutually beneficial relationship in which one organism lives within another; a theory that eukaryotic cells originated through endosymbiotic relationships between ancient prokaryotic cells
- **Evolution theory** - a heritable change in the characteristics within a population from one generation to the next; the development of new types of organisms from preexisting types of organisms over time
- **Fitness** - in evolutionary theory, a measure of an individual's hereditary contribution to the next generation
- **Fossil** - the trace or remains of an organisms that lived long ago, most commonly preserved in sedimentary rock
- **Fossil** - the trace or remains of an organism that lived long ago, most commonly found in sedimentary rock
- **Gene pool** - all of the genes of the reproductively active members of a population
- **Genetic drift** - the random change in allele frequency in a population
- **Geographic isolation** - the physical separation of populations due to geographic barriers that prevent interbreeding
- **Gradualism** - a model of evolution in which gradual change over a long periods of time leads to biological diversity
- **Half-life** - the time required for half of a sample of a radioactive isotope to break down by radioactive decay to form a daughter isotope
- **Hardy-Weinberg principle** - the principle that states that the frequency of alleles in a population does not change over generations unless outside forces act on the population
- **Homologous structure** - anatomical structures in one species that, compared to other anatomical structures in another species, originated from a single anatomical structure in a common ancestor of the two species
- **Immigration** - the movement of an individual or group into an area
- **Isotope** - an atom that has the same number of protons (or the same atomic number) as other atoms of the same element do but that has a different number of neutrons (and thus a different atomic mass)
- **Mass number** - the sum of the numbers of protons and neutrons in the nucleus of an atom
- **Microevolution** - a change in the collective genetic material of a population
- **Microsphere** - a microscopic spherical structure composed of many protein molecules that are organized as a membrane
- **Morphology** - the study of the structure and form of an organism
- **Natural selection** - the process by which individuals that are better adapted to their environment survive and reproduce more successfully than less well adapted individuals do; a theory to explain the mechanism of evolution

- **Ozone** - a gas molecule that is made up of three oxygen atoms
- **Phenotype frequency** - the ratio of individuals with a particular phenotype to the total number of individuals in a population
- **Phylogeny** - the evolutionary history of a species or taxonomic group; the relationships by ancestry among species or taxonomic groups
- **Population genetics** - the study of the frequency and interaction of alleles and genes in populations
- **Postzygotic isolation** - *postmating isolation,* occurs after fertilization
- **Prezygotic isolation** - *premating isolation*, occurs before fertilization
- **Punctuated equilibrium** - a model of evolution in which short periods of drastic change in species, including mass extinctions and rapid speciations, are separated by long periods of little or no change
- **Radioactive decay** - the disintegration of an unstable atomic nucleus into one or more different nuclides, accompanied by the emission of radiation, the nuclear capture or ejection of electrons,or fission
- **Radioactive isotope** - an isotope that has an unstable nucleus and that emits radiation
- **Radiometric dating** - a method of determining the absolute age of an object by comparing the relative percentages of a radioactive (parent) isotope and a stable (daughter) isotope
- **Relative age** - the age of an object in relation to the ages of other objects
- **Reproductive isolation** - the inability of members of a population to successfully interbreed with members of another population of the same or a related species
- **Sexual selection** - an evolutionary mechanism by which traits that increase the ability of individuals to attract or acquire mates appear with increasing frequency in a population; selection in which a mate is chosen on the basis of a particular trait or traits
- **Speciation** - the formation of a new species as a result of evolution
- **Spontaneous generation** - an early and now disproved theory that living organisms come to life spontaneously from non-living material
- **Stabilizing selection** - a type of natural selection in which the average form of a trait is favored and becomes more common
- **Strata** - layer of rock (singular *stratum*)
- **Sympatric speciation** - when two subpopulations become reproductively isolated within the same geographic area
- **Vestigial structure** - a structure in an organism that is reduced in size and function and that may have been complete and functional in the organism’s ancestor

Content Area: Science	**Course: Pre-AP Biology**	**UNIT:** Classification

Unit Description: Organisms are classified based on their origin and their evolutionary history. Binomial nomenclature is used in the naming of organisms and molecular biology is a tool that is used to determine relatedness for grouping.	**Unit Timeline:** 5 weeks

DESIRED Results

Transfer Goal - ***Students will be able to independently use their learning to……***

- Students will be able to plan and conduct an investigation.
- Students will be able to develop and use models to illustrate the organization of interacting systems.
- Students will be able to construct an argument based on evidence.

Understandings – *Students will understand that… (Big Ideas)*

1. All Kingdoms of organisms are connected by the phylogenetic tree of life.
2. Compare and contrast the cell structures, source of energy, body systems and modes of reproduction among living organisms.
3. Scientists plan and carry out investigations in the field or laboratory working collaboratively as well as individually.

Essential Questions: *Students will keep considering:*

1. How are organisms classified?
2. How is molecular biology used as a tool for systematics?
3. What adaptations do organisms have that enable them to carry out their life functions?

Students will know…..	Standard	Students Will Be Able to…..	Standard
● Organisms are classified based on origin and evolutionary history. ● Taxonomists use various keys to classify organisms. ● Binomial nomenclature is used in the classification/naming of organisms. ● Molecular biology provides powerful tools for systematics. ● The relationship between form and function is evident at all levels of biological organization. ● Organisms have unique adaptations that enable them to carry out their essential life functions.	3.1.E.b 3.1.E.a 3.1.E.a 8.1.B.a 3.1.C.a 4.3.C.a	● Define a species in terms of the ability to mate and produce fertile offspring. ● **Explain how similarities used to group taxa might reflect evolutionary relationships (e.g., similarities in DNA and protein structures, internal anatomical features, patterns of development)** ● Explain how and why the classification of any taxon might change as more is learned about the organisms assigned to that taxon (LO1Eb, DOK2) ● Compare protein and DNA sequences to determine relatedness. ● Use amino acid sequences or DNA nucleotides to estimate the time of divergence for species and higher taxa, such as kingdoms and phyla. ● Deduct, given a list of characteristics, the correct kingdom to which an organism belongs. ● Identify the characteristics of those organisms in each Kingdom. ● Explain why viruses are not considered living organisms by most biologists. ● **Predict how populations within an ecosystem may change in number and/or structure in response to hypothesized changes in biotic and/or abiotic factors.** ● **Predict the impact a natural environmental event or human caused change may have on the diversity of different species in an ecosystem.** ● **Illustrate and describe the flow of energy within a food web.** ● Cite specific evidence textual evidence to support	4.3.B.a **3.1.E.a** 3.1.E.b 3.3.B.c 3.1.E.a 3.1.E.b 3.1.E.b 3.1.C.a **4.1.B.b** **4.1.D.a** **4.2.A.a**

		analysis of scientific and technical texts, including analysis of important distinctions the author makes between ideas or pieces of information. ● Summarize complex information or ideas presented in a text, paraphrasing it in simpler but still accurate terms. ● Determine the meaning of key terms, symbols, and domain-specific vocabulary used in a text, attending to the precise meaning of terms as they are used in particular scientific or technical contexts. ● Write informative/explanatory texts, including the narration of historical events or scientific procedures/experiments. ● Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. ● Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically. ● Students apply digital tools to gather, evaluate, and use information.	RST.1 RST.2 RST.4 WHST.1 WHST.4 WHST.6 ISTE 3

EVIDENCE of LEARNING			
Understanding 1	Standards **3.1.E.a** **4.1.B.b** **4.1.D.a** **4.2.A.a** WHST4	**Unit Performance Assessment**: **Description of Assessment Performance Task(s):** ***Classification_Assessment-Taxonomy Project.docx*** Taxonomy Performance Assessment and Scoring Guide The students will be given a hypothetical ecosystem in which there are descriptions of organisms that exist in the ecosystem. The students will draw pictures of the organisms that represent their unique adaptations and create a taxonomic diagram and key to identify these organisms. The students will then illustrate and describe the flow of energy within a food web that they create that represents this ecosystem. The students will have to predict the effects and adaptation within the ecosystem when two organisms have been discovered that were not in the original ecosystem and the effects from a species being eliminated from the ecosystem. **Teacher will assess:** Students will be assessed on the detail of their illustration and logical creation of the scientific names. Organisms should be appropriately placed in the taxonomic diagram and dichotomous key by using identifiable and distinguishable characteristics. The food web must include at least six organisms in at least three trophic levels with a representation of proper connections between these organisms. Appropriate evidence and justification must be provided when describing the effects of discovering two new species in the ecosystem and then the elimination of a species in the ecosystem. **Performance:** **Mastery:** *Students will show that they really understand when they…* ● 14 illustrations of the organisms that are reflective of the adaptations that the organisms have and each has an appropriately written scientific name ● organisms are correctly placed in taxonomic categories reflective of their characteristics ● the dichotomous key is written so that organisms are presented with logical identifying features that lead to correct identification of only one organism and follows the two choice format	**R/R Quadrant** D Communication Critical thinking Creativity

		● the two newly discovered species are correctly placed (adaptation) into the taxonomic scheme and the justification is logical and sufficient detail is provided to support reasoning ● the food web is created with at least six organisms, three trophic levels, and the proper connections are evident in the web ● evidence and justification is provided to support two effects from the elimination of a species from the ecosystem **Scoring Guide:** Scoring guide in document	

SAMPLE LEARNING PLAN
Pre-assessment: 10 Question Multiple Choice Pre-Test Titled “Classification Pre-Test” in appendix. All questions are modeled after the End of Course Exam.

Understanding	**Standards**	**Major Learning Activities:**	**Instructional Strategy:**	**R/R Quadrant:** **21 Century**
1	3.3.B.c WHST.4 WHST.6 ISTE 3	1. Activity: Bird Brains ● Students will compare and evaluate the sequence of amino acids in a gene shared between humans and six other organisms and infer evolutionary relationships among the species. Extend the activity by dividing the class into four teams. Team Stand-N-Share would be a great strategy for the collaboration portion on the lesson. Assign each team one of the following genes: FOXP2, hemoglobin alpha, eyeless, and sonic hedgehog. Have students visit the Kyoto Encyclopedia of Genes and	Similarities and differences Generating and Test Hypothesis Feedback	C Critical Thinking Communication, Collaboration

		Genomes and look up their gene's amino acid sequence in humans. Have students research how many of the six species from their handouts share this gene with humans; for all cases in which species share the gene, have students write down the first ten amino acids listed in the database. Then have students prepare a short report about the gene, how much similarity they discovered between humans and other species, and what scientists know about the gene's function. Students will then formally justify and defend their conclusions as they share their findings with their peers. **Objectives:** Students will be able to: ● explain that different organisms often have the same genes. ● understand how scientists use genetic differences to infer evolutionary relationships. ● relate how shared genes may be a result of shared evolutionary history. ● provide evidence suggesting that living things share common ancestors. Appendix Documents: Bird Brains		
1	4.3.B.a 3.1.E.a 3.1.E.b	2. Activity: Classification of Reef Fish ● Students will look at different Butterfly fish and notice many similarities and differences. They will use the visual representations to determine differences in characteristics ultimately leading to different species found in the same genus. Students will also understand how scientific names are determined for different species from the information provide in the document. Furthermore, students will gain practice in using a dichotomous key to	Nonlinguistic Representation Similarities and Differences	B critical thinking;

		identify an unknown species, which can translate to real world application such as identifying trees, fruits, insects, mushrooms, and other species. ● Objective: Students will be able to classify several members of the same genus of Butterfly Fish based on structural and phenotypic characteristics. Students will understand how scientific names are used, and some of the Greek and Latin origins for the names. Students will be able to use a taxonomic key. Students will become familiar with basic anatomy of fish. Appendix Documents: Classification of Reef Fish		
1, 3	4.3.C.a 3.1.E.a 3.1.E.b WHST.1	3. Activity: Penguin Cladogram Lab ● Students will work cooperatively with a partner to use cards depicting various penguin species to create a cladogram based on phenotypic characteristics (Fan N Pick). As an argumentative writing extension, students can use the evidence from their cladogram to justify a claim based on probable species divergence and defend their argument. ● Objective: Students will be able to infer possible evolutionary relationships based on these characteristics and justify claims through argumentative writing. ● Appendix Documents: Penguin Cladogram Lab	Nonlinguistic Representation Feedback Generating and Testing Hypothesis Argumentative Writing Cooperative Learning	B critical thinking; creativity; collaboration
2	3.1.C.a RST.1 RST.2 RST.4 WHST.1	4. Activity: Are Viruses Alive? ● Students will read an article from Scientific American on the debate of labeling viruses as living or nonliving. They will fill out a diagram as they read on the points for each category. Upon completion, the students will formulate	Similarities and difference Nonlinguistic representation	D Critical Thinking Collaboration

		their own claim using the points from the article as their justification and defend and validate their claim too as they present to their peers. The peers will have an opportunity to provide feedback. A Roundtable Consensus strategy could be implemented as this portion of the activity. A follow up discussion will take place looking how viruses survive and passed from host to host. Finally, the discussion will focus on real world virus and their threat to humanity such as the Flu virus, Ebola Virus, H.I.V., etc. *This would be another discussion that could be shared with History classes as viruses impacted historical change. Also, this would relate to some of the PLTW Biomedical curricula allowing for some possible conversation/sharing with those courses. ● Objective: Students will be able to determine through justifying their claim if virus are alive or not and make connections to virus that impact the world on a daily basis. ● Appendix Documents: Are Viruses Alive?	Argumentative writing Feedback Cooperative Learning	
3	4.1.B.b 4.1.D.a ITSE.3 ITSE.6	5. Activity: Human Impacts on Marine Ecosystems ● Description: Students will learn about human-related impacts that threaten the ocean. Students will begin with an anticipation guide to decide if they agree or disagree with a series of statements both before and after listening to the National Public Radio “Ocean Priorities” podcast. Students will take notes about ocean threats and ocean management and research priorities discussed in the podcast. Students will then analyze a global map of human impacts to marine ecosystems and complete the activity by writing an argumentative response to a question. ● Objective: Students use a variety of media resources to	Summarizing and note-taking	B Critical Thinking Communication

		discuss and analyze human-related pressures placed upon marine ecosystems and resources. Students will be able to explain how human-related events impacts the abiotic and biotic components of various marine ecosystems, identify and discuss the major threats and management priorities for the world oceans ecosystems. National Geographic Education: http://education.nationalgeographic.com/education/activity/human-impacts-on-marine-ecosystems/?ar_a=1 ● Appendix-Link in appendix		

UNIT RESOURCES
Teacher Resources: ● Modern Biology, Holt ©2006 ● Teachers' Domain is a extensive library of free digital media resources produced by public television, designed for classroom use and professional development. Users must register, but content is free. Available online at http://www.teachersdomain.org/ ● 2000 and Beyond: Confronting the Microbe Menace. All animations are appropriate for emerging diseases. Available online at http://www.hhmi.org/biointeractive/disease/video.html ● Howard Hughes Medical Institute virtual lab: Virtual Bacterial Identification. Available online at http://www.hhmi.org/biointeractive/vlabs/bacterial_id/index.html ● Arbor Day Foundation online taxonomic key to common trees online at http://www.arborday.org/trees/whattree/WhatTree.cfm?ItemID=E6A ● Biology Teaching & Learning Resources: Educational Materials by D G Mackean. Although this site offers resources for sale, there are many excellent examples. Available online at http://www.biology-resources.com/ ● Missouri Flora Webpage available online at http://www.missouriplants.com/ ● Grow Native: A joint program of the Missouri Department of Conservation (MDC) and the Missouri Department of Agriculture (MDA), the Grow Native! program helps protect and restore our state's biodiversity by increasing conservation awareness of native plants and their effective use. Available online at http://www.grownative.org/ ● Missouri Botanical Garden's Plant Finder gives botanical information on a wide range of plants. Available online at http://www.mobot.org/gardeninghelp/plantfinder/Alpha.asp ● Nova Now Bird Brains video: http://www.pbs.org/wgbh/nova/nature/bird-brains.html ● Nova Now Activity link: Kegg catalog http://www.genome.jp/kegg/catalog/org_list.html
Student Resources:

- Modern Biology, Holt ©2006
- The St. Louis Zoo has background information on animals in their collection. Available online at http://www.stlzoo.org/
- The ZipcodeZoo works to bring the natural world to armchair, amateur, and professional naturalists. The focus is Applied Biogeography: understanding plants and animals in their place, perhaps even your backyard. Available online at http://zipcodezoo.com/default.asp
- Nova Now activity link: Kegg catalog http://www.genome.jp/kegg/catalog/org_list.html
- National Geographic Education http://education.nationalgeographic.com/education/activity/human-impacts-on-marine-ecosystems/?ar_a=1

Vocabulary:

- **Biodiversity:** the variety of organisms considered at all levels from populations to ecosystems
- **Taxonomy:** the science of describing, naming, and classifying organisms
- **Taxon:** any particular group within a taxonomic system
- **Domain:** categories that are above the kingdom level added on by modern biologists
- **Kingdom:** the largest categories of Linnaeus's hierarchal structure (now second in modern taxonomy), consisting of plants and animals groups
- **Phylum:** subsets below the kingdom level
- **Division:** a taxon at the rank of division**.** The second highest taxonomic classification for the kingdoms Plantae (plants) and fungi, between kingdom level and class level.
- **Class:** subunits that fall below the phylum classification
- **Order:** subunits that fall under class taxa level
- **Family:** subunits that fall under order level
- **Genus:** smaller groupings under family level
- **Species:** the smallest grouping, which contains only a single kind of organism
- **Binomial nomenclature:** system developed by Linnaeus to name organisms (their scientific name) based on two parts: the genus name followed by the species identifier.
- **Systematics:** the classification of organisms in terms of their natural relationships, such as phylogenetics
- **Phylogenetics:** the analysis of the evolutionary or ancestral relationships among taxa. Often compare the visible characteristics among living organisms or fossils of extinct organisms. Can also compare embryonic development and similar gene expression
- **Cladistics:** a system of phylogenetics that uses shared (all members of group have) and derived (feature that evolved only within the group under consideration) characters as the only criteria for grouping taxa.
- **Cladogram:** phylogenetic diagrams that displays the different clads, or groups of organisms that includes ancestors and all descendants
- **Dichotomous key:** a tool that allows the user to determine the identity of items in the natural world, such as trees, wildflowers, mammals, reptiles, rocks, and fish. Keys consist of a series of choices that lead the user to the correct name of a given item