

NAPA COUNTY OFFICE OF EDUCATION – CAREER TECHNICAL EDUCATION
Standardized Course Outline Format

COURSE TITLE	Biology for Biotechnology
DATE	3/6/2018, Reviewed: 2021
INDUSTRY SECTOR/PATHWAY	Health Science and Medical Technology/Biotechnology
UC A-G APPROVED	Science (D) / Biology / Life Sciences
GRADE LEVELS	9th
OCCUPATIONS FOR IDENTIFIED PATHWAY	Clinical Trials Research Coordinator Forensic Pathologist Biostatistician Geneticist Lab Assistant
COURSE OVERVIEW	DESCRIPTION OF COURSE: In this year-long course, the science of biology is explored with a special emphasis on how biology is applied in the field of biotechnology and how it relates to human health and wellness. Throughout the course, recurring activities emphasize laboratory procedures and safety, inquiry-based lab protocols, methods for gathering and analyzing data, and applying what is learned to real world situations. Students will read and write in the discipline to research, document and communicate their findings and propose further research regarding health and wellness. The specific skill sets required for work in biotechnology-related fields are emphasized, while careers in the field will be introduced within the biology content. Students will first be introduced to the field of biology as they explore the characteristics that determine life and the levels of organization for structure and function of living things. Students will be trained in how to properly use and care for the light microscope and use the microscope to observe cells, single celled organisms, and tissues. After engaging students in foundational concepts of what separates life from non-life, students will investigate the building blocks of life, organic compounds and how the elements that form them combine. Once students have explored the foundational molecules of life, they will probe the similarities and differences of prokaryotic and eukaryotic cells and how cells perform the essential functions that define life. Then students will explore how eukaryotic cells can vary in structure and function depending on the role they play within an organism and how various cell types within the human body have specialized structures to help them perform functions, such as the long axon on a nerve cell. Students will gain a deeper understanding of how the body obtains and uses energy at the cellular level as they learn about how the bonds of food and oxygen molecules are broken and new compounds are formed so that cells can obtain energy. Students will gain further experience with the microscope as they examine various cells such as blood, muscle and nerve cells. Students deepen their understanding of cellular

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	variety and specialized functions as they learn about the role of the chloroplast in plants and how photosynthesis transforms light energy into stored chemical energy. As the first portion of the class examines the characteristics of life at the cellular and molecular level, the next major concept is how organisms grow, develop and pass their traits onto the next generation. Students will observe plant and animal cells in various stages of mitosis, then create a stop animation film of mitosis that shows how the daughter cells obtain identical genetic information. Students will also investigate various cancers that result from cells that do not stop dividing. Students will contrast the identical daughter cells of mitosis with the variety of characteristics that can be produced by meiosis as each student will create a fictitious organism called a “Reebop” based on the same parent cells. Students will predict the probability offspring will obtain a particular genotype and phenotype based and various crosses. As a part of their understanding of genetics, students will learn how to use aseptic techniques to do blood typing (simulated) as well as determine which fictitious characters can donate/receive blood from one another. The next segment of the course will show how all cellular processes they have learned about are coded for in the blue print of DNA. Students create a model of the central dogma of molecular biology that outlines the flow of information from DNA to functional polypeptides. Students will then explore how DNA can be applied to various fields such as forensics as they solve a crime using DNA electrophoresis. Up to this point students have learned about all of the aspects of life that support homeostasis, so what about when homeostasis is interrupted by infection or genetic factors? Each student will research a different foreign invader or genetic disorder that can disrupt the human body and the effects both on the individual and the impact on a global level. The feedback mechanisms of immune response and intervention treatments will also be explored. Having learned about the body responds to disease, students will be ready to learn about the complementary interactions among other body systems such as the nervous and circulatory systems. In the final section of this course, students will apply what they have learned about cells, DNA and mutations to explore how a species change over time and the factors that influence change. Knowing that change allows for adaption to different environments students will then study the many aspects of ecology.
COURSE CONTENT	Unit 1: What is Life, Anyway? In this foundational unit students will be challenged to define what makes something living by exploring various living organisms from a bacterial cell, to a sponge to large mammals like an elephant. They will also be introduced to and trained on one of the most recognized tools of scientists, the microscope. Additionally, students will be introduced to biological ethics and biotechnology-related career opportunities that are available in modern society and requirements for this chosen career path. <u>Example Activities</u>

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Students will read their text and create a “Characteristics of Life” chart and then classify various objects as living or nonliving and support their assertion based on their chart. Students will be introduced to the iconic tool of a biologist, the microscope, and be trained in how to focus a light microscope as well as how to determine the size of an object viewed by the light microscope. Students will then use the microscope to view a variety of cells, tissue cross sections and speedy single celled organisms from a local creek. Once students have learned the value and limitations of a light microscope, they will be introduced to other research microscopes and their applications such as the electron microscope and scanning tunneling microscope.

Sample Activity Biological Ethics: After learning what biological ethics is, students will read articles related to ethical aspects of biology, biotechnology, and health sciences. A class discussion & debate will be had to discuss both sides of the debate. Students will learn partly what is involved in health care decision-making processes.

Unit Lab Activities:

Sample Lab 1.1: Introduction to the Light Microscope: Students learn to focus the microscope using low, medium and high power objective lenses, then document what they see using diagrams in their laboratory notebook. Students also use the inverse relationship between the power of the objective lens and the field of view to determine the diameter of the field of view under high power.

Anchor Standards: 2.1, 2.3, 2.4, 2.5, 4.1, 4.2, 4.3, 4.4, 5.1, 5.2, 5.3, 5.4, 5.6,

Pathway Standards: A6.4, A7.5, A7.6, A8.1, A8.2, A8.5, A8.6, A8.7, A8.8, A8.9

Unit 2: The Chemistry of Life – It’s all CHON to Me!

In this unit, the basic components of how atoms combine to form molecules and rearrange during chemical reactions will be introduced with emphasis on the four most common elements in the human body – Carbon, Hydrogen, Oxygen and Nitrogen (CHON). Special properties of water, such as adhesion and cohesion will be explored as water is important in so many aspects of life. Then, students will learn about the key organic compounds essential to life as they use molecule building kits to build organic molecules of a monosaccharide and a disaccharide, an amino acid and a dipeptide, then a portion of a lipid. Students will further explore organic molecules as they test various foods for the presence of monosaccharides, polysaccharides, lipids and protein. Students will then examine the special role enzymes play in the body and how the structure of an enzyme is important in its function. Finally, students will be introduced to how certain organic compound levels in the body can be used to identify disease, such as sugar in the urine.

Example Activities

Sample Project Pop-Up Book on the Compounds of Life: Students will create a pop-up style book that would teach someone about organic compounds, their structure, the types of foods that contain the compounds and how they are used in the body.

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Unit Lab Activities:

Sample Lab 2.1: Testing for Organic Compounds in Food: Students will test various foods for the presence of monosaccharides, polysaccharides, protein and lipids using indicators.

Sample Lab 2.2 Molecule Madness: Students will use models to build examples of a monosaccharide, disaccharide, amino acid, dipeptide and identify specific groups to the teacher such as carboxyl group, R-group, amino group, water produced during synthesis.

Anchor Standards 2.4, 2.5, 5.1, 6.3, 6.6, 7.3, 7.7, 8.1, 9.7, 10.1, 10.2

Pathway Standards A3.1, A3.2, A4.1, A4.2, A4.4, A4.5, A4.6, A4.7, A6.1, A8.1, A8.2, A8.3, A8.4, A8.5, A8.6, A8.8, A8.9

Unit 3: The Immortal Cell

Students have experimented and used models to build examples of organic compounds and are now ready to apply what they have learned to the basic building block of life, the cell. Students will read about prokaryotic and eukaryotic cells and write a comparison and contrast chart. Then students will use a microscope to examine various prokaryotic and eukaryotic cells and write a laboratory report that includes identifying cell structures and their functions for each cell type. Students will further examine the cells that come from various tissues and how the specialized structures of those cells support the functions of the body. Finally, the dynamic structure of the semi-permeable cell membrane and it's function will be investigated as students record what happens when potato pieces are put into isotonic, hypertonic and hypotonic solutions and then write an explanation to explain what they observed.

Example Activities

Sample Cross-Curricular Project: Students in the Biotechnology Pathway read the book The Immortal Life of Henrietta Lacks in their English Class while they are learning about cells in this course. Additionally, students are learning about scaling in their math class. As a culminating project across all three subjects students build a three dimensional scale model of a cell from a particular tissue of the body, and how it's specialized structure supports it's function and current research of diseases being studied using those cells. The students present their project to a small group (2 upperclassman from the Biotechnology Course and one teacher) for a total of 3 presentations. This gives the students a "low pressure" venue to practice their presentation skills for their first project in high school.

Unit Lab Activities:

Sample Lab 3.1: Students observe and diagram cells from various tissues such as a neuron, cardiac muscle and skeletal muscle. Students write about the connection between how the structure supports the function of that cell in the body.

Anchor Standards 2.4, 2.5, 5.1, 6.3, 6.6, 7.3, 7.7, 8.1, 9.7, 10.1, 10.2

Pathway Standards A3.1, A3.2, A4.1, A4.2, A4.4, A4.5, A4.6, A4.7, A6.1, A8.1, A8.2, A8.3, A8.4, A8.5, A8.6, A8.8, A8.9

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Unit 4: Photosynthesis, Let's Get into This!

Students have discovered how cells are the basic unit of life and will now dig deeper into how plant cells capture sunlight energy and convert it into a form that can be stored as carbohydrates and carbon dioxide. Students will also learn that our lives depend on the process of photosynthesis for life and the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere. Students will diagram the basic steps of photosynthesis with an emphasis on atom rearrangement and the relationship between bonds and energy. Students will get further microscope experience as they view and diagram the cross structure of a leaf and explain the importance of the positions of the stomata, guard cells, mesophyll cells and cuticle. Finally, students will be introduced to the spectrophotometer, electromagnetic radiation and the difference between absorbance and transmittance as they graph the wavelengths absorbed a sample of chlorophyll. The correct laboratory skill of a spectrophotometer is a skill students will practice each year of the pathway as it key in determining concentrations of solutions (such as DNA).

Example Activities

Sample Project Mission to Mars: What would it take to grow food on mars? In their attempt to answer this question, students will need to work with others and use a variety of science inquiry skills and research methods. Students will present their findings and recommendations for growing food on mars to a "NASA" panel.

In "The Martian," Mark Watney uses the Martian soil to grow potatoes in the controlled environment of the "Hab." NASA has laid out plans to send people to Mars in the 2030s. What will it take for them to be able to grow food? Will something similar to what happened in the movie work? Note, in the movie, when Watney gets stranded on Mars, he plants potatoes in a greenhouse using Martian soil and his own "metabolic waste."

Resources:

- [LiveScience article](#)
- [NASA article](#)
- [Nature World News article](#)

Unit Lab Activities:

Sample Lab 4.1 Using a Spectrophotometer to Measure Absorbance: Students will use a spectrophotometer to measure the absorbance of a sample of chlorophyll they prepare from various plant sources. Students will graph the absorbance at a series of wavelengths and then analyze where most of the light was observed and then infer where most of the light is transmitted. Students will then calculate transmittance from absorbance at two or three key data points. Students write a standard laboratory report that includes an explanation about the relationship among absorbance, transmittance and the color of plants.

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Sample Lab 4.2 Chromatography of Plant Pigments: Students will grind up various plants and extract the pigments. Students will then separate the pigments using paper chromatography and identify which pigments are present in the sample and calculate the Rf value. Students will also analyze data from other groups to see if pigments from other plants have the same Rf value. Students will write a standard laboratory report that includes an application for chromatography in biotechnology.

Anchor Standards: 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 5.1, 5.2, 5.3, 5.4, 5.6, 6.6, 7.4, 7.8, 8.6, 9.7, 10.1, 10.2, 10.3, 10.4, 11.2, 11.5

Pathway Standards: A1.2, A1.4, A8.1, A8.2, A8.3, A8.4, A8.5, A8.6, A8.7, A8.8, A8.9, A9.4, A9.5

Unit 5: Respiration, It's a Breath of Fresh Air

Students have delved into the production of oxygen and carbohydrates from plants, so it's time for them to see how that relates to digestion and breathing at the cellular level. Students will create a model that demonstrates how the molecules of oxygen and carbohydrates are used by cells to provide our bodies with energy for the functions of life. An emphasis will be placed on how bonds are broken and new compounds that are formed can transport energy to muscles and to maintain homeostasis. Students will further examine what happens when the demand for oxygen exceeds the supply of oxygen.

Example Activities

Sample Activity Energy Flow & Fitness: Students have the opportunity to model the relationship between photosynthesis and cellular respiration. Using puzzle pieces that are colored and cut out, students create a diagram representing the reactants and products produced during these processes, and how they relate to each other. There is an emphasis on the flow of energy and matter.

Unit Lab Activities:

Sample Laboratory 5.1 Cellular Respiration: Students will add yeast, water and sugar to an empty water bottle that has a balloon attached to collect the gas. The amount of gas produced will be measured and then students will be asked to design and test an experiment where they try to increase the amount of gas produced. Students will write a standard laboratory report about their findings, the compound found in the gas produced, and the success of the test they designed.

Sample Lab 5.2 Fermentation: Students will culture yeast cells under aerobic and anaerobic conditions, then use a micro-distillation apparatus to separate out the products. Distillation products will be tested by either a gas chromatograph or the ability to burn when lit by a match. Students will write a standard laboratory report about their findings.

Anchor Standards: 2.2, 2.3 2.4, 2.5, 2.6, 4.1, 4.2, 4.3, 4.4, 4.6, 5.1, 5.2, 5.3, 5.4, 5.6, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 7.3, 7.4, 7.5, 7.7, 8.4, 9.1, 9.2, 9.3, 9.5, 9.6,

Pathway Standards: A1.1, A4.1, A4.2, A4.3, A4.4, A4.5, A4.6, A4.7, A5.1, A5.2, A5.3, A8.1, A8.2, A8.4, A8.5, A8.6, A8.7, A8.8, A8.9

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Unit 6: Cell Growth and Division

Students have learned about cells and how they function, now they will delve into the process of how cells grow and divide to make more cells using the process of mitosis. Complex organisms need to differentiate cells to make various tissues and organs that work together to meet the needs of the whole organism. This process starts with just two cells that join, an egg and a sperm during fertilization. Students will use the microscope to view cells in various stages of mitosis in both plant and animal cells. Students will examine special situations where cells need to divide, such as when there is tissue damage. Students will also visit an interactive website on how cancer is related to mitosis.

Example Activities

Sample Activity Mitosis Stop Animation: Students will work in small groups of 2-3 to create a stop animation model of mitosis using their cell phones, clay and a ring stand as a base for the phone. The stop animation will illustrate a situation where mitosis is involved, such as damage to a tissue or a tumor forming.

Unit Lab Activities:

Sample Lab 6.1 Mitosis in Onion Roots: Students gain experience producing wet mount slides from the tips of onion roots. The students will learn how to prepare, stain, and fix the specimens to microscope slides, a necessary skill component used in biotechnology and clinical laboratories. The students will then compare their slides to prepared mitotic slides to identify the stages of mitosis and will be required to calculate the time spent in each stage. Students will be viewing both plant and animal cells undergoing mitosis. Students will be making predictions about the length of time spent in each mitotic phase and will determine if their predictions are correct after they have calculated the time spent in each phase.

Anchor Standards: 2.3 2.4, 2.5, 4.1,4.3, 4.4, 4.5, 4.6, 5.1,5.2, 5.3, 5.4, 5.6, 6.6, 7.3,7.4, 7.5, 9.1, 9.2, 9.3, 9.7,11.1, 11.5
Pathway Standards: A2.3, A4.1, A4.4, A4.6, A5.1, A5.2, A5.3, A6.1, A6.4,A8.1, A8.2, A8.4, A8.5, A8.6, A8.7, A8.8, A8.9,

Unit 7: Me Oh Mi Oh.... Meiosis

In the last unit students learned about how cells grow and divide to form body cells, this unit expands cell division to the production of egg and sperm cell, as well as the genetic variations that can result through unique combinations of chromosomes, crossing over and mutations. Students will exam case studies where it has been reported that offspring have been affected by the environment and debate both sides of the issue before coming to a conclusion and stating their rationale.

Example Activities

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Sample Assignment Chromosome Map: Students will be given data on the percentage of time crossing over occurs, then create a chromosome map showing the relative distances. This will demonstrate that students understand that the further apart genes are on a chromosome, the more likely they are to participate in a crossing over event.

Unit Lab Activities:

Sample Lab 7.1 Meiosis: In the first part of this lab, students will be modeling the phases of meiosis in lab groups. After they have modeled the different events of meiosis they will then be studying/examining Sordaria pictures. For each picture, they will be counting the number of asci that do not show crossing over and the number showing crossing over. From this calculation they will then be calculating the gene to centromere distance.

Anchor Standards: 2.3 2.4, 2.5, 4.1,4.3, 4.4, 4.5, 4.6, 5.1,5.2, 5.3, 5.4, 5.6, 6.6, 7.3,7.4, 7.5, 9.1, 9.2, 9.3, 9.7,11.1, 11.5

Pathway Standards: A2.3, A4.1, A4.4, A4.6, A5.1, A5.2, A5.3, A6.1, A6.4,A8.1, A8.2, A8.4, A8.5, A8.6, A8.7, A8.8, A8.9,

Unit 8: Surfing the Gene Pool of Genetics

Students will apply concepts of statistics and probability to explain the variation and distribution of expressed traits. Students will be given practice problems involving monohybrid and dihybrid crosses and predict the probable genotype and phenotype of the offspring. Students will then apply what they have learned to co-dominant and incomplete dominant problems. Students will also analyze pedigree charts to determine individual genotype and phenotype including case studies of individuals with genetic disorders. The last portion of this unit will tie together the concepts of chromosomes, meiosis, and the great variety resulting from sexual reproduction by participating in a simulated process of meiosis using beads to create a fictitious organism called a “Reebop.” Students will investigate the chromosomes and inheritance patterns of a “Reebop” to find which traits and dominant, co-dominant, incompletely dominant and sex linked. The final product is a three dimensional organism.

Example Activities

Cross-Curricular Lesson: While students are studying genetics (and on through immunity) in this course, they read the short story Scarlett Ibis in their English class about a boy who has a disorder for which the cause of his condition is never given. Math classes participate in a simulation of the spread of disease and how acquired immunity makes it often difficult to use a simple mathematical equation to predict the spread of infectious diseases. Students each research a genetic disorder or infectious disease selected at random and create both a multimedia presentation and brochure about the disease. Included in the presentation and brochure are the cause, symptoms, treatment, worldwide distribution, and testing for the disease. Students fill in a graphic organizer as classmates give their presentation. Once all of the presentations are complete, students write a diagnosis and defend using support from the research projects for their diagnosis. This project starts during this unit, but is presented during the unit of immunity and disease.

Unit Lab Activities:

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Sample Lab 8.1 ABO Blood Typing: Students will use simulated blood kits to test five blood donors for ABO blood grouping and Rh factor. Students will then be asked to assess which blood donor's blood would be best to give to a car crash patient who has blood type AB-. Students will write up their results in standard laboratory report format.

Anchor Standards: 2.3 2.4, 2.5, 4.1,4.3, 4.4, 4.5, 4.6, 5.1,5.2, 5.3, 5.4, 5.6, 6.6, 7.3,7.4, 7.5, 9.1, 9.2, 9.3, 9.7,11.1, 11.5
Pathway Standards: A2.2, A2.3, A2.6, A4.1, A4.4, A4.6, A5.1, A5.2, A5.3, A6.1, A6.4,A8.1, A8.2, A8.4, A8.5, A8.6, A8.7, A8.8, A8.9,

Unit 9: The Central Dogma

Students in this unit unravel the mystery of how a chromosome is made out of DNA and that DNA is the blueprint for all activities within a cell and directs inheritance of traits. As DNA cannot be seen and is often an abstract concept for students to understand, this unit starts with making a model of DNA and DNA extraction to grab their interest. Students will build a model of DNA using beads and wire that can be attached to their back pack to help them remember the structure of DNA. Students will then extract DNA from strawberries and use a spectrophotometer to measure the absorbance of their DNA. Students will then simulate the processes of replication, transcription, translation using models to build a polypeptide. Students will then write about the process they simulated in their own words. Once students have mastered the central dogma of molecular biology, they will be ready for how it has been manipulated to create consumer products.

Example Activities

Sample Assignment: Students will be given a portion of the gene for the alpha-chain of hemoglobin. Students will first transcribe the chain into mRNA, then give the anti-codon found on tRNA, then translate the mRNA into a polypeptide. Students will diagram each step of the process on a large sheet of butcher paper and write about what is happening as if explaining it to someone else.

Unit Lab Activities:

Sample Lab 9.1 DNA Extraction: Using common materials found at the grocery store, students will be extracting DNA out of strawberries. As a part of this activity, students will determine what other specimens could have been utilized for DNA extraction and why the specific substances in the lab experiment were used to extract and isolate the DNA from the sample. As an extension of this lab, students will be using a spectrophotometer to confirm that the material harvested from their strawberries was in fact DNA.

Anchor Standards: 2.3 2.4, 2.5, 4.1,4.3, 4.4, 4.5, 4.6, 5.1,5.2, 5.3, 5.4, 5.6, 6.6, 7.3,7.4, 7.5, 9.1, 9.2, 9.3, 9.7,11.1, 11.5
Pathway Standards: A2.3, A3.1, A3.2, A3.3, A3.4, A3.5, A4.4, A4.5, A5.1, A5.2, A5.3, A6.4, A7.5, A8.1A8.2, A8.4, A8.5, A8.6, A8.7, A8.8, A8.9

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Unit 10: Genetic Engineering and Biotechnology

Students will apply what they learned in the last unit on molecular biology to how DNA is manipulated to create products for consumers in the biotechnology industry. Students will be introduced to the scope of biotechnology in many fields through high interest reading articles on Genetically Modified Organism, Medicine and Forensics. In the laboratory, students will first practice to become proficient in a few of the tools of biotechnology such as the micropipette and loading a gel. Students will learn through reading and discussion about the various enzymes and their function. Once students have a solid grasp of the basic concepts they will be introduced to recombinant DNA through demonstration and simulations. Then, students will be given a paper “gene of interest” and a paper “plasmid” and will search both for restriction sites that will allow for recombination without disturbing a selectable marker or promoter. Students will simulate the action of a restriction enzyme by cutting both and creating a paper recombinant plasmid. Students will gain a deep understanding for how the long sequence of nucleotides can be complex to navigate to include multiple requirements for recombination.

Example Activities

Sample Activities High Tech Harvest: Genetic Engineering in the Environment – Students will be conducting a series of activities that have students examine both traditional and modern techniques of genetic engineering. These activities will provide students with the opportunity to consider ways genetic engineering can influence natural systems as well as human health. Students will be reading about “super rice” in California and they will be examining how traditional rice differs from genetically modified rice. Students will also be examining both traditional breeding methods from more modern engineering practices. Another part of this activity will be reading about genetically engineered products and how these products can influence the composition, biological diversity and viability of natural systems, as well as human health. By the end of these activities, students should be able to understand the importance of genetic resources in the production of novel biomedical and agricultural products and any bias involved in any of the articles they have read.

Sample Project Genetic Research: Students will research and make presentations about the current field of genetic engineering and the implications of research that is taking place. Students will be able to learn more about what is currently being done in the field and positive and/or negative implications may exist due to what is currently being done in the field.

Unit Lab Activities:

Sample Lab 10.1 Proficiency with Basic Biotech Equipment: Students will use a P-20 and a P-200 micropipette to dispense various requested amounts of liquid onto a laminated sheet to be checked by the teacher for accuracy. Students will then practice pipetting three different samples onto the sides of a microfuge tube and then using a micro-centrifuge to pull the sample together. The total volume will then be tested by the teacher for accuracy. Students will then practice loading dye samples into a “plastic” gel submerged in water to simulate loading a gel electrophoresis. Students whose samples are not accurate will be allowed to repeat as many times as necessary until proficiency is achieved.

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Sample Lab 10.2 The Mystery of Lyle and Louise: In this lab students are introduced to a scenario where a crime has been committed and DNA samples are left behind at the crime scene. Students test the DNA samples as well as the samples of the suspects and determine who was likely to have committed the crime.

Anchor Standards: 2.2, 2.3 2.4, 2.5, 4.1,4.3, 4.4, 4.5, 4.6, 5.1,5.2, 5.3, 5.4, 5.6, 6.6, 7.3,7.4, 7.5,7.8, 8.4, 9.1, 9.2, 9.3, 9.6 , 9.7,10.3, 11.1, 11.5

Pathway Standards: A1.1, A1.3, A1.4, A1.5, A2.3, A3.1, A3.2, A3.3, A3.4, A3.5, A4.4, A4.5, A5.1, A5.2, A5.3, A6.4, A7.5, A7.6, A8.1A8.2, A8.4, A8.5, A8.6, A8.7, A8.8, A8.9

Unit 11: Bacteria, Disease and Immunity

One of the applications in biotechnology from the last unit is the creation and production of new medications to treat diseases and disorders. This unit will focus on the pathogens that cause disease and how our body is constructed with both nonspecific defenses against infection as well as the specific antibody mediated defenses. Students will examine how a vaccination protects individuals against infectious diseases. Students will read about how antibiotics function to kill bacteria and why antibiotics are not a treatment for viral infections. Students will participate in an epidemiology exercise where two people are “infected” with glow in the dark lotion and after shaking hands several times with different people students have to determine who originated the “infection.” Students will also work in teams to apply biological concepts of immunology, virology and molecular genetics to a case study involving an infectious disease outbreak of 2005 in Angola.

Example Activities

Sample Activity Epidemics & Outbreaks – Infectious Disease Case Study: Activity will be introduced watching Contagion or Outbreak and doing a simulation of how diseases are spread using GloGerm. After these activities, students will read a case study and discuss the questions with their Infectious Disease team. They will be acting as a biologist working for the CDC and working for the Special Pathogens branch of the CDC, studying highly infectious diseases. After receiving information about a group of people in Angola that have become ill and are dying from the contagious disease, their job will be to investigate the symptoms and explore the challenges and resources that they will have available for treating the outbreak. They will be investigating diagnostic testing that can be utilized and ultimately will be diagnosing the disease. After diagnosing the disease, they will understand more about the disease and then choose one of three options (writing a paragraph about training to work as a Special Pathogens Agent, a newspaper article reporting on the outbreak, or a public health poster indicating how to prevent the pathogen from spreading) to conclude the activity.

Unit Lab Activities:

Sample Lab 11.1 Bacteria: Lab groups are given 5 petri dishes and have to create a question to be answered about bacteria, write a procedure that includes a control group and only one variable, and then answer their question in the conclusion. Students can test: “Where on campus can the most bacteria be found?”, “At Which Temperature Do Bacteria

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Grow Best”, or “Which Method for Washing Hands is Most Effective for Getting Rid of Bacteria” as a few examples. Students write standard laboratory reports.

Sample Lab 11.2 Simulated ELISA : Read about how ELISA uses antibodies and enzymes to test for diseases that are difficult to diagnose by symptoms alone. Then students are given a scenario of a patient with symptoms of Lyme Disease but there is no indication of being bit by a tick. Students test the patient using the same steps of an ELISA test to determine if she indeed has Lyme Disease. Students perform both a positive and a negative control and a triplicate test, the teacher leads a class discussion of the importance of these procedures with students. Aseptic technique is emphasized and practiced. Students write a standard laboratory report that includes research on other ELISA test applications.

Anchor Standards: 2.2, 2.3 2.4, 2.5, 2.6, 4.1, 4.2, 4.3, 4.4, 4.6,5.1, 5.2, 5.3, 5.4, 5.6, 6.2,6.3, 6.4, 6.5, 6.6, 6.7,7.3,7.4, 7.5, 7.7, 8.4, 9.1,9.2, 9.3, 9.5, 9.6, 11.5

Pathway Standards: A1.1, A1.3, A1.4, A1.5, A2.3, A3.3, A3.4, A4.3, A4.4, A4.5, A4.6, A5.1, A5.2, A5.3, A6.4, A7.5, A7.6, A8.1A8.2, A8.4, A8.5, A8.6, A8.7, A8.8, A8.9

Unit 12: Evolution

Students have learned all about bacteria, viruses and disease in the last unit, and how bacteria can become resistant to antibiotics is the first topic students investigate in this unit as an introduction to how species can change over time. Students will read and discuss the evidence supporting the claims that organisms evolve. Students will construct an explanation based on that the process of evolution results from four factors: potential for a species to increase in number, the heritable genetic variations in a species due to mutations and sexual reproduction, competition for limited resources and the proliferation of the organisms that are best adapted to the environment.

Example Activities

Sample Activity Butterfly Survival Simulation: Students select a multicolored environmental backdrop (scrapbook paper of pine trees, roses, deciduous leaves, etc). One student randomly places five butterflies of 6 different colors (red, green, blue, brown, black, and yellow) on the backdrop. Another student (who was not looking during the placement) simulates a bird eating the butterflies by quickly picking up the first butterfly he/she sees, breaks eye contact with the paper as she places it in her stomach (cup) and repeats for a total of 15 rounds. Each of the surviving butterflies reproduces and the process is repeated. A total of five generations is simulated. Usually students end with either just one or two surviving kinds of butterflies, demonstrating the survival of the fittest based on coloration. Students write a standard laboratory report that includes an explanation of their results.

Unit Lab Activities:

Sample Lab 12.1 Adaptations – Survival of the Fittest:Students simulate variations and adaptations of the hand to observe the impact of these variations on food collection. The increase or decrease of a mutation in a population over several

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generations of food collection is simulated, and data is collected. Students then have the opportunity to evaluate their data to determine how the change in environmental conditions (food source) resulted in an increase in the number of individuals with a specific variation, and the extinction of individuals with another specific variation. Students hypothesize how these populations could result over time in the emergence of new species.

Sample Lab 12.2 Antibiotic Resistance: Students will be simulating that they are a part of a medical lab team that works for a hospital. Understanding that bacteria has become resistant to many of the antibiotics that are used to treat them, they will be evaluating the effectiveness of different antibiotics in killing in Staphylococcus aureus S. aureus bacteria are the cause of Staph infections. They will be given a scenario where two patients have just come to the hospital exhibiting symptoms of a Staph infection. Since antibiotic-resistant Staph infections can get worse quickly, they will be testing the bacteria from both patients for resistance to. If either patient is determined to have a resistant strain, they will need to investigate a different type of treatment for the individual and hypothesize what would happen if they were not given a different type of treatment. As an extension, students will investigate how we decrease the occurrence of antibiotic resistance in microbes? They will research and summarize the problem(s) associated with antibiotic resistance and the possible solutions. Students will argue the effect of antibiotics/antibacterials on the evolution of bacteria and what it may indicate for public health and safety.

Anchor Standards: 2.2, 2.3 2.4, 2.5, 4.1,4.3, 4.4, 4.5, 4.6, 5.1,5.2, 5.3, 5.4, 5.6, 6.6, 7.3,7.4, 7.5, 9.1, 9.2, 9.6 ,9.7,11.1, 11.5
Pathway Standards: A1.3, A1.4, A1.5, A2.3, A2.4, A2.5, A2.6, A3.3, A4.3, A4.4, A4.6, A4.7, A5.1, A5.2, A5.3, A6.4, A7.5, A7.6, A8.1, A8.2, A8.4, A8.5, A8.6, A8.7, A8.8, A8.9

Unit 13: Population Genetics

Students in the last unit explored how a species can change over time, this unit expands on that concept as applied to a population. Students use mathematical representations to support explanations based on evidence about factors affecting biodiversity and populations in ecosystems. Students will furthermore apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

Example Activities

Sample Activity: Students simulate Hardy-Weinberg equilibrium using beans of various colors. Students identify the limitations of Hardy-Weinberg in the real world as part of their conclusion.

Unit Lab Activities:

Sample Lab 13.1 Biodiversity - Population Sampling: In this lab students will perform a mock population study. In the field, it is impossible to count all the individual plants or animals, so samples are taken that represent the whole population and the data is extrapolated to determine the population size, species composition, and other important information. To do this a biologist will divide an area up into smaller grids that can be easily sampled. Of course, the larger the sample size then more likely the data will represent the whole population. Knowing this information not only tells scientists what a population

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looks like now, but allows them to study what might happen to the community under different environmental pressures. Students will be given a bag of beans to represent a plot of forest and the beans are the plant species found in that plant community. They will determine the population size of each plant group and the species composition of the community based on the sampling of the smaller grids. Students will then use the Internet to research and investigate how pesticide use is impacting biodiversity and human health.

Anchor Standards: 2.2, 2.3 2.4, 2.5, 4.1,4.3, 4.4, 4.5, 4.6, 5.1,5.2, 5.3, 5.4, 5.6, 7.3,7.4, 7.5, 9.6 ,9.7,11.1, 11.5

Pathway Standards: A1.1, A1.2, A1.3, A1.4, A1.5, A2.1, A2.2, A2.3, A2.4, A3.2, A4.1, A4.4, A4.5, A4.6, A5.1, A5.2, A5.3, A6.1, A6.4, A7.3, A7.5, A8.1, A8.2, A8.4, A8.5, A8.6, A8.7, A8.8, A8.9

Unit 14: Body Systems

Earlier in the course, students examined how the structures of differentiated cells were essential to performing specific functions. In this unit students will learn how cells work together to form tissues, tissues to form organs and organs to form organ systems, and how the activity of each body system is complementary with the other systems to form a complete organism. Students will first work in groups to build models in clay of each of the body systems, which they present to the class as a review of the overall systems. Two complementary interactions will be investigated in detail. The first complementary overlapping systems to be emphasized are the interactions of organs in the circulatory, respiratory and digestive systems that deliver oxygen and nutrients to the cell and rid the cell of waste. The second overlapping systems will be to contrast information delivery mechanisms of the nervous and endocrine systems, including feedback loops that regulate conditions in the body.

Example Activities

Sample Activity: Students use clay to build representations of each body system and present to class as an overview of all of the body systems.

Unit Lab Activities:

Sample Lab 14.1 How Enzymes Help Digestion: This lab not only demonstrates the importance of enzymes on digestion but gives students another example of a biotechnology product. Students test various milk products for the presence of glucose, then treat those milk products with commercially available lactase and then test the samples again. Students write up a standard laboratory report that includes the role of enzymes in digestion and how people who lack enzymes can be helped. Students will include examples of other enzymes that are commercially available for consumers.

Sample Lab 14.2 Reflexes: Students work in pairs to test reflexes such as pupils to light and knee to reflex mallet. Students diagram the path that the reflex travels from stimulus to central nervous system and explains what occurs within the neuron and at the synapse.

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Pathway Standards: A1.1, A1.3, A1.4, A1.5, A2.3, A2.5, A3.2, A3.3, A3.4, A3.5, A4.1, A4.5, A4.7, A5.1, A5.2, A5.3, A6.1, A6.4, A7.3, A7.5, A8.1, A8.2, A8.4, A8.5, A8.6, A8.7, A8.8, A8.9

Unit 15: Ecology

This unit focuses on the level of organization of biotic and abiotic factors within the biosphere, how carbon, nitrogen and water are cycled, and how energy is transferred from one organism to another within a food web. Students will read a case study where a pollutant at one level of the food web can affect organisms throughout the food web.

Example Activities

Sample Activity Observing Pond Water: Students collect and observe the number and kinds of organisms found in a sample of pond water over a course of 2 weeks. Students describe and try to identify the producers and consumers. Students graph the numbers of one prolific organism over the course of 10 days. Students explain where on the growth curve of a population they believe the pond water population is and explain why.

One of the two project assignments will be assigned:

Project: Ecosystem/Biome Poster or Research Paper – Students will research an ecosystem or biome and create an eye-catching informative poster or write a research paper. Students will include biotic factors (they must include a food web, habitats of dominant wildlife (and their ecological role), characteristics of dominant producers and provide an ecological pyramid), abiotic factors (geographic area of the world their ecosystem/biome is located in and climatic conditions of this area), provide a specific example of their biome, human impact on the biome and any health related concerns to the human population that is known in that ecosystem.

Project: Environmental Impact Report/Debate - For this project, students will choose an environmental issue which is impacting our local ecosystems and will gather data and other information from local newspapers, interviews, impact reports, environmental agencies. Students will present their findings in a formal report and to the class. If there are any contradictory findings, students will form into groups to present their arguments and debate their findings.

Unit Lab Activities:

Sample Lab 15.1 Cycling of Matter & Energy – The Life and Times of Carbon: In this activity, students will start by identifying materials that they think contain carbon and will read an article on biofuels. After reading this article, students will learn about the global carbon cycle and will brainstorm processes that use carbon from different reservoirs and diagram how carbon cycles between these reservoirs. Students will investigate how they reduce their carbon footprint and will conclude the activities examining how different human activities can alter carbon reservoirs and impact the processes that

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	use carbon. They will analyze information about biofuels and discover that this information is utilized to make decisions about our energy needs. <u>Anchor Standards:</u> 2.2, 2.3 2.4, 2.5, 2.6, 4.1, 4.2, 4.3, 4.4, 4.6,5.1, 5.2, 5.3, 5.4, 5.6, 6.2,6.3, 6.4, 6.5, 6.6, 6.7,7.3,7.4, 7.5, 7.7, 8.4, 9.1,9.2, 9.3, 9.5, 9.6, 11.1,11.5 <u>Pathway Standards:</u> A1.1, A1.2, A1.3, A1.4, A1.5, A2.1, A2.2, A2.3, A2.4, A3.2, A4.1, A4.4, A4.5, A4.6, A5.1, A5.2, A5.3, A6.1, A6.4, A7.3, A7.5, A8.1, A8.2, A8.4, A8.5, A8.6, A8.7, A8.8, A8.9																		
PREREQUISITES	Algebra 1 (recommended) (Required)																		
CO-REQUISITES	Algebra 1 (Required)																		
ACADEMIC CREDIT	1 year/10 credits																		
CERTIFICATION	CPR																		
ARTICULATION																			
INSTRUCTIONAL STRATEGIES	Lecture and Demonstrations Multimedia Sources Labs/Stations Project-Based Learning Work-Based Learning																		
INSTRUCTIONAL MATERIALS / TEXTBOOKS	Course Materials Textbooks <table><thead><tr><th>Title</th><th>Author</th><th>Publisher</th><th>Edition</th><th>Website</th><th>Primary</th></tr></thead><tbody><tr><td>Biology</td><td>Miller and Levine</td><td>Pearson/Prentice Hall</td><td>2007</td><td>[empty]</td><td>Yes</td></tr><tr><td>Biotechnology for the New Millenium</td><td>Ellyn Daughterty</td><td>EMC</td><td>2010</td><td>[empty]</td><td>No</td></tr></tbody></table>	Title	Author	Publisher	Edition	Website	Primary	Biology	Miller and Levine	Pearson/Prentice Hall	2007	[empty]	Yes	Biotechnology for the New Millenium	Ellyn Daughterty	EMC	2010	[empty]	No
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Biotechnology for the New Millenium	Ellyn Daughterty	EMC	2010	[empty]	No														

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Literary Texts

Title	Author	Publisher	Edition	Website	Read in entirety
Immortal Life of Henrietta Lacks	Rebecca Skloot	Crown Publishing	2010	[empty]	Yes

Manuals

Title	Author	Publisher	Edition	Website	Read in entirety
Biotechnology for the New Millenium	Ellyn Daughterty	EMC	2010	[empty]	No

Periodicals

Article title	Periodical title	Authors	Date	Website
Mitosis Gets Harder Thanks To New Gene Discovery	Science Daily	Science Daily Staff	2008	www.sciencedaily.com
What makes cell division accurate?	Science Daily	Carnegie / Science Daily Staff	2014	www.sciencedaily.com

Websites

Title	Author(s)/Editor(s)/Compiler(s)	Affiliated Institution or Organization	URL
Dolan DNA Learning Center	[empty]	Cold Spring Harbor Laboratory	www.DNAIc.org

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Nature World News	[empty]	Nature World News	http://www.natureworldnews.com/
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NASA	[empty]	NASA	https://www.nasa.gov/
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Live Science	[empty]	Live Science	https://www.livescience.com/
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Multimedia

Title	Author	Director	Name of video series	Date	Website	Medium of Publication
PBS Learning Media	[empty]	[empty]	Mitosis, Meiosis, Various others	[empty]	www.pbslearningmedia.org	mp3
Cellular Respiration and Various Others	[empty]	[empty]	[empty]	[empty]	www.discovery.com	mp3
Educational DVDs/Videos	[empty]	[empty]	[empty]	[empty]	[empty]	Various

Other

Title	Authors	Date	Course material type	Website
Kahoot.It	[empty]	[empty]	Personal device interactive for gauging student understanding.	www.getkahoot.com

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	Case studies	Various	[empty]	Supplemental	[empty]
	Labs	Various	[empty]	Supplemental Material	[empty]