

# APS DISTRICT HIGH SCHOOL SCIENCE CURRICULUM FRAMEWORK

Course Title: Microbiology CEC Course Number: SEE BELOW

Department: Science ADS Number: SEE BELOW

Prerequisites: Successful completion of one credit each of Biology and Chemistry or their alternatives

Length of Course: One Year Credit/PRI Area: 1.0/1.5 per Sem/Elective Grade Level(s): 11-12

## COURSE AND ADS NUMBERS:

Microbiology (1 credit per semester) 442C2 17144944

Microbiology (1.5 credit per semester) 442C3 17144944

## Important Notes:

*A course that provides more than .5 credits per semester allows the student additional opportunities for in-depth study and application of the course content. The student's time is divided into approximately 40% time in mentorship activities and 60% class time. The student must provide his/her own transportation to the mentorship site and have a signed parent permission form to participate in this program. A typical schedule for this class (442C2) is five hours a week at the mentorship site and 7.5 hours a week of classroom time. The student's instructor and workplace mentor takes an active role in facilitating the student's mentorship work experience.*

**COURSE DESCRIPTION:** This laboratory course\* is designed to provide the student with the necessary skills to pursue a career in medicine or biotechnology. This course encompasses theory and new developments in microbial pathogenesis, microbial genetics, virology, evolution of disease, manipulation of genetic material, biotechnology, and biochemistry. The student develops laboratory techniques in all phases of microbiology commensurate with a college microbiology course. He/She utilizes the latest technology to create digital microbiological photographs and identify unknown bacterial organisms. The student completes a United States Medical Licensing Examination (USMLE) in pathogenic microbiology, creates a microbiology based Webquest, and presents (e.g., PowerPoint) on his/her mentorship experience. He/She integrates literacy strategies (e.g., reading, writing, research) throughout the curriculum.

- 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 align with the State of New Mexico Science Standards (NM), the New Mexico Career Readiness Standards (NM – CR), 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 microbiology science teachers in the Albuquerque Public Schools (APS).

**ASSESSMENTS:**

Assessments may include the following: authentic and performance-based assessment, cooperative learning, teacher observations, checklists, tests and exams, formal and informal writing, small group and full class discussions, oral and multimedia presentations, projects, demonstrations, and portfolios. Assessments are based on appropriate rubrics.

**SUGGESTED TEXTBOOKS AND INSTRUCTIONAL MATERIALS:**

- Current state adopted science textbooks
- Supplementary materials
- Microscopes
- Computers and computer software
- *Microbiology – An Introduction* – Tortura/Funke/Case – Addison Wesley Longman – 2001
- *Laboratory Experiments in Microbiology* – Johnson/Case – Benjamin Cummings – 2001
- *How the Immune System Works* – Sompayrac, Lauren – Blackwell Science – 1999
- *Molecular Model Set for Organic Chemistry* – Prentice Hall – 1984
- *Bad Blood – The Tuskegee Syphilis Experiment* – Jones, James H. – Free Press – 1981
- *The Microbiology Coloring Book* – Elson, Lawrence M., PhD – Benjamin Cummings – 1996
- *Influenza 1918 – The Worst Epidemic in American History* – The American Experience
- *A Paralyzing Fear – The Story of Polio in America*

**SUGGESTED TITLES/AUTHORS WEB SITES:**

- <http://www.tulane.edu/~dmsander/garryfavweb.html>
- <http://www.asmtusa.org>
- <http://people.kuedu/~jbrown/bugs.html>
- <http://www.cde.gov/>
- <http://vm.cfsan.fdagov/mow/intro.html>
- <http://circuit.neb.com/fgn/wow/PARA-URL.HTM>
- <http://research.ucsb.edu/connect/pro/disease.html>
- <http://www.medscape.com>
- <http://www.medweb.emory.edu/MedWeb/>
- <http://www.merck.com/mediquiz/home.jsp>
- <http://www.cdc.gov>
- <http://www.nih.gov>
- <http://www.who.ch/>

Approved by HSCA: \_\_\_\_\_ 12/04 \_\_\_\_\_

**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.

<b>GRADE 11-12</b>	<b>PERFORMANCE STANDARDS</b>	<b>ILLUSTRATIONS</b>
	<ol style="list-style-type: none"> <li>1. Describes the essential components of an investigation, including appropriate methodologies, proper equipment, and safety precautions (NM – I.I.I.1).</li> <li>2. Designs and conducts scientific investigations that include (NM – I.I.I.2):               <ul style="list-style-type: none"> <li>• testable hypotheses,</li> <li>• controls and variables,</li> <li>• methods to collect, analyze, and interpret data,</li> <li>• results that address hypotheses being investigated,</li> <li>• predictions based on results,</li> <li>• re-evaluation of hypotheses and additional experimentation as necessary, and</li> <li>• error analysis.</li> </ul> </li> <li>3. Uses appropriate technologies to collect, analyze, and communicate scientific data (e.g., computers, calculators, balances, microscopes) (NM – I.I.I.3).</li> <li>4. Conveys results of investigations using scientific concepts, methodologies, and expressions, including (NM – I.I.I.4; APS MA IV.5E):               <ul style="list-style-type: none"> <li>• scientific language and symbols,</li> <li>• diagrams, charts, and other data displays,</li> <li>• mathematical expressions and processes (e.g., mean, median, slope, proportionality),</li> <li>• clear, logical, and concise communication, and</li> </ul> </li> </ol>	<p><b>NOTE: Illustrations include suggested activities for attaining each performance standard. A check (✓) refers to a key feature to look for while assessing student performance.</b></p> <p>1, 2, 4, 7. The student is given an unknown bacterial culture and using the scientific method identifies the culture, determines its morphologic and structural characteristics and reports the results using the standard laboratory format.</p> <ul style="list-style-type: none"> <li>✓ appropriate use of equipment</li> <li>✓ safety practices</li> <li>✓ quality control components</li> <li>✓ completion of all required tasks</li> <li>✓ organization of data</li> <li>✓ analysis</li> </ul> <p>3, 8, 11. The student delivers a presentation (e.g., PowerPoint, paper) based on his/her mentorship experience. The student includes a description of responsibilities, site, time spent, scientific connections, and other interesting aspects of the experience. The student also produces a Web Quest (e.g., Bernie Dodge) based on what he/she is studying. He/She lists resources and engages the other students in problem-solving activities. The student is evaluated with a teacher-designed rubric.</p> <ul style="list-style-type: none"> <li>✓ use of technology</li> <li>✓ clear communication</li> <li>✓ representation of data</li> <li>✓ effective presentation</li> <li>✓ adherence to rubric</li> </ul>

<ul style="list-style-type: none"> <li>• reasoned arguments.</li> </ul> <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. Uses scientific reasoning and valid logic to recognize (NM – I.I.II.2):</p> <ul style="list-style-type: none"> <li>• faulty logic,</li> <li>• cause and effect,</li> <li>• the difference between observation and unsubstantiated inferences and conclusions, and</li> <li>• potential bias.</li> </ul> <p>7. Understands how new data and observations can result in new scientific knowledge (NM – I.I.II.3; APS – MA IV.1E).</p> <p>8. Critically analyzes an accepted explanation by reviewing current scientific knowledge (NM – I.I.II.4).</p> <p>9. Examines investigations of current interest in science (e.g., superconductivity, molecular machines, age of the universe). (NM – I.I.II.5).</p> <p>10. 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>11. Creates multiple displays of data to analyze and explain the relationships in scientific investigations (NM – I.I.III.1).</p>	<p>5. The student uses biochemical theories to predict interactions between microorganisms and humans. He/She elucidates immunology through broad biochemical theory.</p> <ul style="list-style-type: none"> <li>✓ clarification of theories</li> <li>✓ predictions/analysis</li> </ul> <p>6. Using teacher-provided case studies, the student researches a disease or syndrome of his/her choice and prepares a presentation (e.g., PowerPoint) for the class. The content includes the etiology of the disease or syndrome; all the signs and symptoms of the disease or syndrome; the biochemistry, microbiology, histology, and cellular processes of the disease or syndrome; normal prognosis of the disease; lab tests used to diagnose the disease or syndrome, including how the tests were performed; the normal values and the values observed in the case, and treatment of the patient, including how and why the treatment is given and the effectiveness of the treatment.</p> <ul style="list-style-type: none"> <li>✓ thorough research</li> <li>✓ all required components</li> <li>✓ analysis</li> <li>✓ effective presentation</li> <li>✓ clear communication</li> </ul> <p>8, 9. The student selects a current scientific topic of special interest to him/her and utilizes the URLs listed in the resources section (i.e., page 2) to produce a Web Quest.</p> <ul style="list-style-type: none"> <li>✓ thoroughness</li> <li>✓ technological skills</li> <li>✓ relevant topics</li> </ul> <p>10. The student participates in a variety of activities to learn about influenza and other viruses. He/She:</p> <ul style="list-style-type: none"> <li>• discusses and shares information about what he/she knows about diseases (e.g., influenza is the deadliest transmissible disease on a yearly basis, what is known about measles),</li> <li>• reads excerpts from Gina Kolata’s book, <i>The Flu</i>, which covers in detail the 1918 epidemic and the modern techniques that were used to investigate the strain that caused the outbreak,</li> <li>• views a video on influenza and takes notes. The information is used to create questions for a Jeopardy® format game that follows after the completion of this unit, and       <ul style="list-style-type: none"> <li>• develops and plays in teams the Jeopardy® game with categories based on influenza and viruses.</li> </ul> </li> </ul>
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	<p>12. 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>13. Identifies and applies measurement techniques and considers possible effects of measurement errors (NM – I.I.III.4).</p>	<ul style="list-style-type: none"> <li>✓ listening skills</li> <li>✓ note taking</li> <li>✓ active participation in discussions</li> <li>✓ cooperation/teamwork</li> </ul> <p>12, 13. The student uses the Biotechnologist software program to analyze and interpret electrophoresis data and presents the results visually (e.g., graphs, illustrations, or models).</p> <ul style="list-style-type: none"> <li>✓ use of technology</li> <li>✓ analysis</li> <li>✓ visual presentation of data</li> <li>✓ effective presentation</li> </ul>
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**STRAND II: CONTENT OF SCIENCE – PHYSICAL SCIENCE****CONTENT STANDARD:** The student understands the structure and properties of matter, the characteristics of energy, and the interactions between matter and energy.**BENCHMARK:** The student understands the properties, underlying structure, and reactions of matter.

<b>GRADE 11-12</b>	<b>PERFORMANCE STANDARDS</b>	<b>ILLUSTRATIONS</b>
	<ol style="list-style-type: none"><li>1. Classifies matter in a variety of ways (e.g., element, compound, mixture, solid, liquid, gas, acidic, basic, neutral) (NM – II.I.1).</li><li>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).</li><li>3. Knows how to use properties to separate mixtures into pure substances (e.g., distillation, chromatography, solubility) (NM – II.I.3).</li><li>4. Describes trends in properties (e.g., ionization energy or reactivity as a function of location on the periodic table, boiling point of organic liquids as a function of molecular weight) (NM – II.I.4).</li><li>5. Understands that matter is made of atoms and that atoms are made of subatomic particles (NM – II.I.5).</li><li>6. Understands atomic structure, including (NM – II.I.6):<ul style="list-style-type: none"><li>• most space occupied by electrons,</li><li>• nucleus made of protons and neutrons,</li><li>• isotopes of an element,</li><li>• masses of proton and neutron 2000 times greater than mass of electron, and</li><li>• atom held together by proton-electron electrical forces.</li></ul></li><li>7. Explains how electrons determine the properties of substances by (NM – II.I.7):<ul style="list-style-type: none"><li>• interactions between atoms through transferring or sharing valence electrons,</li><li>• ionic and covalent bonds, and</li><li>• the ability of carbon to form a diverse array of organic structures.</li></ul></li></ol>	<p>1 – 3, 12 – 15. The student reads the text and listens to lectures to learn basic biochemistry concepts relevant to living systems. He/She illustrates biochemical techniques (e.g., gel electrophoresis, chromatography, osmosis) through hands-on laboratory experiences.</p> <ul style="list-style-type: none"><li>✓ understanding of basic concepts</li><li>✓ individual participation</li><li>✓ standard laboratory procedures</li><li>✓ clear communication of ideas</li></ul> <p>4 – 10. The student studies the periodic table to illustrate covalent, ionic, and polar bonds along with trends and properties associated with the periodicity of the table. He/She is assessed through a variety of test formats (e.g., quiz, essay, multiple choice).</p> <ul style="list-style-type: none"><li>✓ understanding of properties, atomic structure, and states of matter</li><li>✓ analysis/insights</li><li>✓ accuracy</li></ul>

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>8. 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.I.8).</p> <p>9. 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.I.9).</p> <p>10. 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.I.10).</p> <p>11. Knows that some atomic nuclei can change, including (NM – II.I.I.11):</p> <ul style="list-style-type: none"> <li>• spontaneous decay,</li> <li>• half-life of isotopes,</li> <li>• fission,</li> <li>• fusion (e.g., the sun), and</li> <li>• alpha, beta, and gamma radiation.</li> </ul> <p>12. 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>13. 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>14. Knows how to express chemical reactions with balanced equations that show (NM – II.I.I.14):</p> <ul style="list-style-type: none"> <li>• conservation of mass, and</li> <li>• products of common reactions.</li> </ul> <p>15. 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>11. Through discussion and experimentation, the student is introduced to the concept of radioactivity. The student uses photographic plates generated by gel electrophoresis exposure.</p> <ul style="list-style-type: none"> <li>✓ active participation in discussions and experiments</li> <li>✓ comprehension of main ideas</li> <li>✓ proper use of equipment</li> <li>✓ safety standards</li> <li>✓ clear communication of ideas</li> </ul> <p>15. The student listens to lectures and views CD interactive disks to learn about enzyme kinematics. In either an oral or written format, he/she explains key ideas relevant to what was heard and viewed.</p> <ul style="list-style-type: none"> <li>✓ listening and viewing skills</li> <li>✓ effective communication</li> </ul>

**STRAND III: CONTENT OF SCIENCE – LIFE SCIENCE****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"> <li>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).</li> <li>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).</li> <li>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).</li> <li>4. Critically analyzes how humans modify and change ecosystems (e.g., harvesting, pollution, population growth, technology) (NM – II.II.1.4).</li> <li>5. Explains how matter and energy flow through biological systems (e.g., organisms, communities, ecosystems), 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).</li> <li>6. Describes how energy flows from the sun through plants to herbivores to carnivores and decomposers (NM – II.II.1.6).</li> <li>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).</li> <li>8. Understands and explains the hierarchical classification scheme (i.e., domain, kingdom, phylum, class, order, family, genus, species), including (NM – II.II.1.8): <ul style="list-style-type: none"> <li>• classification of an organism into a category,</li> <li>• similarity inferred from molecular structure (DNA) closely matching classification based on anatomical similarities, and</li> <li>• similarities of organisms reflecting evolutionary relationships.</li> </ul> </li> </ol>	<p>1 – 7. The student reads the book <i>Liaisons of Life</i> by Tom Wakeford. After reading the book, the student illustrates information regarding co-evolution of life on Earth, ecosystems, and the fluctuation of ecosystems over time. He/She also participates in discussions on trophic levels and ecological theory. Using the information learned, the student generates questions for a Jeopardy game and participates in teams in the game. He/She is also tested through standardized methods.</p> <ul style="list-style-type: none"> <li>✓ reading analysis</li> <li>✓ synthesis of information</li> <li>✓ active participation in activities</li> <li>✓ clear communication</li> <li>✓ appropriate questions</li> <li>✓ cooperation/team work</li> </ul> <p>Option: The student creates a Web Quest.</p> <p>8, 9. The student details the cladistics of the kingdom monera and discusses the relationships of prokaryotic, eukaryotic, and archeobacteria cells.</p> <ul style="list-style-type: none"> <li>✓ understanding (e.g., classifications, variations)</li> <li>✓ active participation in discussions</li> <li>✓ illustration of specific traits</li> <li>✓ comparisons and contrasts</li> <li>✓ clear communication</li> </ul>

<p>9. Understands variation within and among species, including (NM – II.II.9):</p> <ul style="list-style-type: none"> <li>• mutations and genetic drift, and</li> <li>• factors affecting the survival of an organism natural selection.</li> </ul> <p>10. Knows how DNA carries all genetic information in the units of heredity called genes, including (NM – II.II.1):</p> <ul style="list-style-type: none"> <li>• the structure of DNA (e.g., subunits A, G, C, T),</li> <li>• information-preserving replication of DNA, and</li> <li>• alteration of genes by inserting, deleting, or substituting parts of DNA.</li> </ul> <p>11. Uses appropriate vocabulary to describe inheritable traits (i.e., genotype, phenotype) (NM – II.II.2).</p> <p>12. Explains the concepts of segregation, independent assortment, and dominant/recessive alleles (NM – II.II.3).</p> <p>13. Identifies traits that can and cannot be inherited (NM – II.II.4).</p> <p>14. Knows how genetic variability results from the recombination and mutation of genes, including (NM – II.II.5):</p> <ul style="list-style-type: none"> <li>• sorting and recombination of genes in sexual reproduction results in a change in DNA that is passed on to offspring, and</li> <li>• radiation or chemical substances can cause mutations in cells, resulting in a permanent change in DNA.</li> </ul> <p>15. Understands the principles of sexual and asexual reproduction, including meiosis and mitosis (NM – 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.7).</p> <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.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.9).</p>	<p>10 – 16. The student views a two-hour video called <i>Cracking the Code of Life</i>. After the viewing, the student explains the overall mechanisms of DNA, biosynthesis, and replication. He/She participates in a variety of activities that allow a demonstration of his/her understanding of these concepts and clarifications of his/her own thinking regarding these concepts.</p> <ul style="list-style-type: none"> <li>• uses molecular models to construct proteins, RNA, and DNA,</li> <li>• discusses in detail the difference between prokaryotic and eukaryotic cells and genetic replication using the “one-gene, one-protein” hypothesis,</li> <li>• constructs with the class a six foot model of a DNA molecule ( A kit is used.),</li> <li>• conducts lab experiments on genetics and DNA, and</li> <li>• uses the influenza virus to illustrate the effects of mutations and deletion in living organisms.</li> </ul> <ul style="list-style-type: none"> <li>✓ viewing skills</li> <li>✓ clear communication</li> <li>✓ active participation in all activities</li> <li>✓ synthesis of information</li> <li>✓ accuracy of models</li> <li>✓ correct protein sequences</li> <li>✓ standard lab procedures</li> <li>✓ comparisons and contrasts</li> </ul> <p>17 – 22. The student reads <i>Dark Life</i> by Michael Ray Taylor which addresses the origin of life on Earth, the evolutionary relationship of bacteria, and how natural selection has affected and driven the biotic component of the Earth. The student demonstrates knowledge and understanding through classroom discussions, creating posters or other visuals relating life, and participating in a Jeopardy® format game.</p> <ul style="list-style-type: none"> <li>✓ reading analysis</li> <li>✓ individual participation in discussions</li> <li>✓ creativeness</li> </ul>
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	<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>22. Analyzes how evolution by natural selection and other mechanisms explains many phenomena including the fossil record of ancient life forms and similarities (e.g., 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"> <li>• parts of a cell and their functions (e.g., nucleus, chromosomes, plasma, and mitochondria),</li> <li>• storage of genetic material in DNA,</li> <li>• similarities and differences between plant and animal cells, and</li> <li>• prokaryotic and eukaryotic cells.</li> </ul> <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"> <li>• differentiation, regulated through the selected expression of different genes, and</li> <li>• specialized cells, response to stimuli (e.g., nerve cells, sense organs).</li> </ul>	<ul style="list-style-type: none"> <li>✓ visual representations</li> <li>✓ effective communication</li> <li>✓ appropriate and challenging questions</li> </ul> <p>23 – 29. The student learns about the structure and function of prokaryotic and eukaryotic cells. Using the <i>Microbiology Coloring Book</i>, the student produces drawings that illustrate the differences between these cells. Along with the drawings, the student reads required text chapters relative to the differences in these types of cells and takes the on-line tests recommended in the readings. The student utilizes disease mechanisms (e.g., cholera) to illustrate ionic intercellular transport.</p> <ul style="list-style-type: none"> <li>✓ visual representations</li> <li>✓ reading analysis</li> <li>✓ proficiency in assessments</li> <li>✓ effective communication</li> </ul> <p>See also illustration #17-25 in this strand and the first illustration in Strand II.</p>
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	<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"><li>• promotion or inhibition of biochemical reactions by enzymes,</li><li>• processes of respiration (e.g., energy production, ATP), and</li><li>• communication from cell to cell by secretion of a variety of chemicals (e.g., hormones).</li></ul>	
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**STRAND IV: SCIENCE IN 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"> <li>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.1.1).</li> <li>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.1.2).</li> <li>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.1.3).</li> <li>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.1.4).</li> <li>5. Understands that applications of genetics can meet human needs and can create new problems (e.g., agriculture, medicine, cloning) (NM – III.I.1.5).</li> <li>6. Analyzes the impact of digital technologies on the availability, creation, and dissemination of information NM – III.I.1.6).</li> </ol>	<ol style="list-style-type: none"> <li>1. The student views the movie <i>Outbreak</i> and compares and contrasts the validity of the information presented. The student produces a list of inaccuracies in the movie with an explanation for each on why he/she has chosen that item. <ul style="list-style-type: none"> <li>✓ observation skills</li> <li>✓ comparisons and contrasts</li> <li>✓ compilation of inaccuracies</li> <li>✓ support for position</li> </ul> </li> <li>2 – 4, 6. Through use of the Biotechnologist Software, the student describes the rapid technological advances possible in science. In addition, the student completes the seven lab exercises that go along with the text. The student follows standard lab procedures submitting lab write-ups which include his/her hypothesis, data, calculations, and conclusions. <ul style="list-style-type: none"> <li>✓ technology skills</li> <li>✓ specific examples</li> <li>✓ completion of all tasks</li> <li>✓ adherence to lab procedures</li> <li>✓ safety practices</li> <li>✓ effective communication</li> </ul> </li> <li>5. Through discussion the student shares the knowledge he/she already has regarding the applications of genetics. To build on this knowledge, the student views the Nova video <i>The Brain Eater</i> which illustrates how genetic manipulation leads to advances as well as detrimental effects in humans. After the viewing, the student writes a one-page interpretation paper on whether the aspects seen in the video are correct.</li> </ol>

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>7. Describes uses of radioactivity (e.g., nuclear power, nuclear medicine, radiometric dating) (NM – III.I.I.8).</p> <p>8. 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.I.10).</p> <p>9. 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.I.11).</p> <p>10. Explains how societies can change ecosystems and how these changes can be reversible or irreversible (NM – III.I.I.12).</p> <p>11. Identifies how science has produced knowledge that is relevant to individual health and material prosperity (NM – III.I.I.15).</p>	<ul style="list-style-type: none"> <li>✓ viewing skills</li> <li>✓ active participation in discussions</li> <li>✓ personal reflections</li> <li>✓ analysis</li> <li>✓ elements of effective writing</li> </ul> <p>7. See Strand II, the illustration for performance standard # 11.</p> <p>8. See Strand III, the illustration for performance standards # 10 – 16.</p> <p>9, 10. The student reads <i>Bad Blood – The Tuskegee Syphilis Experiment</i> by James H. Brown to learn how treatment or nontreatment of a disease can impact an individual. After reading the book, the student participates in a variety of ways (e.g., writing a paper, discussion) to exhibit an analysis and/or critique of the book.</p> <ul style="list-style-type: none"> <li>✓ reading analysis</li> <li>✓ defense of argument</li> <li>✓ societal issues</li> <li>✓ effective communication</li> </ul> <p>See also Strand III, the illustration for performance standards #10 – 16, specifically the influenza activity.</p> <p>11, 13. The student views a Frontline video entitled <i>Modern Meat</i>. The content of the video addresses how science is used to increase material property and introduces questions that science cannot answer. After the video the student discusses those unanswered questions, selects one to research further, and proposes possible solutions.</p> <ul style="list-style-type: none"> <li>✓ viewing skills</li> <li>✓ active participation in discussions</li> <li>✓ effective communication</li> <li>✓ thorough research</li> <li>✓ problem solving</li> </ul>

<b>GRADE 11-12</b>	<b>PERFORMANCE STANDARDS</b>	<b>ILLUSTRATIONS</b>
	<p>12. Understands that reasonable people may disagree about some issues that 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.I.16).</p> <p>13. 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.I.17).</p> <p>14. 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.I.18).</p> <p>15. 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.I.19).</p>	<p>12. Through lecture the student conceptualizes that biological systems are greater than the sum of their parts and how science is ultimately dependent upon faith. The student is evaluated through his/her willingness to participate in discussions that follow the lecture.</p> <ul style="list-style-type: none"> <li>✓ listening skills</li> <li>✓ active participation in discussions</li> </ul> <p>14, 15. Integrated consistently in the curriculum throughout the year is the career connection. Current textbooks interject the “real-life” aspect and applications in almost every chapter, and the instructor takes every opportunity to insert that in, whether it be through personal experiences or through questioning (e.g., What does a technician do? What is a phlebotomist?). The student talks about his personal career interest and explains where science is used in this career.</p> <p>See Strand I, illustration #3, 8, 11.</p>

**STRAND V: MENTORSHIP****CONTENT STANDARD:** The student gains an understanding of theory and new developments in the field of microbiology.**BENCHMARK:** The student examines and analyzes theories and clinical aspects of microbiology through hands-on mentorship experiences.

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<ol style="list-style-type: none"> <li>1. Analyzes and integrates positive behavior, conduct, and social manners within the school, workplace, and community (NM – CR 4A).</li> <li>2. Demonstrates ability to work cooperatively to accomplish objectives set by student mentor and instructor (NM – CR 4B).</li> <li>3. Demonstrates appropriate and legal behaviors necessary to obtain and maintain employment (NM – CR 4C).</li> <li>4. Applies safety standards related to the school, community, and workplace (NM – CR 4D).</li> <li>5. Demonstrates responsible behavior related to environmental concerns (NM – CR 4E).</li> <li>6. Exhibits ability to work with others from diverse backgrounds (NM – CR 5C).</li> <li>7. Conforms to established rules and regulations (NM – CR 4C, 4D).</li> <li>8. Maintains appropriate appearance and punctuality (NM – CR 4A).</li> <li>9. Completes assigned tasks in a timely manner (NM – CR 4B, 4C).</li> </ol>	<p>1, 3 – 5, 7 – 11. The student keeps a journal and makes daily entries relating to his/her mentorship experience. The entry includes the date, what was learned, the duties and responsibilities of that day, time spent on task, and a personal reflection of that day’s experience (positive and negative). At the end of the course, each student presents orally to the class highlights of his/her experience.</p> <ul style="list-style-type: none"> <li>✓ regular entries</li> <li>✓ all required components</li> <li>✓ assessment of the experience</li> <li>✓ personal reflection</li> <li>✓ effective communication</li> </ul> <p>2, 6, 7, 9, 11. The student meets with the instructor and the on-site mentor on a regular basis (e.g., weekly, monthly) to talk about the progress of the student and to assess if any changes or adjustments need to be made. The student also produces weekly time sheets and other documents that account for the student’s investment of time, energy, and task responsibilities. The student is evaluated by the use of a rubric.</p> <ul style="list-style-type: none"> <li>✓ cooperation/collaboration</li> <li>✓ adherence to rubric</li> <li>✓ submission of proper documents</li> </ul> <p><b>Note:</b> In addition to the on-site visits by the instructor, he/she also makes periodic telephone calls to the mentor as part of the supervisory responsibilities of participation in this mentorship program. Close supervision ensures that the placement is a good fit, that both mentor and student are working together to meet goals, and that adjustments and/or changes can be made, if necessary, for the student to be successful.</p>

<b>GRADE 11-12</b>	<b>PERFORMANCE STANDARDS</b>	<b>ILLUSTRATIONS</b>
	<p>10. Communicates knowledge gained in the mentorship setting (NM – CR 5D).</p> <p>11. Follows directions (NM – CR 1D).</p>	<p>10. Over the course of the semester or year, the student encounters in his/her mentorship experience a variety of case studies centered around disease. Each semester the student selects one that has had great appeal and/or interest to him/her, researches it, and prepares a presentation (e.g., PowerPoint, term paper, video) for the class. The presentation includes the etiology of the disease, immunology (i.e., how the body reacts), the epidemiology, the treatment, the prognosis of the disease, and a description of his/her mentoring experience. The student’s presentation is evaluated by both the instructor and classmates using a scoring guide with which he/she is familiar.</p> <ul style="list-style-type: none"> <li>✓ all required components</li> <li>✓ adherence to rubric</li> <li>✓ effective communication</li> <li>✓ accuracy</li> <li>✓ powerful presentation</li> </ul>

**STRAND VI: LITERACY****CONTENT STANDARD:** The student communicates scientific principles through reading, writing, speaking, and research 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
	<ol style="list-style-type: none"> <li>1. Develops and demonstrates proficiency with the following strategies to approach reading for information across content areas (APS – LA I.1):               <ul style="list-style-type: none"> <li>• scans reading selection to determine whether a text contains relevant information,</li> <li>• uses the headings and subheadings of the material to make predictions and to validate comprehension of text,</li> <li>• reads and rereads to decode meaning, and</li> <li>• reviews and summarizes essential elements of text for overview.</li> </ul> </li> <li>2. Identifies and uses roots, prefixes, and suffixes to determine meaning of words (APS – LA I.4).</li> <li>3. Uses textual evidence to develop and support an interpretation of a scientific process or concept (APS – LA II.2).</li> <li>4. Develops increased competence in using the writing process to create a final product (APS – LA III.1).</li> <li>5. Develops increased competence in using elements of effective writing (APS – LA III.2).</li> </ol>	<p><b>Note:</b> The very nature of science courses entails that the student be involved in research, exploration, and experimentation. This requires the student to read through his/her research studies; write up findings in the form of lab reports; work with other students collaboratively, requiring whole or small group discussions; listen to others’ viewpoints whether it be through print, video, or guest speaker; and display data in an organized fashion. Consequently, literacy strategies are reflected in every strand. The following citations illustrate specific examples of these strategies; although, numerous opportunities are presented throughout the year and throughout the curriculum.</p> <p>1 – 3. See Strand I, the illustration for performance standard # 10; Strand II, the 1<sup>st</sup> illustration; Strand III, 1<sup>st</sup> illustration and the illustration for performance standards # 17 – 22; and Strand IV, the illustration for performance standards # 9, 10.</p> <p>4 – 7. See Strand I, the 2<sup>nd</sup> illustration; and the illustrations for performance standards # 8, 9 and # 12, 13; Strand IV, 2<sup>nd</sup> illustration; and Strand V, 1<sup>st</sup> illustration.</p>

GRADE 11-12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	<p>6. Supports an informed opinion (APS – LA III.6):</p> <ul style="list-style-type: none"> <li>• uses appropriate language, reasoning, and organizational structure for the audience and purpose,</li> <li>• provides relevant and convincing reasons, uses various types of evidence, and</li> <li>• demonstrates an awareness of possible questions, concerns, or counterarguments.</li> </ul> <p>7. Responds to a variety of written, electronic, and other media (APS – LA III.7).</p> <p>8. Develops increased competence with speaking and language conventions (APS – LA IV.3).</p> <p>9. Demonstrates appropriate discussion in group discussions (APS – LA V.2).</p> <p>10. Evaluates the information, explanations, or ideas of others (APS – LA V.5).</p> <p>11. Evaluates information to develop informed opinions (APS – LA VI.1).</p> <p>12. Develops increased competence in using research strategies (APS – LA VI.5).</p>	<p>8. See Strand I, the 2<sup>nd</sup> illustration; Strand II, the illustration for performance standard # 15; Strand III, the illustration for performance standards # 10 – 16; Strand IV, last illustration; and Strand V, the illustration for performance standard # 10.</p> <p>9, 10. See Strand I, the illustration for performance standard # 10; Strand II, the illustrations for performance standards # 11 and # 15; Strand III, the 1<sup>st</sup> illustration and the illustration for performance standards # 10 – 16; and Strand IV, the 1<sup>st</sup> illustration and the illustrations for performance standards # 5 and # 11, 13.</p> <p>11, 12. See Strand I the illustrations for performance standards # 6 and # 8, 9; and Strand IV, the illustration for performance standards # 11, 13.</p>