I have read and understand the syllabus. Student: _______________ Parent: ______________

# Flagstaff High School Pre-AP Biology Syllabus

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Course website: www.tinyurl.com/lenzbio

**Course Overview**

The content of this course is aligned with the Arizona Science Standards and the content of instruction is guided by the National Research Council of the National Academy of Science's *Framework for K-12 Science Education* and College Board's *AP Biology Curriculum Framework*. This course is structured around the core and component ideas (see below). You will develop essential biology knowledge by applying science practices (see below) through inquiry-style experiences that will provide you with an organizational framework for connecting knowledge from across disciplines into a coherent and scientifically based view of the world. You will develop the habits of mind that are necessary for scientific thinking and that allow you to engage in science in ways that are similar to those used by scientists. This course is an Alpine Institute designated science class, and as such, will have a place-based emphasis that promotes the development of the following five core values: Inquiry, Community, Stewardship, Critical thinking and Reflection. This year we will be working with the following community partners: Flagstaff EcoRanch, Friends of the Rio de Flag, the Arboretum, and the National Park Service. You may take part in a service-learning trip to the Arboretum at Flagstaff in September and a second trip to a different location (to be determined) in the Spring. You may need to contribute $5 - $10 for the two trips. Finally, I would like to inform you that we are participating in a program called GK12, which will involve collaboration between our class and Northern Arizona University (NAU) biology PhD candidates.

**Core and Component Ideas in Biology**

1) Ecosystems: Interactions, Energy, and Dynamics
2) From Molecules to Organisms: Structures and Processes
3) Heredity: Inheritance and Variation of Traits
4) Biological Evolution: Unity and Diversity

**Science Practices**

1) Create, describe, refine, and ***use scientific representations and models*** of scientific phenomena to analyze situations or solve problems.
2) Justify the ***use of mathematical routines*** to solve problems, apply a mathematical routine to a data set, and apply appropriate estimation techniques.
3) ***Engage in scientific questioning*** by posing, refining, and evaluating scientific questions.
4) Pan and ***implement data collection strategies*** by selecting the type of data necessary to answer a question, designing a plan for data collection, collecting data, and/or evaluating sources of data.
5) ***Perform data analysis*** and evaluate evidence by searching for patterns and relationships, refining observations and measurements based on these, and evaluate data presented in data sets in relation to a scientific question.
6) ***Justify claims using scientific evidence***, construct explanations based on evidence, make predictions, evaluate alternative scientific explanations, and explain why scientific explanations are refined or replaced.
7) ***Connect knowledge*** of phenomena and models across both spatial and temporal scales and connect concepts across domains.

**Grade Determination**

- Flagstaff High School has adopted a 80% measurement/performance and 20% practice grade breakdown.
- Below you will see how the percentage of points will be awarded within each category, each semester:

***Measurement/performance:*** 4 exams (including semester final) worth 12.5% each (50% of category total), 4 quizzes worth 7.5% each (30% of category total), 4 examples of performance to include: lab reports/lab quiz/performance rubrics, free response question writing, and case-studies 5% each (20% of category total)
***Practice:*** 4 unit packets with assignments worth 25% each
**Actual number of assignments within each category may differ from what is planned*

**Materials Required Each Class Session**

| | |
|---|---|
| **Section in a 3-ring binder:** unit packet, loose-leaf notebook paper, graph paper, organized class handouts and returned work | **Following items kept in a pencil pouch:** scientific calculator (i.e. TI-30), pencils, eraser, highlighter, four colored pencils (your choice of colors), and dry-erase board marker |

**Please let me know if you require assistance acquiring any of the materials listed above*

**Safety Expectations**

Conduct yourself in a responsible manner. Keep food in your backpack, drink only from a sealable water bottle, and keep your work-space clutter-free. Practice only the lab-specific safety and experimental procedures that are demonstrated during the pre-lab activity. Inform me if you have any allergies, including to antibiotics (antibiotics are used in microbiology labs). We will practice safety in the school courtyards and during excursions to the Francis Short Pond. Failure to follow proper procedures will result in removal from the laboratory and/or outdoor environment.

**Classroom Rules**

Our classroom practices the school-wide expectations of Focus, Honor, and Success (FHS).

**Statement of Academic Integrity Expectations:**

Integrity of scholarship is essential for an academic community. Flagstaff High School expects that students will honor this principle and in so doing protect the validity of Flagstaff High School's intellectual work. For students, this means that all academic work will be done by the individual to whom it is assigned, without unauthorized aid of any kind.

**Classroom Procedures**

***Start of class*** – Prior to the bell: pick up materials by the door as you enter, sit according to seating chart, read the posted entrance announcements, setup your desk with all needed materials, and turn off and stow cellphone.
***Missing required materials*** – Prior to the bell, you may ask to borrow an item from a classmate or your teacher.
***During class*** – Stay focused, on-task, and use your class time efficiently. Work collaboratively with your peers to practice skills and build understanding.
***Absences*** – You are expected to check the course website's complete lesson folder (www.tinyurl.com/lenzbio) and review the PDF lesson and complete assigned work. See me with questions upon your return. Missed lab experiences will require you to complete an alternate assignment. A missed exam or quiz must be completed during the announced after school make-up session.
***Out of class privileges*** – Each semester, you will be provided with three bathroom passes. You may earn additional passes through some reasonable compensation. Please alert me if you have a medical need that requires more frequent bathroom trips. Unused passes may be submitted for extra credit at the end of the semester.
***Ending Class*** – You will be instructed to pack-up (this should take no more than 30 seconds) and class will end after successful completion of one of several possible ticket-out-the-door activities.
***Missing/Late work***- Must be completed by the date of the summative assessment (exam) over the content of the work.

**Office Hours**

**Daily 2:30 – 3:00**

*If you need to see me before school, please make an appointment so that I know to expect you

**Extra credit opportunities:** Submit unused bathroom passes at end of semester, Festival of Science, and Stem Night

**Suggested Parent Participation**

- Monitor student grades weekly on-line using ParentVUE and communicate questions and concerns via email.
- Become familiar with the support and content offered on the course website (www.tinyurl.com/lenzbio).
- View and discuss together with your student ongoing work in the student's biology packet
- Sign student packet/study-guide at the end of each unit and confirm that the student has enacted a study plan to prepare for the exams and quizzes.

Core and Component Ideas in Biology from *Framework for K-12 Science Education*

## Ecosystems: Interactions, Energy, and Dynamics

***Interdependent Relationships in Ecosystems***

Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.

***Cycles of Matter and Energy Transfer in Ecosystems***

Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web, and there is a limit to the number of organisms that an ecosystem can sustain.

The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil and are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved; some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. Competition among species is ultimately competition for the matter and energy needed for life. Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged between the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.

***Ecosystem Dynamics, Functioning, and Resilience***

A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.

***Social Interactions and Group Behavior***

Animals, including humans, having a strong drive for social affiliation with members of their own species and will suffer, behaviorally as well as physiologically, if reared in isolation, even if all of their physical needs are met. Some forms of affiliation arise from the bonds between offspring and parents. Other groups form among peers. Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives.

## From Molecules to Organisms: Structures and Processes

***Structure and Function***

Systems of specialized cells within organisms help them perform the essential functions of life, which involve chemical reactions that take place between different types of molecules, such as water, proteins, carbohydrates, lipids, and nucleic acids. All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Outside that range (e.g., at a too high or too low external temperature, with too little food or water available), the organism cannot survive. Negative feedback mechanisms are used to maintain homeostasis.

***Growth and Development of Organisms***

In multicellular organisms, individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. As successive subdivisions of an embryo's cells occur, programmed genetic instructions and small differences in their immediate environments activate or inactivate different genes, which cause the cells to develop differently—a process called differentiation. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. In sexual reproduction, a specialized type of cell division called meiosis occurs that results in the production of sex cells, such as gametes in animals (sperm and eggs), which contain only one member from each chromosome pair in the parent cell

***Organization for Matter and Energy Flow in Organisms***

The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. The sugar molecules thus formed contain carbon, hydrogen, and oxygen; their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. For example, aerobic (in the presence of oxygen) cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Anaerobic (without oxygen) cellular respiration follows a different and less efficient chemical pathway to provide energy in cells. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy loss to the surrounding environment. Matter and energy are conserved in each change. This is true of all biological systems, from individual cells to ecosystems.

***Information Processing***

In complex animals, the brain is divided into several distinct regions and circuits, each of which primarily serves dedicated functions, such as visual perception, auditory perception, interpretation of perceptual information, guidance of motor movement, and decision making about actions to take in the event of certain inputs. In addition, some circuits give rise to emotions and memories that motivate organisms to seek rewards, avoid punishments, develop fears, or form attachments to members of their own species and, in some cases, to individuals of other species (e.g., mixed herds of mammals, mixed flocks of birds). The integrated functioning of all parts of the brain is important for successful interpretation of inputs and generation of behaviors in response to them.

## Heredity: Inheritance and Variation of Traits

***Inheritance of Traits***

In all organisms the genetic instructions for forming species' characteristics are carried in the chromosomes. Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function.

***Variation of Traits***

The information passed from parents to offspring is coded in the DNA molecules that form the chromosomes. In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depend on both genetic and environmental factors.

# Biological Evolution: Unity and Diversity

***Evidence of Common Ancestry and Diversity***
Genetic information, like the fossil record, also provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence.

***Natural Selection***
Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. The traits that positively affect survival are more likely to be reproduced and thus are more common in the population.

***Adaptation***
Natural selection is the result of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. Natural selection leads to adaptation—that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and

***Biodiversity and Humans***
Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). Biological extinction, being irreversible, is a critical factor in reducing the planet's natural capital.
Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. These problems have the potential to cause a major wave of biological extinctions—as many species or populations of a given species, unable to survive in changed environments, die out—and the effects may be harmful to humans and other living things. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.

**Pre-AP Biology Unit Plans**

**Unit I. Experimental Design, Hypothesis Testing, and Animal Behavior**
- Critique investigation designs and identify the independent and dependent variables
- Behavioral ecology investigation (the effect of abiotic factors on isopod behavior): define the ultimate cause (evolutionary significance) of animal behavior, perform background research on isopods, propose a model that explains how environmental cues affect the behavior of isopods, pose a scientific question, formulate null and alternate hypotheses, plan a controlled experiment, collect data, create graphical representations, perform a chi-squared test of significance, create a mini-poster, and present findings.
- Watch/discuss: Flight of the Butterflies
- Read/discuss Sefarth article: Monkey responses to three different alarm calls: evidence of predator classification and semantic classification. With discussion of communication and learning.

**Unit II. Ecology**
- Watch/discuss: Flight of the Butterflies
- Justify claims using scientific evidence to identify abiotic and biotic changes that occur across an elevation gradient and connect to the life-zone concept through the construction of a physical model with brief exploration of the following AZ habitat types (temperate grasslands, pinyon-juniper, Ponderosa Forest, and Mixed-Conifer Forest).
- Biodiversity inquiry activities: identify and explain global patterns in biodiversity, describe and explain the

relationship between habitat island size and biodiversity, explore the effects of habitat loss and fragmentation on biodiversity, and discuss the relationship between biodiversity and human welfare.

- Justify claims using scientific evidence to identify abiotic and biotic changes that occur following disturbances using the case-study of post-fire ecological succession on the San Francisco Peaks.
- Explore seasonal cycles in global primary productivity and [$CO_2$] using both time-lapse satellite imagery and data from the Mauna Loa observatory. Analyze graphs of global atmospheric [$CO_2$] showing seasonal patterns, long-term patterns, and relationship to global mean temperature change over time. Analyze data that shows the effect of temperature on decomposition.
- Use, create, and analyze diagram models of the flow of energy through ecosystems (food chains and food webs).
- Watch/discuss a TED Talk that answers the question of where the matter goes when we lose weight (connect to the Carbon Cycle).
- Inquiry: in an interactive white-boarding activity, discover where the mass comes from when an acorn grows into a mature oak tree (connect to the Carbon cycle).
- Justify claims using scientific evidence to describe patterns in trophic efficiency, pyramids of biomass and numbers, and predict the effect of loss of decomposition on nutrient-cycling.
- Inquiry investigation: grow rapid-radishes from seed, create diagrams that show the cycle of matter and flow of energy in the model system, and quantify net primary productivity using dry-mass and bomb-calorimetry data.
- Arboretum expedition: Explore the SW Experimental Garden Array (SEGA) instrument design and connect to climate-change investigations. Explore regional climate model data and discuss predicted: snowfall and rainfall patterns, and plant and animal community changes. Discuss an example of ecological mismatch in birds.
- Explore both logistic and exponential models of population growth (collect data, organize into data tables, graph data, and compare/contrast patterns). Tie population size back to available energy.
- Use a hands-on physical simulation to model predator-prey population dynamics followed by a discussion of the density-dependent role of predation in stabilizing populations, as well as, a critique of the model.
- Use a computer to model how changes in the quantity and quality of available plant life in an ecosystem effect an herbivore population over time. Explore the density-dependent role of competition in population dynamics.
- NCCSTS case-study (interactive white-board case): Who set the moose loose? (trophic cascade and keystone species concepts).

**Unit III. Cell Structure and Function**

- Model and summarize the mechanism behind the unique properties of water and connect to the mechanism of transpiration and to the formation of hydration spheres.
- Explore the structure and function of stomata, make microscope observations, collect and pool data, determine mean stomatal density, calculate standard deviation, standard error of the mean (SEM), and use 2 x SEM to help determine whether there is a significant difference in stomatal density on the top and bottom surfaces of leaves. Connect observed patterns to evolution and ecology.
- Make microscope observations of leaf and stem-cross sections and observe and discuss xylem using tree cookies and together with the stomata investigations, be able to describe and explain how/why plant cells, tissues and organs work together to exchange energy and matter with the environment.
- Use dialysis tubing to explore the permeability of a model cell membrane to different substances. Connect findings to the structure and function of the plasma membrane.
- Inquiry investigation: Create model cells using agar to determine the most efficient size and shape of cells for diffusion.
- Connect the structure of the alveoli of the lungs and the microvilli of the intestines to their functions. Create a diagram of the movement of $CO_2$/$O_2$ into and out of cells of the alveoli due to diffusion.
- Inquiry investigation: Explore osmosis in live tissue by placing potato cores in differing concentrations of sucrose solutions. Collect and graph data on % change in mass. Infer the concentration of each sucrose solution (test by creating a density column) and interpolate to determine the concentration of solutes present in the potato tissue. Practice applying standard deviation and standard error of the mean concepts.
- Make microscope observations of plant cells exposed to salt-water and then quantify the effect of salt concentration on % seed germination. Pool data across classes to determine means, standard deviation, and standard error of the mean. Connect to genetic variation, selective pressure, adaptation, environmental change, and agricultural concerns in the arid SW.

- Explain the significance of Eukaryotic organelles and critique the cell as factory model in terms of an analogy to explore the functions of the different cellular organelles.
- NCCST case-study: Tuna for lunch? (Mercury Bioaccumulation and biomagnification concepts).

**Unit IV. Energy and Matter in Living Systems**

- Inquiry activity: Explore the diversity of carbon-based molecules through construction using molecular modeling kit.
- Model the creating of polymers through dehydration synthesis and their breakdown back into monomers.
- Inquiry activity: compare the pH change of water and a biological buffer with the addition of acid and base. Connect to how acids and bases can denature proteins such as enzymes.
- Create a physical model that represents the primary to quaternary structure of a protein and connect structure to enzyme-function and the effect of denaturing due to pH or temperature changes.
- Perform a hands-on model with toothpicks to explore enzyme activity.
- Inquiry investigation: Design and conduct an experiment to describe the relationship between an independent variable (enzyme concentration, substrate concentration, temperature, or pH) and enzyme activity. Summarize relationships discovered across different investigations.
- Inquiry investigation: Formulate a scientific question concerning the relationship between an independent variable and the rate of cellular respiration in yeast. Connect results back to the function of enzymes.
- Use diagram models to answer questions about functions of cells (muscle, neurons, cell-division) that are carried out by organisms that involve the conversion of ATP to ADP.
- Use a diagram model to show how an exergonic reaction (cellular respiration), required to regenerate ATP, is paired with an endergonic reaction such as is required to build (new proteins).
- Compare the number of molecules of ATP that is produced during fermentation and cellular respiration. Evaluate, using common exercise phenomena (lactic acid buildup).

**Unit V. The cell cycle, cancer, meiosis, and genetics**

- Explore data to make a claim with justification for which cell types divide continuously, only under specific circumstances, and not at all. Discuss the significance of the rate of cell division to the functioning of organisms.
- Inquiry activity: Interpret diagrams, graphical displays, and model the process of mitosis.
- Use microscope slides of plant and animal tissue in an argument-driven inquiry designed to answer the question: Do plants and animal cells spend the same proportion of time in the cell cycle?
- Play the cell cycle control game (by nobelprize.org) to explore check points that control the cell cycle.
- Inquiry activity: Make a claim with justification for how cells with identical DNA can, through control of gene-activation, differentiate into different tissue-types.
- Conduct research to compare embryonic and different types of adult stem cells. Identify current applications of plant and animal stem cells and describe problems surrounding the use of these cells.
- Inquiry activity: Interpret diagrams, graphical displays, and model meiosis (including crossing-over) to show how the process of meiosis reduces the number of chromosomes and results in genetically unique daughter cells.
- Model independent assortment of chromosomes during meiosis. Organize data in a table, identify a pattern and use to derive an equation to solve for the number of unique gametes possible.
- Summarize how sexual reproduction results in genetic diversity and investigate the pros and cons of sexual and asexual reproductive strategies.
- Inquiry activity: Perform an interactive on-line karyotype analysis to diagnose patients with chromosome abnormalities & then use a physical model to demonstrate type of nondisjunction that resulted in the abnormality.
- Student collaborative research: Explore the hallmarks of cancer.
- Observe microscope tissue-slides and on-line tissue images in an argument-driven inquiry designed to answer the question: Which of these patients could have cancer?
- Research the link between HPV virus and cervical cancer and connect to the story of Henrietta Lacks.
- Inquiry activity: Are you a supertaster? Explore the genetics of PTC-taste ability, and determine the density of your taste-buds. Discuss variation and the evolutionary significance of tasting ability. Use a model to explore the lock-key relationship between the taste molecule and the protein receptor molecule.
- Use a combination of interactive on-line tutorials, guided practice, partner practice, and individual practice to solve the following types of genetics problems: monohybrid cross, dihybrid cross, sex-linked, pedigree analysis, and calculation of probabilities, and infer the genotype of parents in a cross given data sets.
- NCSSTS case-study: A Sickeningly Sweet Baby Boy (pedigree analysis).

- Inquiry activity: Simulate the inheritance of a trait (skin color) that is polygenic and create a histogram to show the distribution of skin-color.
- Inquiry activity: Explore how nature and nurture combine in determining risk for heart-disease.
- Watch/discuss: Cracking your genetic code.
- Discuss the pros and cons of genetic tests.
- Watch/discuss: GATTACA.

**Unit VI. DNA to Trait and Biotechnology**

- Use a microscope to observe the DNA in the nucleus of your own cheek cells and then extract and purify that DNA.
- Use data that was available to Watson and Crick to perform the argument-driven inquiry of creating a model of DNA.
- Model: transcription with an emphasis on base-pairing, and tie to the Meselson-Stahl experiment.
- Model: transcription and translation and summarize the salient features of these processes.
- Inquiry activity: Trace the effects of the sickle-cell mutation through transcription and translation and discuss whether this mutation is a beneficial, harmful or neutral mutation
- Inquiry activity: Compare mutant to wild-type DNA – locate the mutation, describe the change at the DNA and at the protein-level, rank different mutations in terms of how altered the protein-products are.
- Model the action of restriction enzymes in cutting DNA, and the separation of DNA fragments by electrophoresis.
- Perform RFLP analysis to answer questions about: genotype, parental-status, crime-scenes, endangered species trade and read/discuss an article about each of these uses of the technology.
- Perform gel electrophoresis to answer questions in a crime-scene scenario.
- Model the action of restriction enzymes and DNA ligase in creating recombinant DNA using paper and pop-bead models. Discuss applications of this technology, i.e. for the production of human insulin by bacteria.
- Discuss the CRISPR Cas 9 technology.

**Unit VII. Evolution**

- Make claims with justification for shared common ancestry based on anatomical, embryological, and molecular homologies.
- Learn how to interpret phylogenies by exploring the on-line tutorial: What does *T. rex* taste like?
- Inquiry data-based investigation: Solve a phylogenetic puzzle by constructing a phylogenetic tree using real data from the University of California Berkeley on biogeography, morphology, and DNA sequences.
- Inquiry investigation: Artificial selection - measure and graph the distribution of height for the first generation of rapid-plants. Selectively breed only the tallest 10% of plants. Collect and plant the seeds. Graph the distribution of heights for the second generation and compare the mean and standard error of the means for both generations.
- Inquiry investigation: Microbiology lab – quantify, rank, and compare the sensitivity of two types of bacteria to six different antibiotics. Make a claim with justification for which antibiotic a doctor should prescribe. Analyze data on percent resistance over time to make claims with evidence for the evolution of antibiotic resistance in bacteria.
- NCCSTS case-study: Widow birds (sexual selection)
- Explore the opposing selective pressures both for and against spots in guppies due to the action of both sexual selection and the selective pressure of predation.
- Inquiry activity: Use HHMI data to explore the genetics of fur-color in rock pocket mice and use mathematical analysis to discuss whether color-matching results in a selective-advantage for mice. Calculate the change in frequency of both fur color alleles over time. Discuss results in terms of the definition of microevolution.
- Perform an active, kinesthetic simulation to explore violations to Hardy Weinberg Equilibrium and compare simulation results to those generated from a computer model.
- Explore the effect of a genetic bottleneck on genetic diversity. Discuss the consequences of loss variation.
- Watch & discuss several biointeractive videos from Howard Hughes Medical Institute

**Unit VIII. Animal Physiology**

- Read and discuss Jared Diamond's article "The Arrow of Disease". Discuss how zoonotic diseases evolve.
- Case-study: white-nose syndrome in North American *myotis* bats.
- Participate in a disease-transmission simulation, map and analyze the rate of spread, discuss the significance.
- Use multiple resources to explore the viral-lifestyle: getting into a host, gaining entry into the right cell-type, hijacking the cell's machinery, lytic-cycle (tie symptoms to mode of spreading virus to a new host).
- Case-study HIV: discuss rapid rate of evolution, molecular clock used to infer timing of first human infection, and discuss how the CCR5 mutation is a form of genetic resistance
- Act in a kinesthetic model of antigen/antibody interaction in the specific immune response.
- Watch/discuss Bonnie Bassler's TED Talk on quorum-sensing in bacteria and discuss the possible new antibiotics.
- Act in a kinesthetic model of a signal-transduction pathway.
- Inquiry activity: perform diagram and graphical analysis to determine the role of insulin and glucagon in the maintenance of blood glucose homeostasis.
- Explore an imbalance in the negative feedback system associated with Type 1 and Type 2 diabetes. Given data sets, diagnose patients with Type 1 and 2 diabetes.
- Play a role in a kinesthetic model of an action potential and the release of neurotransmitter from a neuron.