

APS DISTRICT HIGH SCHOOL SCIENCE CURRICULUM FRAMEWORK

Course Title: AP Biology District Course Number: 44131

Department: Science NM STARS Number: 17154144

Prerequisites: Completion of Biology and Chemistry with a C or better is strongly recommended.

Length of Course: One Year Credit/PRI Area: .50 per Sem/Elective Grade Level(s): 11-12

Important Notes:

The College Board states that "The AP Biology course is designed to be taken by students after the successful completion of a first course in high school biology and one in high school chemistry as well." Please see apcentral.collegeboard.com

To be approved as an instructor for AP Biology, the teacher must attend an AP Biology Summer Institute, and have his/her syllabus for the course approved by the College Board.

COURSE DESCRIPTION: This laboratory course* is designed to be the equivalent of a college introductory biology course taken by biology majors. It is an intense course of study stressing strong study skills, critical thinking skills, and time management skills. Topics of study include molecules, cells, heredity, evolution, organisms, populations, and ecology. Laboratory work is strongly emphasized, including DNA biotechnology, biochemistry, and population dynamics. At the completion of this course, the student is strongly encouraged to take the AP exam. The student who demonstrates sufficient qualification on this exam may receive college level credit and advance to upper level course work in biology at the college level. The student is expected to complete some course assignments outside the school year (i.e., summer).

* Lab Courses: A minimum of 250 minutes per week of directed class activity for 36 weeks, 40% of which must be lab oriented, for a total of 150 clock hours (90 hours of class plus 60 hours of lab) shall be required for one (1) unit of credit, excluding passing period. [APS Procedural Directives, Section I – Instruction, Basis for offering credit].

References in parentheses following each performance standard refer to and are aligned with the State of New Mexico Science Standards (NM) and the Albuquerque Public Schools Language Arts Standards (APS - LA).

STRATEGIES:

The “Illustrations” column in the Program of Studies provides exemplars of the performance standards, strategies, and best practices suggested by the Science Teachers in the Albuquerque Public Schools.

ASSESSMENTS:

The “Illustrations” column also incorporates a variety of assessments and “check for” items, suggested by science education teachers. Assessments include the following: authentic and performance-based assessment, cooperative learning, teacher observations, role playing, checklists, rubrics, tests, quizzes and exams, laboratory work, formal and informal writing, individual and peer conferences, small group and full class discussions, oral and multimedia presentations, projects, demonstrations, and portfolios/notebooks.

SUGGESTED TEXTBOOKS AND INSTRUCTIONAL MATERIALS:

- *Biology*, 7th ed. - Neil A. Campbell and Jane B. Reece - Benjamin Cummings, San Francisco – 2002 - www.aw-bc.com
- *Biology*, 5th ed. - Helena Curtis and N. Sue Barnes - Worth Publishers, New York – 1889 - www.worthpublishers.com
- *Biological Science*, 6th ed. - James Gould, et.al., - Norton & Company, New York – 1996 - www.wwnorton.com
- *Biology*, 7th ed. - Sylvia Mader - McGraw-Hill Publishers, Boston – 2001 - www.mhhe.com
- *Life: The Science of Biology* - William Purves, et.al., - W.H. Freeman, New York – 2001 - www.whfreeman.com
- *Biology*, 6th ed. - Peter Raven, et.al., - McGraw-Hyll Publishers, Boston – 2002 - www.mhhe.com
- *Biology: The Unity and Diversity of Life*, 9th ed. - Cecie Starr - Brooks/Cole Publishing Company, Pacific Grove, CA, 3110 - www.brookscole.com
- *Biology*, 6th ed. - Eldra Pear Soloman, et.al., - Brookes/Cole Publishing Company, Australia – 2002 - www.brookscole.com
- *Asking About Life* - Allan J. Tobin, et.al., - Brooks/Cole Publshing Company – 2001 - www.brookscole.com
- *Biology: The Science of Life*, 4th ed. - Robert A. Wallace, et.al., - Addison-Wesley Publishing Company, New York – 2001 - www.aw-bc.com

SUGGESTED TITLES/AUTHORS WEB SITES:

- www.apcentral.collegboard.com - The Teachers’ Resources section of AP Central offers reviews of textbooks, articles, Web sites, and other teaching resources

Approved by HSCA: 01/08

STRAND I: SCIENTIFIC THINKING AND PRACTICE

CONTENT STANDARD: The student understands the processes of scientific investigations and uses inquiry and scientific ways of observing, experimenting, predicting, and validating to think critically.

- BENCHMARKS:**
- A. The student uses accepted scientific methods to collect, analyze, and interpret data and observations and to design and conduct scientific investigations and communicate results.
 - B. The student understands that scientific processes produce scientific knowledge that is continually evaluated, validated, revised, or rejected.
 - C. The student uses mathematical concepts, principles, and expressions to analyze data, develop models, understand patterns and relationships, evaluate findings, and draw conclusions.

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<ul style="list-style-type: none">1. Describes the essential components of an investigation, including appropriate methodologies, proper equipment, and safety precautions (NM - I.I.I.1).2. Designs and conducts scientific investigations that include (NM - I.I.I.2):<ul style="list-style-type: none">• testable hypotheses,• controls and variables,• methods to collect, analyze, and interpret data,• results that address hypotheses being investigated,• predictions based on results,• re-evaluation of hypotheses and additional experimentation as necessary, and• error analysis.3. Uses appropriate technologies to collect, analyze, and communicate scientific data (e.g., computers, calculators, balances, microscopes) (NM - I.I.I.3).	<p>NOTE: Illustrations include suggested activities for attaining each performance standard. A check (✓) refers to a key feature to look for while assessing student performance.</p> <p>All labs in the illustrations are found in the <i>Biology Lab Manual For Students</i> and are recommended laboratory activities by the College Board AP[®] Advanced Placement Program.[®]</p> <p>1, 2, 4, 6, 12, 13, 15, 16. Lab One: Diffusion And Osmosis The student completes a lab on diffusion and osmosis. He/She investigates the processes of diffusion and osmosis in a model membrane system and investigates the effect of solute concentration on water potential as it relates to living plant tissue.</p> <ul style="list-style-type: none">✓ the ability to do the following:<ul style="list-style-type: none">• measure the water potential of a solution in a controlled experiment,• determine the osmotic concentration of living tissue or an unknown solution from experimental data,• describe the effects of water gain or loss in animal and plant cells, and• relate osmotic potential to solute concentration and water potential.

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>4. Conveys results of investigations using scientific concepts, methodologies, and expressions, including (NM - I.I.I.4):</p> <ul style="list-style-type: none"> • scientific language and symbols, • diagrams, charts, and other data displays, • mathematical expressions and processes (e.g., mean, median, slope, proportionality), • clear, logical, and concise communication, and • reasoned arguments. <p>5. Understands how scientific theories are used to explain and predict natural phenomena (e.g., plate tectonics, ocean currents, structure of atoms) (NM - I.I.I.5).</p> <p>6. Understands how scientific processes produce valid, reliable results including (NM - I.I.II.1):</p> <ul style="list-style-type: none"> • consistency of explanations with data and observations, • openness to peer review, • full disclosure and examination of assumptions, • testability of hypotheses, and • repeatability of experiments and reproducibility of results. <p>7. Uses scientific reasoning and valid logic to recognize (NM - I.I.II.2):</p> <ul style="list-style-type: none"> • faulty logic, • cause and effect, • the difference between observation and unsubstantiated inferences and conclusions, and • potential bias. <p>8. Understands how new data and observations can result in new scientific knowledge (NM - I.I.II.3).</p>	<p>2, 4-7. Lab Eleven: Animal Behavior In this two-fold lab the student observes some aspects of animal behavior. He/She observes pillbugs and designs an experiment to investigate his/her responses to environmental variables. In the second lab the student observes and investigates mating behavior in fruit flies (or other organism).</p> <ul style="list-style-type: none"> ✓ the ability to do the following: <ul style="list-style-type: none"> • describe some aspects of animal behavior, such as orientation behavior, agonistic behavior, dominance display, or mating behavior, and • understand the adaptiveness of the behaviors studied. <p>5, 7, 11, 13. Lab Eight: Population Genetics and Evolution In this lab the student learns about the Hardy-Weinberg law of genetic equilibrium and studies the relationship between evolution and changes in allele frequency by using the class to represent a sample population.</p> <ul style="list-style-type: none"> ✓ the ability to do the following: <ul style="list-style-type: none"> • calculate the frequencies of alleles and genotypes in the gene pool of a population using the Hardy-Weinberg formula, and • discuss natural selection and other causes of microevolution as deviations from the conditions required to maintain Hardy-Weinberg equilibrium. <p>1-7, 12-14, 16. Lab Seven: Genetics Of Organisms In this lab the student uses living organisms to do genetic crosses. The student learns how to collect and manipulate the organisms, collect data from F₁ and F₂ generations, and analyze the results from a monohybrid, dihybrid, or sex-linked cross. The procedures that follow apply to fruit flies (other organisms may be used).</p> <ul style="list-style-type: none"> ✓ the ability to do the following: <ul style="list-style-type: none"> • investigate the independent assortment of two genes and determine whether the two genes are autosomal or sex-linked using a multigeneration experiment, and • analyze the data from the genetic crosses using chi-square analysis techniques. <p>8-11. The student selects a variety of scientific magazines and journals, reads a variety of articles on a common topic, summarizes each, and provides an opinion following a magazine/journal review format</p>

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>9. Critically analyzes an accepted explanation by reviewing current scientific knowledge (NM - I.I.II.4).</p> <p>10. Examines investigations of current interest in science (e.g., superconductivity, molecular machines, age of the universe) (NM - I.I.II.5).</p> <p>11. Examines the scientific processes and logic used in investigations of past events (e.g., using data from crime scenes, fossils), investigations that can be planned in advance but are only done once (e.g., expensive or time-consuming experiments such as medical clinical trials), and investigations of phenomena that can be repeated easily and frequently (NM - I.I.II.6).</p> <p>12. Creates multiple displays of data to analyze and explains the relationships in scientific investigations (NM - I.I.III.1).</p> <p>13. Uses mathematical models to describe, explain, and predict natural phenomena (NM - I.I.III.2).</p> <p>14. Uses technologies to quantify relationships in scientific hypotheses (e.g., calculators, computer spreadsheets and databases, graphing software, simulations, modeling) (NM - I.I.III.3).</p> <p>15. Identifies and applies measurement techniques and consider possible effects of measurement errors (NM - I.I.III.4).</p> <p>16. Uses mathematics to express and establish scientific relationships (e.g., scientific notation, vectors, dimensional analysis) (NM - I.I.III.5).</p>	<p>provided by the teacher.</p> <ul style="list-style-type: none"> ✓ use of writing conventions ✓ citation of source (e.g., name of source, date or volume, title of article, page number) ✓ well-developed opinion with supporting facts <p>NOTE: The following labs can also be used for many of the performance standards presented in Strand I:</p> <p>Lab Two: Enzyme Catalysis Lab Three: Mitosis and Meiosis Lab Four: Plant Pigments and Photosynthesis Lab Five: Cell Respiration Lab Six: Molecular Biology Lab Nine: Transpiration Lab Ten: Physiology of The Circulatory System Lab Twelve: Dissolved Oxygen and Aquatic Primary Productivity</p> <p>Complete information and instruction guidelines for each lab can be found in the <i>Biology Lab Manual For Students</i> provided by the College Board AP[®] Advanced Placement Program.[®]</p>

STRAND II: THE CONTENT OF SCIENCE-LIFE**CONTENT STANDARD:** The student understands the properties, structures, and processes of living things and the interdependence of living things and their environments.

- BENCHMARKS:**
- A. The student understands how the survival of species depends on biodiversity and on complex interactions, including the cycling of matter and the flow of energy.
 - B. The student understands the genetic basis for inheritance and the basic concepts of biological evolution.
 - C. The student understands the characteristics, structures, and functions of cells.

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<ol style="list-style-type: none"> 1. Knows that an ecosystem is complex and may exhibit fluctuations around a steady state or may evolve over time (NM - II.II.1.1). 2. Describes how organisms cooperate and compete in ecosystems (e.g., producers, decomposers, herbivores, carnivores, omnivores, predator-prey, symbiosis, mutualism) (NM - II.II.1.2). 3. Understands and describes how available resources limit the amount of life an ecosystem can support (e.g., energy, water, oxygen, nutrients) (NM - II.II.1.3). 4. Critically analyzes how humans modify and change ecosystems (e.g., harvesting, pollution, population growth, technology) (NM - II.II.1.4). 	<ol style="list-style-type: none"> 1. The student critically analyzes issues related to the current use of the Rio Grande River (e.g., measures to help preserve riparian forests and aquatic ecosystems or to rescue endangered species such as the Silvery Minnow). <ul style="list-style-type: none"> ✓ understanding of the complexity of an ecosystem ✓ complete analysis of the issue(s) 2, 6. Lab Twelve: Dissolved Oxygen and Aquatic Primary Productivity The student completes two labs: <ol style="list-style-type: none"> (a) The student measures and analyzes the dissolved oxygen (DO) concentration in water samples at varying temperatures. (b) The student measures and analyzes the primary productivity of natural waters or lab cultures using screens to simulate the attenuation (decrease) of light with increasing depth. <ul style="list-style-type: none"> ✓ The ability to do the following: <ul style="list-style-type: none"> • measure primary productivity based on changes in dissolved oxygen in a controlled experiment, and • investigate the effects of changing light intensity on primary productivity in a controlled experiment. 3, 4. After a discussion/lecture with notes, the student constructs a timeline model of the Rio Grande river and its development over the last several hundred thousand years (e.g., its channelization in very recent times and the quick disappearance of the riparian forests along its length). He/She with a group builds a three-dimensional model of the river as it appeared before and after human habitation of the Albuquerque region. With the group the student writes an analysis of the changes that have occurred. <ul style="list-style-type: none"> ✓ analysis of human interaction with the environment ✓ accurate depiction of the model river

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>5. Explains how matter and energy flow through biological systems (e.g. organisms, communities, ecosystems), and how the total amount of matter and energy is conserved but some energy is always released as heat to the environment (NM - II.II.1.5).</p> <p>6. Describes how energy flows from the sun through plants to herbivores to carnivores and decomposers (NM - II.II.1.6).</p> <p>7. Understands and explains the principles of photosynthesis (i.e., chloroplasts in plants convert light energy, carbon dioxide, and water into chemical energy) (NM - II.II.1.7).</p> <p>8. Understands and explains the hierarchical classification scheme (i.e., domain, kingdom, phylum, class, order, family, genus, species), including (NM - II.II.1.8):</p> <ul style="list-style-type: none"> • classification of an organism into a category, • similarity inferred from molecular structure (DNA) closely matching classification based on anatomical similarities, and • similarities of organisms reflecting evolutionary relationships. <p>9. Understands variation within and among species, including (NM - II.II.1.9):</p> <ul style="list-style-type: none"> • mutations and genetic drift, and • factors affecting the survival of an organism natural selection. 	<p>5, 13. Lab Ten: Physiology of The Circulatory System In this lab the student completes three components:</p> <ol style="list-style-type: none"> (a) The student learns how to measure blood pressure. (b) The student measures pulse rate under different conditions: standing, reclining, after the baroreceptor reflex, and during and immediately after exercise. The blood pressure and pulse rate are analyzed and related to an index of relative fitness. (c) The student measures the effect of temperature on the heart rate of the water flea, <i>Daphnia Magna</i>, or other organism. <ul style="list-style-type: none"> ✓ The ability to do the following: <ul style="list-style-type: none"> • measure heart rate and blood pressure in a human volunteer, • describe the effect of changing body position on heart rate and blood pressure, • explain how exercise changes heart rate, • determine a human's fitness index, • analyze cardiovascular data collected by the entire class, and • discuss and explain the relationship between heart rate and temperature. <p>7. The student writes a poem or song explaining photosynthesis concepts.</p> <ul style="list-style-type: none"> ✓ observation of teacher guidelines for poem or song format ✓ correct information pertaining to concepts ✓ understanding of concepts in the context of song or poem <p>8. The student classifies items from a grocery store, music store, or closet into a hierarchical scheme.</p> <ul style="list-style-type: none"> ✓ appropriate design of scheme ✓ correct classification ✓ evidence of understanding of hierarchical classification <p>9-12, 14, 28. Lab Seven: Genetics of Organisms: See Strand I, Illustration 1 - 6, 12 - 14, 16.</p> <p>9, 20, 21. Lab Eight: Population Genetics and Evolution: See Strand I, Illustration 5, 7, 11, 13.</p>

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>10. Knows how DNA carries all genetic information in the units of heredity called genes, including (NM - II.II.II.1):</p> <ul style="list-style-type: none"> • the structure of DNA (e.g., subunits A, G, C, T), • information-preserving replication of DNA, and • alteration of genes by inserting, deleting, or substituting parts of DNA. <p>11. Uses appropriate vocabulary to describe inheritable traits (i.e., genotype, phenotype) (NM - II.II.II.2).</p> <p>12. Explains the concepts of segregation, independent assortment, and dominant/recessive alleles (NM - II.II.II.3).</p> <p>13. Identifies traits that can and cannot be inherited (NM - II.II.II.4).</p> <p>14. Knows how genetic variability results from the recombination and mutation of genes, including (NM - II.II.II.5):</p> <ul style="list-style-type: none"> • sorting and recombination of genes in sexual reproduction results in a change in DNA that is passed on to offspring, and • radiation or chemical substances can cause mutations in cells, resulting in a permanent change in DNA. <p>15. Understands the principles of sexual and asexual reproduction, including meiosis and mitosis (NM - II.II.II.6).</p> <p>16. Knows that most cells in the human body contain 23 pairs of chromosomes including one pair that determines sex and that human females have two X chromosomes and human males have an X and a Y chromosome (NM - II.II.II.7).</p>	<p>15,16. Lab Three: Mitosis and Meiosis</p> <p>In this lab the student investigates the processes of mitosis and meiosis:</p> <p>(a) The student uses prepared slides of onion root tips to study plant mitosis and to calculate the relative duration of the phases of mitosis in the meristem of root tissue. He/She may use prepared slides of the whitefish blastula to study mitosis in animal cells and to compare animal mitosis with plant mitosis.</p> <p>(b) The student simulates the states of meiosis by using chromosome models. He/She studies the crossing over and recombination that occurs during meiosis. The student observes the arrangements of ascospores in the asci from a cross between wild type <i>Sordaria Fimicola</i> and mutants for tan spore coat color in this fungus. The student uses these arrangements to estimate the percentage of crossing over that occurs between the centromere and the gene that controls the tan spore color.</p>

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>17. Describes the evidence for the first appearance of life on Earth as one-celled organisms, over 3.5 billion years ago, and for the later appearance of a diversity of multicellular organisms over millions of years (NM - II.II.II.8).</p> <p>18. Critically analyzes the data and observations supporting the conclusion that the species living on Earth today are related by descent from the ancestral one-celled organisms (NM – II.II.II.9).</p> <p>19. Understands the data, observations, and logic supporting the conclusion that species today evolved from earlier, distinctly different species, originating from the ancestral one-celled organisms (NM - II.II.II.10).</p> <p>20. Understands that evolution is a consequence of many factors, including the ability of organisms to reproduce, genetic variability, the effect of limited resources, and natural selection (NM - II.II.II.11).</p> <p>21. Explains how natural selection favors individuals who are better able to survive, reproduce, and leave offspring (NM - II.II.II.12).</p>	<p>✓ The ability to do the following:</p> <ul style="list-style-type: none"> • recognize the stages of mitosis in a plant or animal cell, • calculate the relative duration of the cell cycle stages, • describe how independent assortment and crossing over can generate genetic variation among the products of meiosis, • use chromosome models to demonstrate the activity of chromosomes during meiosis and mitosis, • relate chromosome activity to Mendel's laws of segregation and independent assortment, • demonstrate the role of meiosis in the formation of gametes or spores in a controlled experiment using an organism of students choice, • calculate the map distance of a particular gene from a chromosome's centromere or between two genes using an organism of students choice, • compare and contrast the results of meiosis and mitosis in plant cells, and • contrast the result of meiosis and mitosis in animal cells. <p>17-19. In groups the student works to complete a chart that runs from 4.6 billion years in the past to present day. The student shows different representative organisms that have evolved at each time interval. He/She then writes what similarities and differences more recent organisms have with ancestral species.</p> <ul style="list-style-type: none"> ✓ accurate evidence of organisms ✓ correct analysis of data that supports a conclusion ✓ use of writing conventions

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>22. Analyzes how evolution by natural selection and other mechanisms explains many phenomena including the fossil record of ancient life forms and similarities (both physical and molecular) among different species (NM - II.II.II.13).</p> <p>23. Knows that cells are made of proteins composed of combinations of amino acids (NM - II.II.III.1).</p> <p>24. Knows that specialized structures inside cells in most organisms carry out different functions, including (NM - II.II.III.2):</p> <ul style="list-style-type: none"> • parts of a cell and their functions (e.g., nucleus, chromosomes, plasma, and mitochondria), • storage of genetic material in DNA, • similarities and differences between plant and animal cells, and • prokaryotic and eukaryotic cells. <p>25. Describes the mechanisms for cellular processes (e.g., energy production and storage, transport of molecules, waste disposal, synthesis of new molecules) (NM – II.II.III.3).</p> <p>26. Knows how the cell membrane controls which ions and molecules enter and leave the cell based on membrane permeability and transport (i.e., osmosis, diffusion, active transport, passive transport) (NM - II.II.III.4).</p> <p>27. Explains how cells differentiate and specialize during the growth of an organism, including (NM - II.II.III.5):</p> <ul style="list-style-type: none"> • differentiation, regulated through the selected expression of different genes, and • specialized cells, response to stimuli (e.g., nerve cells, sense organs). 	<p>22, 23. Using illustrations of various types of dinosaurs/ancient life forms, the student identifies specialized adaptations of each type. In full group discussions the student considers why so many variations existed, what they all had in common with one another, and what happened to them and why.</p> <ul style="list-style-type: none"> ✓ correct identification of dinosaurs/ancient life forms ✓ accurate analysis of variations ✓ understanding of the concept of evolution <p>24, 26, 29. Lab Nine: Transpiration In this lab the student:</p> <ol style="list-style-type: none"> (a) applies what he/she learned about water potential from Lab One: diffusion and osmosis to the movement of water within the plant, (b) measures transpiration under different lab conditions, and (c) studies the organization of the plant stem and leaf as it relates to these processes by observing sections of tissue. <ul style="list-style-type: none"> ✓ The ability to do the following: <ul style="list-style-type: none"> • test the effects of an environmental variable on rates of transpiration using a controlled experiment, and • make thin sections of stem to identify xylem and phloem cells and relate the function of these vascular tissues to the structures of their cells. <p>25, 26, 29. Lab Two: Enzyme Catalysis The student observes the conversion of hydrogen peroxide (H₂O₂) to water and oxygen gas by the enzyme catalase, measures the amount of oxygen generated, and calculates the rate of the enzyme-catalyzed reaction.</p> <ul style="list-style-type: none"> ✓ The ability to do the following: <ul style="list-style-type: none"> • measure the effects of changes in temperature, pH, enzyme concentration and substrate concentration on reaction rates of an enzyme-catalyzed reaction in a controlled experiment, and • explain how environmental factors affect the rate of enzyme-catalyzed reactions. <p>27. The student researches and describes teratogenic effects of social drugs on different embryologic tissues at various times in development and presents the findings to the class.</p> <ul style="list-style-type: none"> ✓ observation of guidelines for scientific research ✓ presentation of findings in an appropriate scientific format ✓ writing conventions ✓ presentation techniques

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>28. Knows that DNA directs protein building (e.g., role of RNA) (NM - II.II.III.6).</p> <p>29. Describes how most cell functions involve chemical reactions, including (NM - II.II.III.7):</p> <ul style="list-style-type: none"> • promotion or inhibition of biochemical reactions by enzymes, • processes of respiration (e.g., energy production, ATP), and • communication from cell to cell by secretion of a variety of chemicals (e.g., hormones). 	<p>NOTE: The following labs can also be used for many of the performance standards presented in this strand:</p> <p>Lab Four: Plant Pigments and Photosynthesis Lab Five: Cell Respiration Lab Six: Molecular Biology Lab Seven: Genetics of Organisms Lab Eleven: Animal Behavior Lab Twelve: Dissolved Oxygen and Aquatic Primary Productivity</p> <p>Complete information and instruction guidelines for each lab can be found in <i>Biology Lab Manual For Students</i> provided by the College Board AP[®] Advanced Placement Program.</p>

STRAND III: THE CONTENT OF SCIENCE-EARTH AND SPACE**CONTENT STANDARD:** The student understands the structure of Earth, the solar system, and the universe, the interconnections among them, and the processes and interactions of Earth's systems.**BENCHMARK:** The student examines the scientific theories of the origin, structure, energy, and evolution of Earth and its atmosphere, and their interconnections.

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<ol style="list-style-type: none">1. Describes the characteristics and the evolution of Earth in terms of the atmosphere and the biosphere (NM - II.III.II.1).2. Understands the changes in Earth's past and the investigative methods used to determine geologic time, including (NM - II.III.II.4):<ul style="list-style-type: none">• rock sequences, relative dating, fossil correlation, and radiometric dating, and• geologic time scales, historic changes in life forms, and the evidence for absolute ages (e.g., radiometric methods, tree rings, paleomagnetism).3. Knows that Earth's systems are driven by external (i.e., the sun) sources of energy (NM - II.III.II.6).4. Describes the patterns and relationships in the circulation of air and water driven by the sun's radiant energy, including global climate, global warming, and the greenhouse effect (NM - II.III.II.8).5. Knows that Earth's system contains a fixed amount of natural resources that cycle among land, water, the atmosphere, and living things (e.g., carbon and nitrogen cycles, rock cycle, water cycle, ground water, aquifers) (NM - II.III.II.9).6. Explains how layers of the atmosphere (e.g., ozone, ionosphere) change naturally and artificially (NM - II.III.II.11).	<ol style="list-style-type: none">1. The student makes a model of the four layers of Earth's atmosphere that represents the characteristics of each layer and describes each.<ul style="list-style-type: none">✓ accuracy and detail of model✓ correct identification and information about each layer2. The student conducts a general search of the eras on the geologic timetable and looks for individual events that occurred during each era. He/She determines if these events were placed in time by relative or absolute dating or both, providing justification for each. The student organizes these events into a geologic timetable of his/her own.<ul style="list-style-type: none">✓ correct information on geologic eras✓ appropriate design and correct information of geologic timetable✓ citation of sources3, 5. Lab Twelve: Dissolved Oxygen and Aquatic Primary Productivity: See Strand II, Illustration 2-4, 6.4, 5. The student researches sources of atmospheric carbon dioxide. He/She calculates the amount of carbon dioxide he/she produces (carbon footprint) using information from the website www.carbonfootprint.com. He/She then chooses three ways that he/she can reduce his/her carbon footprint.4, 6. The student researches whether global warming exists, supports his/her argument with evidence, and participates in classroom debate to deliberate it. The student in an essay presents and supports his/her conclusions after considering all the points contributed in the debate.<ul style="list-style-type: none">✓ research tools and procedures✓ citation of sources

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>7. Explains how the availability of ground water through aquifers can fluctuate based on multiple factors (i.e., rate of use, rate of replenishment, surface changes, and changes in temperature) (NM - II.III.II.12).</p>	<ul style="list-style-type: none"> ✓ participation in debate ✓ supporting quotes and information ✓ effective elements of writing <p>7. The student predicts how water moves through gravel, sand, and clay and then tests his/her hypothesis by placing gravel, sand, and clay in the three soda bottles or plastic cups. The material should fill the containers to a depth of about 8 cm. The student looks closely at each container using a hand-held magnifying glass. To demonstrate how groundwater moves through underground rock formations, the student pours about 120 to 240 ml of water into each container and discusses the results. Which container emptied the fastest? Which emptied the slowest? How would different materials influence water in movement of natural systems?</p> <ul style="list-style-type: none"> ✓ participation in and use of scientific investigation ✓ correct response to questions

STRAND IV: THE CONTENT OF PHYSICAL SCIENCE**CONTENT STANDARD:** The student understands the structure and properties of matter, the characteristics of energy, and the interactions between matter and energy.**BENCHMARKS:** A. The student understands the properties, underlying structure, and reactions of matter.

B. The student understands the transformation and transmission of energy and how energy and matter interact.

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<ol style="list-style-type: none">1. Classifies matter in a variety of ways (e.g., element, compound, mixture, solid, liquid, gas, acidic, basic, neutral) (NM - II.I.1).2. Identifies, measures, and uses a variety of physical and chemical properties (e.g., electrical conductivity, density, viscosity, chemical reactivity, pH, melting point) (NM - II.I.2).3. Knows how to use properties to separate mixtures into pure substances (e.g., distillation, chromatography, solubility) (NM – II.I.3).	<ol style="list-style-type: none">1. The student uses universal pH indicator paper to classify household substances as acidic, basic or neutral. ✓ correct classification2, 8, 14. Lab Six: Molecular Biology In this lab the student investigates some basic principles of molecular biology:<ol style="list-style-type: none">(a) Plasmids containing specific fragments of foreign DNA are used to transform <i>Escherichia Coli</i> cells, conferring antibiotic (ampicillin) resistance.(b) Restriction enzyme digests of phage <i>Lambda</i> DNA are used to demonstrate techniques for separating and identifying DNA fragments using gel electrophoresis. ✓ The ability to do the following:<ul style="list-style-type: none">• use plasmids as vectors to transform bacteria with a gene for antibiotic resistance in a controlled experiment,• demonstrate how restriction enzymes are used in genetic engineering,• use electrophoresis to separate DNA fragments,• describe the biological process of transformation in bacteria,• calculate transformation efficiency,• be able to use multiple experimental controls to design a procedure to select positively for antibiotic-resistant transformed cells, and• determine unknown DNA fragment sizes when given DNA fragments of known size.3-5, 12-15, 17, 19, 22. Lab Four: Plant Pigments and Photosynthesis In this lab the student completes two tasks. The student separates plant pigments using chromatography and measures the rate of photosynthesis

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>4. Understands that matter is made of atoms and that atoms are made of subatomic particles (NM - II.I.5).</p> <p>5. Understands atomic structure, including (NM - II.I.6):</p> <ul style="list-style-type: none"> • most space occupied by electrons, • nucleus made of protons and neutrons, and • isotopes of an element. <p>6. Explains how electrons determine the properties of substances by (NM - II.I.7):</p> <ul style="list-style-type: none"> • interactions between atoms through transferring or sharing valence electrons, • ionic and covalent bonds, and • the ability of carbon to form a diverse array of organic structures. <p>7. Makes predictions about elements using the periodic table (e.g., number of valence electrons, metallic character, reactivity, conductivity, type of bond between elements) (NM - II.I.8).</p> <p>8. Understands how the type and arrangement of atoms and their bonds determine macroscopic properties (e.g., boiling point, electrical conductivity, hardness of minerals) (NM - II.I.9).</p> <p>9. Knows that states of matter (i.e., solid, liquid, gas) depend on the arrangement of atoms and molecules and on their freedom of motion (NM - II.I.10).</p> <p>10. Knows that some atomic nuclei can change, including (NM - II.I.11):</p>	<p>in isolated chloroplasts using the dye DPIP. The transfer of electrons during the light-dependent reactions of photosynthesis reduces DPIP, changing it from blue to colorless.</p> <ul style="list-style-type: none"> ✓ The ability to do the following: <ul style="list-style-type: none"> • separate pigments and calculate their r_f values, • describe a technique to determine photosynthetic rates, • compare photosynthetic rates at different light intensities or different wavelengths of light using controlled experiments, and • explain why the rate of photosynthesis varies under different environmental conditions. <p>5. The student draws various representations of atoms such as the Bohr model or Lewis dot structures.</p> <ul style="list-style-type: none"> ✓ correct representation ✓ methodical drawings <p>6. The student works in groups to compose a newspaper about various organic macromolecules including lipids, proteins, and carbohydrates. In the newspaper the student explains the formation and decomposition, importance, and use in the body of each type of compound.</p> <ul style="list-style-type: none"> ✓ demonstration of understanding and explaining of scientific concepts ✓ explanation of concepts in succinct writing style (e.g., article) ✓ writing conventions <p>7. The student finds electronegativity values on the periodic table for various elements and makes predictions as to the type of bonds they will form with other elements.</p> <ul style="list-style-type: none"> ✓ correct interpretation of periodic table ✓ correct values ✓ predictions based on evidence <p>9. The student draws water molecules in different phases of matter, being sure to show what effect hydrogen bonding has on the arrangement and freedom of motion.</p> <ul style="list-style-type: none"> ✓ accurate and neat drawings ✓ attached explanation of effect to each drawing <p>10. The student uses half-life calculations to determine absolute dating of</p>

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<ul style="list-style-type: none"> • spontaneous decay, and • half-life of isotopes. <p>11. Knows that chemical reactions involve the rearrangement of atoms and that they occur on many timescales (e.g., picoseconds to millennia) (NM - II.I.I.12).</p> <p>12. Understands types of chemical reactions (e.g., synthesis, decomposition, combustion, redox, neutralization) and identifies them as exothermic or endothermic (NM - II.I.I.13).</p> <p>13. Knows how to express chemical reactions with balanced equations that show (NM - II.I.I.14):</p> <ul style="list-style-type: none"> • conservation of mass, and • products of common reactions. <p>14. Describes how the rate of chemical reactions depends on many factors that include temperature, concentration, and the presence of catalysts (NM - II.I.I.15).</p> <p>15. Identifies different forms of energy, including kinetic, gravitational (potential), chemical, thermal, nuclear, and electromagnetic (NM - II.I.II.1).</p> <p>16. Explains how thermal energy (heat) consists of the random motion and vibrations of atoms and molecules and is measured by temperature (NM - II.I.II.2).</p> <p>17. Understands that energy can change from one form to another (e.g., changes in kinetic and potential energy in a gravitational field, heats of reaction, hydroelectric dams) and knows that energy is conserved in these changes (NM - II.I.II.3).</p> <p>18. Explains how heat flows in terms of the transfer of vibrational motion of atoms and molecules from hotter to colder regions (NM - II.I.II.5).</p> <p>19. Describes the characteristics of electromagnetic waves (e.g., visible light, radio, microwave, X-ray, ultraviolet, gamma) (NM - II.I.II.8):</p> <ul style="list-style-type: none"> • energy of electromagnetic waves carried in discrete energy packets (photons) whose energy is inversely proportional to wavelength. 	<p>various organic specimens.</p> <ul style="list-style-type: none"> ✓ correct calculations <p>11 – 15, 17, 21. Lab Five: Cell Respiration</p> <p>In this experiment the student works with seeds that are living but dormant. A seed contains an embryo plant and a food supply surrounded by a seed coat. When the necessary conditions are met, germination occurs and the rate of cellular respiration greatly increases. In this lab the student measures the following:</p> <ol style="list-style-type: none"> (a) oxygen consumption during germination, (b) the change in gas volume in respirometers containing either germinating or nongerminating pea seeds, and (c) the rate of respiration of these peas at two different temperatures. <ul style="list-style-type: none"> ✓ The ability to do the following: <ul style="list-style-type: none"> • calculate the rate of cell respiration from experimental data, • relate gas production to respiration rate, • test the rate of cellular respiration in germinating versus nongerminating seeds in a controlled experiment, and • test the effect of temperature on the rate of cell respiration in germinating versus nongerminating seeds in a controlled experiment. <p>16, 20. See Lab Two: Enzyme Catalysis: Strand II, Illustration 25, 26, 29.</p> <p>18. The student participates in an interactive lecture about kinetic energy and responds to a question and answer period directed by the teacher.</p> <ul style="list-style-type: none"> ✓ note-taking techniques ✓ participation in interactive lecture and discussion ✓ demonstration of understanding the scientific concepts involved in the lecture

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>20. Understands the concept of equilibrium (i.e., thermal, mechanical, and chemical) (NM - II.I.II.11).</p> <p>21. Understands that the ability of energy to do something useful (work) tends to decrease (and never increases) as energy is converted from one form to another (NM - II.I.II.6).</p> <p>22. Understands that electromagnetic waves carry energy that can be transferred when they interact with matter (NM - II.I.II.7).</p> <p>23. Knows that materials containing equal amounts of positive and negative charges are electrically neutral, but a small excess or deficit of negative charges produces significant electrical forces (NM - II.I.III.3).</p>	<p>23. Lab Seven: Genetics of Organisms: See Strand I, Illustration 1-7, 12-14, 16.</p> <p>NOTE: The following labs can also be used for many of the performance standards presented in this strand: Lab Ten: Physiology of The Circulatory System Lab Twelve: Dissolved Oxygen and Aquatic Primary Productivity</p> <p>Complete information and instruction guidelines for each lab can be found in <i>Biology Lab Manual For Students</i> provided by the College Board AP[®] Advanced Placement Program[®].</p>

STRAND V: SCIENCE AND SOCIETY**CONTENT STANDARD:** The student understands how scientific discoveries, inventions, practices, and knowledge influence and are influenced by individuals and societies.**BENCHMARK:** The student examines and analyzes how scientific discoveries and their applications affect the world and explains how societies influence scientific investigations and applications.

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<ol style="list-style-type: none">1. Knows how science enables technology but also constrains it, and recognizes the difference between real technology and science fiction (e.g., rockets vs. antigravity machines; nuclear reactors vs. perpetual-motion machines; medical X-rays vs. Star-Trek tricorders) (NM - III.I.1).2. Understands how advances in technology enable further advances in science (e.g., microscopes and cellular structure; telescopes and understanding of the universe) (NM - III.I.2).3. Evaluates the influences of technology on society (e.g., communications, petroleum, transportation, nuclear energy, computers, medicine, genetic engineering) including both desired and undesired effects, and including some historical examples (e.g., the wheel, the plow, the printing press, the lightning rod) (NM - III.I.3).4. Understands the scientific foundations of common technologies (e.g., kitchen appliances, radio, television, aircraft, rockets, computers, medical X-rays, selective breeding, fertilizers and pesticides, agricultural equipment) (NM - III.I.4).5. Understands that applications of genetics can meet human needs and can create new problems (e.g., agriculture, medicine, cloning) (NM - III.I.5).6. Analyzes the impact of digital technologies on the availability, creation, and dissemination of information (NM - III.I.6).7. Describes how human activities have affected ozone in the upper atmosphere and how it affects health and the environment (NM - III.I.7).	<p>1-3, 5, 6, 11, 14, 15, 17, 18. Lab Six: Molecular Biology: See Strand IV, Illustration 2, 8, 14.</p> <p>1, 3, 4, 9, 14, 16, 18. Lab Ten: Physiology of The Circulatory System: See Strand II, Illustration 5, 13.</p> <p>7. The student participates in a brainstorming session on what human activities have affected the ozone and how each activity affects the health of organisms and the environment. The student chooses one activity and suggests ways he/she and the fellow members of the class can reduce the use of the activity. The student presents these suggestions (e.g., poster board, PowerPoint presentation).</p>

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>8. Describes uses of radioactivity (e.g., nuclear power, nuclear medicine, radiometric dating) (NM - III.I.8).</p> <p>9. Describes how scientific knowledge helps decision makers with local, national, and global challenges [e.g., Waste Isolation Pilot Project (WIPP), mining, drought, population growth, alternative energy, climate change] (NM - III.I.9).</p> <p>10. Describes major historical changes in scientific perspectives (e.g., atomic theory, germs, cosmology, relativity, plate tectonics, evolution) and the experimental observations that triggered them (NM - III.I.10).</p> <p>11. Knows that societal factors can promote or constrain scientific discovery (e.g., government funding, laws and regulations about human cloning and genetically modified organisms, gender and ethnic bias, AIDS research, alternative-energy research) (NM - III.I.11).</p> <p>12. Explains how societies can change ecosystems and how these changes can be reversible or irreversible (NM - III.I.12).</p> <p>13. Describes how environmental, economic, and political interests impact resource management and use in New Mexico (NM - III.I.13).</p> <p>14. Identifies how science has produced knowledge that is relevant to individual health and material prosperity (NM - III.I.15).</p> <p>15. Understands that reasonable people may disagree about some issues that</p>	<ul style="list-style-type: none"> ✓ participation in class discussion ✓ accurate information on human causes of ozone depletion ✓ appropriate suggestions to lessen effects ✓ accurate poster design or PowerPoint presentation <p>8. The student uses half-life calculations to determine absolute dating of various organic specimens.</p> <ul style="list-style-type: none"> ✓ correct calculations <p>9. Student views the movie An Inconvenient Truth or Global Dimming (NOVA) and participates in a discussion about how information impacts local and national decisions.</p> <ul style="list-style-type: none"> ✓ participation in class discussion ✓ accurate information on human causes of global warming ✓ appropriate suggestions to lessen effects <p>10, 12. Lab Eight: Population Genetics and Evolution: See Strand I, Illustration 5, 7, 11, 13.</p> <p>11. The student views Cloning (National Geographic) or other video about current topics in scientific research. He/She researches current controversial scientific topics and write a short report about the topic. He/She studies the underlying scientific principles of the topic, and gathers evidence for and against the research. The student then writes his/her opinion about the topic, supporting his/her view with information from the research. The student then participates in a debate presenting information either supporting or against the research topic.</p> <p>12, 13, 15, 16, 18. Lab Twelve: Dissolved Oxygen and Aquatic Primary Productivity: See Strand II, Illustration 2-4, 6.</p> <p>NOTE: The following labs can also be used for many of the performance standards presented in this strand: Lab Two: Enzyme Catalysis Lab Three: Mitosis And Meiosis Lab Seven: Genetics Of Organisms Lab Nine: Transpiration Lab Eleven: Animal Behavior</p> <p>Complete information and instruction guidelines for each lab can be found</p>

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>are of interest to both science and religion (e.g., the origin of life on Earth, the cause of the Big Bang, the future of Earth) (NM - III.I.16).</p> <p>16. Identifies important questions that science cannot answer (e.g., questions that are beyond today's science, decisions that science can only help to make, questions that are inherently outside of the realm of science) (NM - III.I.17).</p> <p>17. Understands that scientists have characteristics in common with other individuals (e.g., employment and career needs, curiosity, desire to perform public service, greed, preconceptions and biases, temptation to be unethical, core values including honesty and openness) (NM - III.I.18).</p> <p>18. Knows that science plays a role in many different kinds of careers and activities (e.g., public service, volunteers, public office holders, researchers, teachers, doctors, nurses, technicians, farmers, ranchers) (NM - III.I.19).</p>	<p>in <i>Biology Lab Manual For Students</i> provided by the College Board AP[®] Advanced Placement Program[®].</p>

STRAND VI: LITERACY**CONTENT STANDARD:** The student communicates biological principles through reading, writing, and speaking opportunities.**BENCHMARK:** The student demonstrates proficiency in reading comprehension, specialized vocabulary, and a variety of writing and speaking requirements.

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>1. Develops and demonstrates proficiency with the following strategies to approach reading for information across content areas (APSLA I.1):</p> <ul style="list-style-type: none"> • scans reading selection to determine whether a text contains relevant information, • uses the headings and subheadings of the material to make predictions and to validate comprehension of text, • reads and rereads to decode meaning, and • reviews and summarizes essential elements of text for overview. <p>2. Identifies and uses roots, prefixes, and suffixes to determine meaning of words (APSLA I.4).</p> <p>3. Uses textual evidence to develop and support an interpretation of a scientific process or concept (APSLA II.2).</p> <p>4. Develops increased competence in using the writing process to create a final product (APSLA III.1).</p>	<p>1, 3, 4-8. The student analyzes lab results and communicates them in an accurate and effective manner. The student accomplishes this by constructing a reasoned argument, careful and logical writing, and using charts and graphs. In the discussion the student includes other plausible explanations, but he/she clearly identifies and supports the best explanation of the observed results. Other components of the lab report might include an explanation of the statistical analysis, an oral presentation, and the appropriate responses to critical questions. The student responds to discussion questions meant to stimulate and direct dialogue about a topic or concept.</p> <ul style="list-style-type: none"> ✓ speaking and writing conventions ✓ analytical skills ✓ accurate visual representations ✓ active participation in science activities <p>1, 2, 4-6. The student selects a variety of scientific magazines and journals, reads a variety of articles on a common topic, summarizes each, and provides an opinion following a magazine/journal review format provided by the teacher.</p> <ul style="list-style-type: none"> ✓ writing conventions ✓ citation of source (e.g., name of source, date or volume, title of article, page number) ✓ well-developed opinion with supporting facts <p>2. The student maintains a vocabulary list that includes the word, its etymology, the prefixes, suffixes, and definition.</p> <ul style="list-style-type: none"> ✓ completion of vocabulary note with required information <p>3. See Strand II, Illustration set 17-19.</p>

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>5. Develops increased competence in using elements of effective writing (APSLA III.2).</p> <p>6. Supports an informed opinion (APSLA III.6):</p> <ul style="list-style-type: none"> • uses appropriate language, reasoning, and organizational structure for the audience and purpose, • provides relevant and convincing reasons, uses various types of evidence, and • demonstrates an awareness of possible questions, concerns, or counterarguments. <p>7. Responds to a variety of written, electronic, and other media (APSLA III.7).</p> <p>8. Develops increased competence with speaking and language conventions (APSLA IV.3).</p>	<p>7. The student uses appropriate technology to aid in the collection, analysis, and presentation of data. The student uses computers and spreadsheets to organize the raw data and summarizes it by using statistical analysis. He/She produces graphs and charts that clearly and concisely communicate the results.</p> <ul style="list-style-type: none"> ✓ demonstration of technology skills ✓ correct responses to activities appropriate to the assignments <p>1-8. The student designs and conducts an investigation by doing the following:</p> <ul style="list-style-type: none"> • defining the problem, • designing an experiment, • identifying constants and variables (independent and dependent), • developing a control group, and • using repeated trials in the experimental design. <p>✓ correct use of investigation procedures</p>