OFFICE OF CURRICULUM, INSTRUCTION, & PROFESSIONAL DEVELOPMENT

HIGH SCHOOL COURSE OUTLINE
(Revised June 2011)

<table>
<thead>
<tr>
<th>Department</th>
<th>Science</th>
<th>Course Title</th>
<th>Biotechnology 1-2</th>
<th>Course Code</th>
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</thead>
<tbody>
<tr>
<td>Abbreviation</td>
<td>Biotech 1-2</td>
<td>Grade Level</td>
<td>10, 11</td>
<td>Grad Requirement</td>
</tr>
<tr>
<td>Course Length</td>
<td>2 semesters</td>
<td>Credits per Semester</td>
<td>5</td>
<td>Approved for Honors</td>
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<tr>
<td>CTE Industry Sector</td>
<td>Health Science and Medical Technology</td>
<td>CTE Pathway</td>
<td>Biotechnology Research and Development</td>
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<td>Prerequisites</td>
<td>Biology 1-2 with a &quot;C&quot; or better</td>
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<tr>
<td>Co-requisites</td>
<td>Integrated Math Program (IMP) 5-6 maintaining a &quot;C&quot; or better</td>
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<td>Meets NCAA Requirement</td>
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**COURSE DESCRIPTION:**
Biotechnology 1-2 is a course designed to give students a comprehensive introduction to the scientific concepts and laboratory research techniques currently used in the field of biotechnology. Students attain knowledge about the field of biotechnology and deeper understanding of the biological concepts used. In addition, students develop the laboratory, critical thinking, and communication skills currently used in the biotechnology industry. Furthermore, students will explore and evaluate career opportunities in the field of biotechnology through extensive readings, laboratory experiments, class discussions, research projects, guest speakers, and workplace visits. The objectives covered in this course are both academic and technical in nature and are presented in a progressively rigorous manner.

**COURSE PURPOSE: GOALS** (Student needs the course is intended to meet)
Students will:

**CONTENT**
- Students will learn the basic biological and chemical processes of cell, tissues, and organisms. They will also learn the historical experiments that led to the central dogma of molecular biology and understand the basic processes of DNA replication, transcription and translation. Students will also gain an understanding of and exposure to assorted topics/concepts in biotechnology.

**SKILLS**
- Students will apply the basic principles of molecular biology to develop techniques that can indirectly measure the molecular status of cells. They will learn basic laboratory skills used in academic and industrial biotechnology laboratories, including best practices, including the methodologies used in the isolation and analysis of large macromolecules such as DNA and proteins. Students will also model the steps involved in the production of a recombinant DNA biotechnology product.

**LITERACY**
- Students will learn to understand and use professional biotechnology literature for purposes of research for projects and individual class topics. Written assessments and laboratory analyses will help students learn to write concisely and accurately, while encouraging analytical thinking referenced to observations.

**APPLICATIONS**
- Students will demonstrate understanding of the role of biotechnology in society, including the risks and benefits. They will learn the significance of biotechnology in pharmaceutical development, agriculture, forensics, genetic testing, industrial products, and scientific research. Students will also learn how a biotechnology company works and the roles of its employees and understand how bioinformatics is used in research.
Health Science and Medical Technology Industry Sector
A. Biotechnology Research and Development Pathway

A1.0 Students know the role of the biotechnology industry and biotechnology product development in curing diseases:
A1.1 Understand the role of the biotechnology industry and its impact on society.
A1.2 Understand the role of biotechnology product development in curing genetic, environmental, and behavioral diseases.
A1.3 Understand the legal and ethical issues regarding the use of biotechnology to cure diseases.
A1.4 Understand the relationship between biochemistry and biotechnology product development.

A2.0 Students know the fundamentals of mathematical and scientific concepts related to biotechnology:
A2.1 Understand basic mathematical concepts related to the field, such as the calculation of percentages and ratios and the difference between standard deviation and various measures of central tendency.
A2.2 Understand the basic structure of a chromosome and the difference between a dominant homozygous trait and a heterozygous trait.
A2.3 Know the basic structures and functions of cells and how this knowledge is used in biotechnology.
A2.4 Understand the central theory of molecular biology.

A3.0 Students understand the role of recombinant DNA and genetic engineering, bioprocessing, monoclonal antibody production, separation and purification of Biotechnology products, nanotechnology, bioinformatics, genomics, proteomics, and transcriptomics in biotechnical product development:
A3.1 Understand recombinant DNA, genetic engineering, monoclonal antibody production, separation and purification of biotechnology products, and bioprocessing.
A3.2 Understand how the fields of nanotechnology, bioinformatics, genomics, proteomics, and transcriptomics influence new and emerging career opportunities.

A4.0 Students understand the principles of solution preparation, contamination control, measurement and calibration, and emergency laboratory response:
A4.1 Students understand how molarity relates to solution preparation.
A4.2 Know how to calculate the molarity of a given solution and how to measure the pH of that solution.
A4.3 Know how to prepare a serial dilution of a microbial culture.
A4.4 Understand the importance and requirements of using sterile techniques in a laboratory.

A5.0 Students understand biotechnology product design and development, laboratory procedures, product licensure, and the regulatory process for product development and clinical trials:
A5.1 Understand the process of developing biotechnology products in an industrial setting.
A5.2 Understand the role of preclinical and clinical trials in biotechnology product development.
A5.3 Know the role of quality assurance in clinical trials.

A6.0 Students understand the ethical, moral, legal, and cultural issues related to the use of biotechnology research and product development:
A6.1 Understand the relationship between morality and ethics in the development of biotechnology health care products.
A6.2 Know the differences between personal, professional, and organizational ethics.
A6.3 Understand the necessity for accurate documentation and recordkeeping in biotechnology research and product development.
A6.4 Understand the need for ethical policies and procedures in institutions engaged in biotechnology research and product development.

CA SCIENCE CONTENT STANDARDS:

Grade 9-12 Biology/Life Sciences:
Cell Biology
1. The fundamental life processes of plants and animals depend on a variety of chemical reactions that occur in specialized areas of the organism’s cells. As a basis for understanding this concept, students know:
   a. cells are enclosed within semipermeable membranes that regulate their interaction with their surroundings. (CST)
   b. enzymes are proteins and catalyze biochemical reactions without altering the reaction equilibrium and the activities of enzymes depend on the temperature, ionic conditions, and the pH of the surroundings. (CST)
   c. how prokaryotic cells, eukaryotic cells (including those from plants and animals), and viruses differ in complexity and general structure. (CST)
   d. the Central Dogma of molecular biology outlines the flow of information from transcription of ribonucleic acid (RNA) in the nucleus to translation of proteins on ribosomes in the cytoplasm. (CST)
   e. the role of the endoplasmic reticulum and Golgi apparatus in the secretion of proteins. (CST)
   f. usable energy is captured from sunlight by chloroplasts and is stored through the synthesis of sugar from carbon dioxide. (CST)
   g. the role of the mitochondria in making stored chemical bond energy available to cells by completing the breakdown of glucose to carbon dioxide. (CST)
Genetics
4. Genes are a set of instructions encoded in the DNA sequence of each organism that specify the sequence of amino acids in proteins characteristic of that organism. As a basis for understanding this concept, students know:
   a. the general pathway by which ribosomes synthesize proteins, using tRNAs to translate genetic information in mRNA. (CST)

5. The genetic composition of cells can be altered by incorporation of exogenous DNA into the cells. As a basis for understanding this concept, students know:
   a. the general structures and functions of DNA, RNA, and protein. (CST)
   b. how to apply base-pairing rules to explain precise copying of DNA during semiconservative replication and transcription of information from DNA into mRNA. (CST)
   c. how genetic engineering (biotechnology) is used to produce novel biomedical and agricultural products. (CST)
   d.* how basic DNA technology (restriction digestion by endonucleases, gel electrophoresis, ligation, and transformation) is used to construct recombinant DNA molecules.
   e.* how exogenous DNA can be inserted into bacterial cells to alter their genetic makeup and support expression of new protein products.

Physiology
10. Organisms have a variety of mechanisms to combat disease. As a basis for understanding the human immune response, students know:
   b. the role of antibodies in the body's response to infection. (CST)
   d. there are important differences between bacteria and viruses with respect to their requirements for growth and replication, the body's primary defenses against bacterial and viral infections, and effective treatments of these infections. (CST)

Grade 9-12 Chemistry:
Acids and Bases
5. Acids, bases, and salts are three classes of compounds that form ions in water solutions. As a basis for understanding this concept, students know:
   a. the observable properties of acids, bases, and salt solutions. (CST)
   b. acids are hydrogen-ion-donating and bases are hydrogen-ion-accepting substances. (CST)
   c. strong acids and bases fully dissociate and weak acids and bases partially dissociate. (CST)
   d. how to use the pH scale to characterize acid and base solutions. (CST)

Solutions
6. Solutions are homogenous mixtures of two or more substances. As a basis for understanding this concept, students know:
   a. the definitions of solute and solvent. (CST)
   b. how to describe the dissolving process at the molecular level by using the concept of random molecular motion. (CST)
   c. temperature, pressure, and surface area affect the dissolving process. (CST)
   d. how to calculate the concentration of a solute in terms of grams per liter, molarity, parts per million, and percent composition. (CST)

Organic Chemistry and Biochemistry
10. The bonding characteristics of carbon allow the formation of many different organic molecules of varied sizes, shapes, and chemical properties and provide the biochemical basis of life. As a basis for understanding this concept, students know:
   a. large molecules (polymers), such as proteins, nucleic acids, and starch, are formed by repetitive combinations of simple subunits. (CST)
   b. the bonding characteristics of carbon that result in the formation of a large variety of structures ranging from simple hydrocarbons to complex polymers and biological molecules. (CST)
   c. amino acids are the building blocks of proteins. (CST)
   f.* the R-group structure of amino acids and know how they combine to form the polypeptide backbone structure of proteins.

Grade 9-12 Physics:
Waves
4. Waves have characteristic properties that do not depend on the type of wave. As a basis for understanding this concept, students know:
   e. radio waves, light, and X-rays are different wavelength bands in the spectrum of electromagnetic waves whose speed in a vacuum is approximately $3 \times 10^8$ m/s (186,000 miles/second).
Grade 9-12 Investigation and Experimentation:
1. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop their own questions and perform investigations. Students will:
   a. select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.
   b. identify and communicate sources of unavoidable experimental error.
   c. identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.
   d. formulate explanations by using logic and evidence.
   f. distinguish between hypothesis and theory as scientific terms.
   j. recognize the issues of statistical variability and the need for controlled tests.
   l. analyze situations and solve problems that require combining and applying concepts from more than one area of science.
   m. investigate a science-based societal issue by researching the literature, analyzing data, and communicating the findings.
   n. know that when an observation does not agree with an accepted scientific theory, the observation is sometimes mistaken or fraudulent and that the theory is sometimes wrong.

COURSE PURPOSE: EXPECTED INTEGRATED OUTCOMES

Students are also expected to proficiently apply common skills that are relevant across curriculum areas and career pathways. The following are those skills most applicable to this science course.

CTE Foundation Standards:
from the California Career Technical Education Model Curriculum Standards, adopted by the California State Board of Education in May, 2005.

Foundation Standard 2: Communications
Students understand the principles of effective oral, written and multimedia communication in a variety of formats and contexts.

Reading (Grades 9-10)
1.3 Identify Greek, Roman, and Norse mythology and use the knowledge to understand the origin and meaning of new words.
2.2 Prepare a bibliography of reference materials for a report using a variety of consumer, workplace, and public documents.
2.3 Generate relevant questions about readings on issues that can be researched.
2.8 Evaluate the credibility of an author's argument or defense of a claim by critiquing the relationship between generalizations and evidence, the comprehensiveness of evidence, and the way in which the author's intent affects the structure and tone of the text (e.g., in professional journals, editorials, political speeches).

Writing (Grades 9-10)
1.3 Use clear research questions and suitable research methods (e.g., library, electronic media, personal interview) to elicit and present evidence from primary and secondary sources.
1.5 Synthesize information from multiple sources and identify complexities and discrepancies in the information and the different perspectives found in each medium (e.g., almanacs, microfiche, news sources, in-depth field studies, speeches, journals, technical documents).
2.3 Write expository compositions, including analytical essays and research reports:
   2.3.a Marshal evidence in support of a thesis and related claims, including information on all relevant perspectives.
   2.3.b Convey information and ideas from primary and secondary sources accurately and coherently.
   2.3.c Make distinctions between the relative value and significance of specific data, facts, and ideas.
   2.3.d Include visual aids by employing appropriate technology to organize and record information on charts, maps, and graphs.
   2.3.e Anticipate and address readers' potential misunderstanding, biases, and expectations.
   2.3.f Use technical terms and notations accurately.

2.6 Write technical documents:
   2.6.a Report information and convey ideas logically and correctly.
   2.6.b Offer detailed and accurate specifications.
   2.6.c Include scenarios, definitions, and examples to aid comprehension (e.g., troubleshooting guide).
   2.6.d Anticipate reader’s problems, mistakes, and misunderstandings.

Written and Oral English Language Conventions (Grades 9-10)
1.4 Produce legible work that shows accurate spelling and correct use of the conventions of punctuation and capitalization.
Listening and Speaking (Grades 9-10)

1.7 Use props, visual aids, graphs, and electronic media to enhance the appeal and accuracy of presentations.

2.3 Apply appropriate interviewing techniques:
   2.3.a Prepare and ask relevant questions.
   2.3.b Make notes of responses.
   2.3.c Use language that conveys maturity, sensitivity, and respect.
   2.3.d Respond correctly and effectively to questions.
   2.3.e Demonstrate knowledge of the subject or organization.
   2.3.f Compile and report responses.
   2.3.g Evaluate the effectiveness of the interview.

2.5 Deliver persuasive arguments (including evaluation and analysis of problems and solutions and causes and effects).
   2.5.a Structure ideas and arguments in a coherent, logical fashion.
   2.5.b Use rhetorical devices to support assertions (e.g., by appeal to logic through reasoning; by appeal to emotion or ethical belief; by use of personal anecdote, case study, or analogy).
   2.5.c Clarify and defend positions with precise and relevant evidence, including facts, expert opinions, quotations, expressions of commonly accepted beliefs, and logical reasoning.
   2.5.d Anticipate and address the listener’s concerns and counterarguments.

Foundation Standard 3: Career Planning and Management
Students understand how to make effective decisions, use career information, and manage career plans.

3.5 Understand the past, present, and future trends that affect careers, such as technological developments and societal trends, and the resulting need for lifelong learning.

Foundation Standard 4: Technology
Students know how to use contemporary and emerging technological resources in diverse and changing personal, community, and workplace environments.

4.2 Understand the use of technological resources to gain access to, manipulate, and produce information, products, and services.

4.3 Understand the influence of current and emerging technology on selected segments of the economy.

Foundation Standard 5: Problem Solving and Critical Thinking
Students understand how to create alternative solutions by using critical and creative thinking skills, such as logical reasoning, analytical thinking, and problem solving techniques.

5.1 Apply appropriate problems-solving strategies and critical thinking skills to work-related issues and tasks.

5.3 Use critical thinking skills to make informed decisions and solve problems.

Foundation Standard 6: Health and Safety
Students understand health and safety policies, procedures, regulations, and practices, including the use of equipment and handling of hazardous materials.

6.1 Know the policies, procedures, and regulations regarding health and safety in the workplace, including employers’ and employees’ responsibilities.

6.2 Understand critical elements of health and safety practices related to storing, cleaning, and maintaining tools, equipment, and supplies.

Foundation Standard 7: Responsibility and Flexibility
Students know the behaviors associated with the demonstration of responsibility and flexibility in personal, workplace, and community settings.

7.1 Understand the qualities and behaviors that constitute a positive and professional work demeanor.

7.2 Understand the importance of accountability and responsibility in fulfilling personal, community, and workplace roles.

7.3 Understand the need to adapt to varied roles and responsibilities.

7.4 Understand that individual actions can affect the larger community.

Foundation Standard 8: Ethics and Legal Responsibilities
Students understand professional, ethical, and legal behavior consistent with applicable laws, regulations, and organizational norms.

8.2 Understand the concept and application of ethical and legal behavior consistent with workplace standards.

8.3 Understand the role of personal integrity and ethical behavior in the workplace.
Foundation Standard 9: Leadership and Teamwork
Students understand effective leadership styles, key concepts of group dynamics, team and individual decision making, the benefits of workplace diversity, and conflict resolution.

9.1 Understand the characteristics and benefits of teamwork, leadership, and citizenship in the school, community, and workplace setting.

9.2 Understand the ways in which pre professional associations and competitive career development activities enhance academic skills, promote career choices, and contribute to employability.

9.3 Understand how to organize and structure work individually and in teams for effective performance and the attainment of goals. [re: Biotechnology Management]

9.4 Understand how to interact with others in ways that demonstrate respect for individual and cultural differences and for the attitudes and feelings of others.

OUTLINE OF CONTENT AND RECOMMENDED TIME ALLOTMENT:
This course represents a blending of science academic content and deep career applications. As such, the two primary sources for content focus are the CA Science Content Standards and the CA Career Technical Education Model Curriculum Standards. Reference abbreviations used in the Task Analysis section refer to these documents as follows:

- **PS-A** refers to the Biotechnology Research and Development Pathway within the Health Science and Medical Technology Industry Sector of the CA CTE Pathway Standards [page 2].
- **FS** refers to the Foundation Standards of the CA CTE Model Curriculum Standards [pages 4 through 6].
- **B** refers to the high school Biology/Life Science standards of the CA Science Content Standards
- **C** refers to the high school Chemistry standards of the CA Science Content Standards
- **P** refers to the high school Physics standards of the CA Science Content Standards
- **IE** refers to the high school Investigation and Experimentation skill standards of the CA Science Content Standards

Content sequencing, Labs/Demos, and time allocations are only suggestions and may be adjusted to suit school site curriculum plans, available materials, and student needs.

Introduction to Biotechnology Past and Present

<table>
<thead>
<tr>
<th>History and Development of Recombinant DNA Technology</th>
<th>Perf. Std. Measures</th>
<th>Instructional Support</th>
<th>Appx Time</th>
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<tbody>
<tr>
<td><strong>(CONTENT)</strong> “Students know…”</td>
<td><strong>(SKILL)</strong> “Students are able to…”</td>
<td><strong>Perf. Std. Measures</strong> How students DEMONSTRATE KNOWLEDGE and SKILL.</td>
<td><strong>Instructional Support</strong></td>
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<tr>
<td><strong>Key Assignments:</strong></td>
<td><strong>Suggested:</strong></td>
<td><strong>Biotech SNM, 1.1-2</strong></td>
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<tr>
<td><strong>Supplemental Resources:</strong></td>
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<tr>
<td><strong>Key Vocabulary:</strong></td>
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<table>
<thead>
<tr>
<th>Content Standards</th>
<th>Skills Focus</th>
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</thead>
</table>
| Understand the role of the biotechnology industry and its impact on society. (PS-A1.1) | **Research Skills**  
Students will use university library electronic resources to perform thorough literature searches.  
Evaluate scientific reports with well-supported and clearly presented opinions.  
**Presentation Skills**  
Students will use PowerPoint software to present information on research. |

Understand the role of biotechnology product development in curing genetic, environmental, and behavioral diseases. (PS-A1.2) | **Research Skills**  
Students will use university library electronic resources to perform thorough literature searches.  
Evaluate scientific reports with well-supported and clearly presented opinions.  
**Presentation Skills**  
Students will use PowerPoint software to present information on research. |

- Identify the major scientific discoveries that lead to recombinant DNA technology, including those in chemistry, genetics, microbiology, and fermentation technology.
- Explain how biotechnology discoveries are used in industry today.
- Describe major historic developments in biotechnology fields such as pharmaceuticals, agriculture, diagnostics, industrial products, instrumentation and research and development.

5 Days
# Introduction to Biotechnology Past and Present

<table>
<thead>
<tr>
<th>Basic Scientific Methodologies</th>
<th>Perf. Std. Measures</th>
<th>Instructional Support</th>
<th>Appx Time</th>
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<tr>
<td><strong>Content Standards</strong></td>
<td><strong>Perf. Std. Measures</strong></td>
<td><strong>Instructional Support</strong></td>
<td><strong>Appx Time</strong></td>
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<td>How students DEMONSTRATE KNOWLEDGE and SKILL.</td>
<td><strong>Supplemental Resources:</strong></td>
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<td>&quot;Students are able to ...&quot;</td>
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<td><strong>Key Assignments:</strong></td>
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<td><strong>(CONTENT)</strong></td>
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<td>**B-SNM. Lab Manual 1b, pp. 4-6 &quot;Laboratory Safety&quot;</td>
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<tr>
<td><strong>(SKILL)</strong></td>
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<td>**B-SNM. Lab Manual 1a, pp. 2-4 &quot;How to Set Up a Legal Scientific Notebook&quot;</td>
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<tr>
<td><strong>Basic Scientific Methodologies</strong></td>
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<td><strong>Key Vocabulary:</strong></td>
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<tr>
<td>Understand the necessity for accurate documentation and recordkeeping in biotechnology research and product development. (PS-A6.3)</td>
<td>Use the scientific method to conduct a valid experiment, including hypothesis formation, data collection, and data analysis.</td>
<td><strong>documentation hazards qualitative quantitative</strong></td>
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<tr>
<td>Understand basic mathematical concepts related to the field, such as the calculation of percentages and ratios and the difference between standard deviation and various measures of central tendency. (PS-A2.1)</td>
<td>Develop scientific questions, hypotheses, and experimental plans.</td>
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<td>Understand the appropriate responses to a laboratory accident. (PS-A4.5)</td>
<td>Create data tables and graphs using Excel® for the purpose of collecting and analyzing data.</td>
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<tr>
<td><strong>Skills Focus:</strong></td>
<td>Interpret and critically analyze quantitative and qualitative data.</td>
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<td>Use critical thinking skills to make informed decisions and solve problems. (FS 5.3)</td>
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<td>Distinguish between hypothesis and theory as scientific terms. (IE-1f)</td>
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<tr>
<td>Select and use appropriate tools and technology to perform tests, collect data, analyze relationships, and display data. (IE-1a)</td>
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<td>Identify and communicate sources of unavoidable experimental error. (IE-1b)</td>
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<tr>
<td>Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions. (IE-1c)</td>
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# Introduction to Biotechnology Past and Present

## Basic Biotechnology Methodologies

<table>
<thead>
<tr>
<th>Content Standards</th>
<th>Perf. Std. Measures</th>
<th>Instructional Support</th>
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</thead>
<tbody>
<tr>
<td>Students know how the principles of solution preparation, contamination control, measurement and calibration, and emergency laboratory response. (PS-A4.0) also, (C-6a-d)</td>
<td>Calculate and prepare solutions based on mass/volume, % mass/volume, and molar concentrations.</td>
<td>Biotech SNM, 3.1-6, 4.2, 2.1-2, 1.3</td>
<td>28 Days</td>
</tr>
<tr>
<td>Students understand how molarity relates to solution preparation. (PS-A4.1)</td>
<td>Properly and safely use and monitor a variety of scientific equipment, including pH meters, microscopes, spectrophotometers, pipets, micropipettes, balances, etc.</td>
<td>Safety in Biotech Lab.</td>
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<tr>
<td>Understand the importance and requirements of using sterile techniques in a laboratory. (PS-A4.4)</td>
<td>Determine proper equipment to use for a given task and the most appropriate units to use.</td>
<td>Set Up, Calibration, Use, and Maintenance of Lab Equipment</td>
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</tr>
<tr>
<td>Students know how genetic engineering (biotechnology) is used to produce novel biomedical and agricultural products. (B-5c)</td>
<td>Practice proper set up, calibration, and maintenance of common lab equipment.</td>
<td>Biotech SNM, Lab Manual 3a, pp. 32-35 “Making Solutions of Very Small Volumes”</td>
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### Skills Focus:
- Select and use appropriate tools and technology to perform tests, collect data, analyze relationships, and display data. (IE-1a)
- Formulate explanation by using logic and evidence. (IE-1d)
- Know that when an observation does not agree with an accepted scientific theory, the observation is sometimes mistaken or fraudulent, and that the theory is sometimes wrong. (IE-1m)

### Key Assignments:
- Solution and Dilution Preparation
  - [See description on p. 18.]

### Suggested:
- •

### Supplemental Resources:
- • Safety in Biotech Lab.
- • Set Up, Calibration, Use, and Maintenance of Lab Equipment
  - top-loading balance
  - analytical balance
  - pH meter and electrodes
  - spectrophotometer
  - micro centrifuges
  - clinical centrifuges
  - micropipettes
  - gel electrophoresis equipment
  - gel documentation systems
  - fume hoods
  - vortex mixers
  - temperature probes
  - microscopes
- • B-SNM, Lab Manual 3a, pp. 32-35 “Making Solutions of Very Small Volumes”
- • B-SNM, Lab Manual 3b, pp. 35-39 “Measuring VERY Small Volumes”
- • B-SNM, Lab Manual 3c, pp. 40-42 “Measuring Mass”
- • B-SNM, Lab Manual 3e, pp. 45-49 “Making Solutions of Differing Mass/Volume Conc’s”
- • B-SNM, Lab Manual 3f, pp. 50-54 “Making Solutions of Differing % Mass/Volume Conc’s”
- • B-SNM, Lab Manual 3g, pp. 55-58 “Making Solutions of Differing Molar Conc’s”
- • B-SNM, Lab Manual 3h, pp. 59-62 “Making Dilutions”
- • B-SNM, Lab Manual 2b, pp. 17-22 “Characteristics of Model Organisms”

### Key Vocabulary:
- calibration
- molarity
- aliquot
- dilution
- sterile technique
- purification
- validity

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### Time
- 28 Days

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### Supplemental Resources:
- "Model Organisms"
### Characteristics of Organisms Used in Biotechnology

<table>
<thead>
<tr>
<th>Life at the Cellular Level</th>
<th>Cellular Level Life Cycle</th>
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<tbody>
<tr>
<td><strong>Content Standards</strong></td>
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<tr>
<td>“Students know…”</td>
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<tr>
<td><strong>Perf. Std. Measures</strong></td>
<td><strong>Perf. Std. Measures</strong></td>
</tr>
<tr>
<td>How students DEMONSTRATE</td>
<td>How students DEMONSTRATE</td>
</tr>
<tr>
<td>KNOWLEDGE and SKILL.</td>
<td>KNOWLEDGE and SKILL.</td>
</tr>
<tr>
<td><strong>Instructional Support</strong></td>
<td><strong>Instructional Support</strong></td>
</tr>
<tr>
<td><strong>Appx Time</strong></td>
<td><strong>Appx Time</strong></td>
</tr>
</tbody>
</table>

#### Life at the Cellular Level

- **Students know** cells are enclosed within semipermeable membranes that regulate their interaction with their surroundings. (B-1a)
- **Students know** how prokaryotic cells, eukaryotic cells, and viruses differ in complexity and general structure. (B-1c)
- **Students know** the roles endoplasmic reticulum and Golgi apparatus, and of chloroplasts and mitochondria. (B-1e,f,g)
- **Know the basic structures and functions of cells and how this knowledge is used in biotechnology.** (PS-A2.3)

**Skills Focus:**
- research

**Key Assignments:**
- none

**Suggested:**
- Biotech SNM, 2.1-2, 4.2

**Supplemental Resources:**
- Cellular Structures in Biotechnology
  - Students will research the significant cellular structures used in modern biotechnology, including various nucleic acid structures and organelles needed for protein production.

**Key Vocabulary:**
- prokaryotic
- eukaryotic
- organelles

#### Cellular Level Life Cycle

- **Outline the life cycle and characteristics of model organisms used in the biotechnology industry, including various bacteria (E. coli) and fungi (yeasts and Aspergillus).**
- **Explain the basic concepts of cell growth.**
- **Explain the integrated processes involved in cellular reproduction, including DNA replication, mitosis, meiosis, and protein synthesis.**

**Skills Focus:**
- sterile technique

**Key Assignments:**
- none

**Suggested:**
- Biotech SNM, 4.2-3

**Supplemental Resources:**
- B-SNM, Lab Manual 4f, pp. 74-76 “Sterile Technique and Pouring Plates”

**Key Vocabulary:**
- Central Theory (Dogma)
<table>
<thead>
<tr>
<th>Culturing Model Organisms</th>
<th>Key Assignments:</th>
<th>Instructional Support</th>
<th>Appx Time</th>
</tr>
</thead>
</table>
| Know how to prepare a serial dilution of a microbial culture. (PS-A4.3) | • Use various methods to monitor the growth of cell cultures. 
• Describe conditions that promote cell growth under aseptic conditions in the laboratory and workplace. 
• Explain how environmental factors affect the growth of model organisms in the laboratory. | Biotech SNM, (no reference) 
Supplemental Resources: 
• Model Organism Growth / Media Preparation and Cell Culture Using Sterile Technique 
Students will prepare and inoculate media plates with model organisms E. coli and Aspergillus and grow broth cultures of them. 
• B-SNM, Lab Manual 4e, pp. 71-74 “Media Prep” 
• B-SNM, Lab Manual 4g, pp. 76-79 “Bacteria Cell Culture” | 5 Days |
| **Skills Focus:** aseptic technique | **Suggested:** Solution Preparation and Dilution 
Students will make appropriate mass/vol and mass/mass solutions and create serial dilutions. | | |
## DNA and Protein Structure / Function

<table>
<thead>
<tr>
<th>Cellular Macromolecules</th>
<th>Content Standards (SKILL)</th>
<th>Perf. Std. Measures (CONTENT)</th>
<th>Instructional Support</th>
<th>Appx Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students know large molecules (polymers) are formed by repetitive combinations of simple subunits, such as amino acids in proteins. <strong>(C-10a,c)</strong></td>
<td>“Students know...”</td>
<td>How students DEMONSTRATE KNOWLEDGE and SKILL.</td>
<td><strong>Key Assignments:</strong></td>
<td>4 Days</td>
</tr>
<tr>
<td>Students know the bonding characteristics of carbon that result in the formation of a large variety of structures ranging from simple hydrocarbons to complex polymers and biological molecules. <strong>(C-10b)</strong></td>
<td>“Students are able to...”</td>
<td></td>
<td><strong>Suggested:</strong></td>
<td></td>
</tr>
<tr>
<td>Students know the R-group structure of amino acids and know how they combine to form the polypeptide backbone structure of proteins. <strong>(C-10f)</strong></td>
<td></td>
<td></td>
<td><strong>Macromolecule Research</strong> Students will use university library electronic resources to study specific macromolecules, noting how the three dimensional structure determines function through exposed functional groups or allowing for shape change.</td>
<td></td>
</tr>
<tr>
<td>Students know the general structures and functions of DNA, RNA, and protein. <strong>(B-5a)</strong></td>
<td></td>
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<tr>
<td></td>
<td>- Discuss the structure and function of the macromolecules that compose cells: carbohydrates DNA lipids RNA protein</td>
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<tr>
<td></td>
<td>- Conduct indicator tests (Benedict’s, Iodine, Biuret) for common cellular macromolecules.</td>
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<tr>
<td></td>
<td>- Identify the monomers comprising DNA, RNA, and proteins.</td>
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<tr>
<td></td>
<td>- Explain how the macromolecule structures facilitate their functions.</td>
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<td></td>
<td><strong>Skills Focus:</strong> research and presentation</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Key Vocabulary:</strong> polymer monomer</td>
<td></td>
</tr>
</tbody>
</table>

### Instructional Support
- **Biotech SNM.** 2.3
- **Supplemental Resources:**
  - B-SNM, Lab Manual 2a, pp. 14-17 “Dissecting a ‘Cell’ and Examining its Components”
- **Key Vocabulary:** polymer monomer
DNA Structure, Function, Isolation and Analysis

Understand the central theory of molecular biology. (PS-A2.4) and (B-1d & 4a)

- Identify both the general and special routes of information transfer in biological systems.
- Describe the roles of DNA, RNA, and ribosomes in protein synthesis.
- Apply base-pairing rules to explain precise copying of DNA during semiconservative replication and transcription of information from DNA into mRNA. (B-5b)
- Explain the basic concepts of cell growth and reproduction: DNA replication, mitosis, meiosis, and protein synthesis.
- Describe the relationship between nitrogen bases, nucleotides, and nucleic acids.
- Recognize nucleotides on a DNA double helix model.
- Explain how the structure of DNA affects its function.
- Explain how the structure of DNA affects its isolation from cells and solutions.

Understand the basic structure of a chromosome. (PS-A2.2)

- Isolate genomic DNA from cells and analyze its purity and concentration.
- Perform routine tasks with DNA including extraction from multiple sources, restriction digestion, size determination, ligations and transformations, and gel documentation.
- Isolate plasmid DNA from cells (mini-preparation) and analyze its purity and concentration.
- Explain the principles involved in agarose gel electrophoresis.
- Prepare, load, run, visualize, and analyze DNA samples on an agarose gel.
- Describe the differences in samples of eukaryotic and prokaryotic DNA samples on a gel.

**Skills Focus:**
Select and use appropriate tools and technology to perform tests, collect data, analyze relationships, and display data. (IE-1a)

- Identify and communicate sources of unavoidable experimental error. (IE-1b)
- Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions. (IE-1c)
- Analyze situations and solve problems that require combining and applying concepts from more than one area of science. (IE-1d)

**Key Assignments:**
- DNA Isolation and Indicator Analysis
  (See description on p. 18.)
- Agarose Gel Electrophoresis
  (See description on p. 18.)
- DNA Synthesis and PCR
  (See description on p. 18.)

**Supplemental Resources:**
- B-SNM, Lab Manual 4a, pp. 64-65 “Making Solutions for DNA Isolation”
- B-SNM, Lab Manual 4b, pp. 65-67 “DNA Spooling”
- B-SNM, Lab Manual 4h, pp. 79-82 “DNA Extraction from Bacteria”

**Key Vocabulary:**
- semiconservative replication
- transcription
- mini-preparation
- nucleotides
- nitrogen bases
- nucleic acids
- bioprocessing
- ligation
- transformation
- isolation

**Appx Time:** 15 Days
## DNA and Protein Structure / Function

### Protein Structure, Function, Isolation and Analysis

<table>
<thead>
<tr>
<th>Content Standards</th>
<th>Perf. Std. Measures</th>
<th>Instructional Support</th>
<th>Appx Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Students know</strong></td>
<td>Protein Structure, Function, Isolation and Analysis</td>
<td>Biotech SNM, 4.4, 5.1-3</td>
<td>30 Days</td>
</tr>
<tr>
<td>Proteins can differ from one another in the number and sequence of amino acids.</td>
<td>How students DEMONSTRATE KNOWLEDGE and SKILL.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students know why proteins having different amino acid sequences typically have different shapes and chemical properties.</td>
<td>Instructional Support</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students know enzymes are proteins that catalyze biochemical reactions without altering the reaction equilibrium and the activities of enzymes depend on the temperature, ionic conditions, and the pH of the surroundings.</td>
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</tr>
<tr>
<td><strong>Skills Focus:</strong></td>
<td>Key Assignments:</td>
<td>Suggested:</td>
<td></td>
</tr>
<tr>
<td>Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.</td>
<td>• Protein Isolation and Indicator Analysis</td>
<td>Biotech SNM, 4.4, 5.1-3</td>
<td></td>
</tr>
<tr>
<td>• Describe primary, secondary, tertiary, and quaternary structure in proteins.</td>
<td>(See description on p. 18.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Use the internet to find information about the structure and function of specific proteins.</td>
<td>• Polyacrylamide Gel Electrophoresis</td>
<td>B-SNM, Lab Manual 4i, pp. 82-84 “Making Agarose Gels for Separating and Analyzing DNA Fragments”</td>
<td></td>
</tr>
<tr>
<td>• Prepare protein solutions and dilutions at specific concentrations and pH values.</td>
<td>(See description on p. 18.)</td>
<td>B-SNM, Lab Manual 4j, pp. 85-87 “Using Gel Electrophoresis to Study DNA Molecules”</td>
<td></td>
</tr>
<tr>
<td>• Use protein indicator solutions to identify the presence and concentration of protein in solution.</td>
<td>• Protein and Enzyme Studies / Assays</td>
<td>B-SNM, Lab Manual 5b, pp. 92-94 “Action of Different Enzymes”</td>
<td></td>
</tr>
<tr>
<td>• Explain the relationship between amino acids, peptides, and proteins.</td>
<td>(See description on p. 18.)</td>
<td>B-SNM, Lab Manual 5e, pp. 95-96 “Developing an Assay for Protease Activity”</td>
<td></td>
</tr>
<tr>
<td>• Explain the principles involved in polyacrylamide gel electrophoresis.</td>
<td></td>
<td>B-SNM, Lab Manual 5f, pp. 101-106 “Characterizing Proteins by PAGE”</td>
<td></td>
</tr>
<tr>
<td>• Describe the meaning of differences in peptide bands seen on polyacrylamide gels.</td>
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<tr>
<td>• Explain the function of enzymes and how their activity is affected by temperature and pH.</td>
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<tr>
<td>• Perform enzyme activity assays.</td>
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<tr>
<td><strong>Skills Focus:</strong></td>
<td>Key Vocabulary:</td>
<td>· catalyze · gel electrophoresis</td>
<td></td>
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<tr>
<td>Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.</td>
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</tbody>
</table>

### Products and Applications of Modern Biotechnology

<table>
<thead>
<tr>
<th>Content Standards</th>
<th>Perf. Std. Measures</th>
<th>Instructional Support</th>
<th>Appx Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Applying Biotechnology</strong></td>
<td><strong>Students know how</strong></td>
<td>Biotech SNM, 6.2-4</td>
<td>5 Days</td>
</tr>
<tr>
<td>Genetic engineering (biotechnology) is used to produce novel biomedical and agricultural products.</td>
<td><strong>Biotechnology</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Compare and contrast pure and applied scientific research in the field of biotechnology.</td>
<td>How students DEMONSTRATE KNOWLEDGE and SKILL.</td>
<td></td>
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<tr>
<td>• Identify several products obtained through recombinant DNA technology.</td>
<td></td>
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<tr>
<td>• Cite examples of plant parts or extracts used as pharmaceuticals.</td>
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<tr>
<td>• Use internet resources to find information about herbal remedies, traditional pharmaceuticals, and recombinant pharmaceuticals.</td>
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</tr>
<tr>
<td>• Identify several local biotechnology companies specializing in the production of pharmaceuticals, agricultural products, industrial products, and research instruments and reagents.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Skills Focus:</strong></td>
<td>Key Assignments:</td>
<td>Suggested:</td>
<td></td>
</tr>
<tr>
<td>compare and contrast</td>
<td>• none</td>
<td>Biotech SNM, 6.2-4</td>
<td></td>
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<tr>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Supplemental Resources:</strong></td>
<td><strong>Key Vocabulary:</strong></td>
<td>pure science applied science herbal remedy traditional pharmaceutical recombinant pharmaceutical</td>
<td></td>
</tr>
<tr>
<td>• Remedies and Treatments</td>
<td></td>
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<tr>
<td>Students will analyze the relative merits of herbal remedies, traditional pharmaceuticals, and recombinant pharmaceuticals.</td>
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</tbody>
</table>
## Products and Applications of Modern Biotechnology

<table>
<thead>
<tr>
<th>Content Standards</th>
<th>Perf. Std. Measures</th>
<th>Instructional Support</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Industrial Production</strong></td>
<td>How students DEMONSTRATE KNOWLEDGE and SKILL.</td>
<td>Biotech SNM, 6.1</td>
</tr>
<tr>
<td>Understand the process of developing biotechnology products in an industrial setting. (PS-A5.1)</td>
<td><strong>Key Assignments:</strong></td>
<td><strong>Supplemental Resources:</strong></td>
</tr>
<tr>
<td>• Explain how companies decide on the research and development targets and potential products.</td>
<td>• Assay for Antimicrobial Activity [See description on p. 18.]</td>
<td></td>
</tr>
<tr>
<td>• Describe the major steps as a product moves through a company's product pipeline.</td>
<td>• Amylase Assay Development [See description on p. 18.]</td>
<td></td>
</tr>
<tr>
<td>• Produce and test plant extracts for antimicrobial activity.</td>
<td>• Peroxidase Assay Development [See description on p. 18.]</td>
<td></td>
</tr>
<tr>
<td>• Collect and test native bacteria for amylase production.</td>
<td><strong>Suggested:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Skills Focus:</strong></td>
<td></td>
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</tr>
<tr>
<td>Select and use appropriate tools and technology to perform tests, collect data, analyze relationships, and display data.</td>
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<tr>
<td>(IE-1a)</td>
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</table>

<table>
<thead>
<tr>
<th>Content Standards</th>
<th>Perf. Std. Measures</th>
<th>Instructional Support</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assays and Assay Development</strong></td>
<td>How students DEMONSTRATE KNOWLEDGE and SKILL.</td>
<td>Biotech SNM, 5.1</td>
</tr>
<tr>
<td><strong>Chemical and Biochemical Assays</strong></td>
<td></td>
<td><strong>Supplemental Resources:</strong></td>
</tr>
<tr>
<td>Perform qualitative assays.</td>
<td></td>
<td>• B-SNM, Lab Manual 5d, pp. 97-99 &quot;Testing for the Presence of Protein in Solution&quot;</td>
</tr>
<tr>
<td>• Describe how assays for reactants or products can indicate the presence or activity of an enzyme.</td>
<td></td>
<td><strong>Key Vocabulary:</strong></td>
</tr>
<tr>
<td>• Design an assay that shows the presence and activity of an enzyme.</td>
<td>• assay ELISA</td>
<td></td>
</tr>
<tr>
<td>• Compare and contrast the use of different assays in research and production of protein products.</td>
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<tr>
<td>• Explain how Benedict's Solution and Lugol's Iodine are used in glucose and starch testing.</td>
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<tr>
<td><strong>Skills Focus:</strong></td>
<td></td>
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<tr>
<td>Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.</td>
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<tr>
<td>(IE-1c)</td>
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</table>

<table>
<thead>
<tr>
<th>Content Standards</th>
<th>Perf. Std. Measures</th>
<th>Instructional Support</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>pH Effects</strong></td>
<td>How students DEMONSTRATE KNOWLEDGE and SKILL.</td>
<td>Biotech SNM, 7.2-3</td>
</tr>
<tr>
<td>Students know the properties of both strong and weak acids and bases, as well as salt solutions, and how the pH scale characterizes them. (C-5a-d)</td>
<td></td>
<td><strong>Supplemental Resources:</strong></td>
</tr>
<tr>
<td>Know how to calculate the molarity of a given solution and how to measure the pH of that solution. (PS-A4.2)</td>
<td></td>
<td>• Making Buffer Solutions</td>
</tr>
<tr>
<td>• Discuss the difference between acids, bases, and neutral solutions.</td>
<td></td>
<td>Students will make several buffers at various volumes, concentrations, and pH. They will then use the resulting buffer pH to illustrate percent error and quality control, adjusting the pH of the solutions produced if necessary.</td>
</tr>
<tr>
<td>• Differentiate strong from weak acids and bases based on ionization.</td>
<td></td>
<td>• B-SNM, Lab Manual 7c, pp. 130-132 “Making the pH of Solutions&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• B-SNM, Lab Manual 7d, pp. 132-133 “Making an Appropriate Buffer for Protein Storage and Activity”</td>
</tr>
<tr>
<td><strong>Skills Focus:</strong></td>
<td></td>
<td><strong>Key Vocabulary:</strong></td>
</tr>
<tr>
<td>Identify and communicate sources of unavoidable experimental error.</td>
<td>• pH Meter Use [See description on p. 18.]</td>
<td>pH</td>
</tr>
<tr>
<td>(IE-1b)</td>
<td></td>
<td>buffer</td>
</tr>
</tbody>
</table>
## Assays and Assay Development

<table>
<thead>
<tr>
<th>Physical Assays Using Spectro-photometer</th>
<th>Perf. Std. Measures</th>
<th>Instructional Support</th>
<th>Appx Time</th>
</tr>
</thead>
</table>
| Students know radio waves, light, and X-rays are different wavelength bands in the spectrum of electromagnetic waves whose speed in a vacuum is approximately $3 \times 10^8$ m/s. | • Explain the relationship between wavelength and the color of light.  
• Cite the colors of different wavelengths of light. | Biotech SNM, 7.1, 7.4 | 2 Days |
| **Perform spectrophotometric analysis.** | **Key Assignments:**  
• Using Spectrophotometry to Study Molecules  
(See description on p. 18.)  
• Protein Concentration Assays  
(See description on p. 18.)  
**Suggested:** | B-SNM, Lab Manual 7f, pp. 130-132 “Using the Spectrophotometer to Study the Amylase Protein” |
| • Identify the common parts found on visible light spectrophotometers and describe their functions.  
• Outline the steps of using a visible spectrophotometer.  
• Describe the relationship between light transmittance and light absorbance in a sample.  
• Use a visible spectrophotometer to produce absorbance spectra.  
• Prepare a serial dilution of a solution and measure its absorbance at a given wavelength. | | |
| **Skills Focus:** | **Key Vocabulary:** | |
| compare and contrast | spectrum wavelength absorbance spectrophotometer |

<table>
<thead>
<tr>
<th>Determining Validity</th>
<th>Perf. Std. Measures</th>
<th>Instructional Support</th>
<th>Appx Time</th>
</tr>
</thead>
</table>
| Understand basic mathematical concepts related to the field, such as the difference between standard deviation and various measures of central tendency. | • Use a standard curve to determine the concentration of a solution.  
• Use a spreadsheet to do a linear regression to calculate concentration.  
• Use statistical analysis including the standard deviation, to determine the validity of data. | Biotech SNM, 7.4, 10.5 | 5 Days |
| **Skills Focus:** | **Key Assignments:**  
Select and use appropriate tools and technology to perform tests, collect data, analyze relationships, and display data.  
(IE-1a)  
Identify and communicate sources of unavoidable experimental error.  
(IE-1b)  
Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.  
(IE-1c)  
Recognize the issues of statistical variability and the need for controlled tests.  
(IE-1j)  
**Suggested:** | **Supplemental Resources:**  
Validating Assay Data  
Students will analyze data from assays using multiple methods.  
B-SNM, Lab Manual 7g, pp. 137-141 “Determining the Conc. of Amylase in Solution” |
| | | **Key Vocabulary:** | |
| | standard curve standard deviation linear regression validity |
## Recombinant DNA and Genetic Engineering

<table>
<thead>
<tr>
<th>Content Standards (CONTENT)</th>
<th>Perf. Std. Measures (SKILL)</th>
<th>Instructional Support</th>
<th>Appx Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Isolating Desired DNA</strong></td>
<td>How students DEMONSTRATE KNOWLEDGE and SKILL.</td>
<td>Biotech SNM, 4.4</td>
<td>10 Days</td>
</tr>
<tr>
<td>Students know how basic DNA technology (restriction digestion by endonucleases, gel electrophoresis, ligation, and transformation) is used to construct recombinant DNA molecules. (B-5d*)</td>
<td><strong>Key Assignments:</strong></td>
<td>Supplemental Resources:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Discuss methods to isolate DNA and specific genes for engineering purposes.</td>
<td>• B-SNM, Lab Manual 4i, pp. 82-84 “Agarose Gels for Separating and Analyzing DNA Fragments”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Enumerate the activities and uses of restriction enzymes.</td>
<td>• B-SNM, Lab Manual 4j, pp. 85-87 “Using Gel Electrophoresis to Study DNA Molecules”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Conduct restriction digestion of a plasmid.</td>
<td><strong>Suggested:</strong></td>
<td></td>
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<tr>
<td></td>
<td><strong>Skills Focus:</strong> Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.</td>
<td></td>
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</tr>
<tr>
<td><strong>Recombination</strong></td>
<td><strong>Key Assignments:</strong></td>
<td>Biotech SNM, 8.1-2</td>
<td>15 Days</td>
</tr>
<tr>
<td>Students know how exogenous DNA can be inserted into bacterial cells to alter their genetic makeup and support expression of new protein products. (B-5e*)</td>
<td>• Restriction Digestion / Enzyme Mapping with Agarose Gel Electrophoresis Analysis</td>
<td>Supplemental Resources:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• List the steps in the production of a recombinant DNA molecule.</td>
<td>• Recombinant Plasmid / Cloning Vectors</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Cite examples of vectors used in transformation, transduction, and transfection.</td>
<td>Students will learn about restriction endonuclease enzymes, their use in making recombinant plasmid vectors and how these cloning vectors may be cloned.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Describe the steps in a bacterial transformation including competency, recovery, and selection.</td>
<td>• B-SNM, Lab Manual 8a, pp. 146-148 “Restriction Analysis of the Lambda Phage DNA Sequence”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Conduct a bacterial transformation and select for transformants.</td>
<td>• B-SNM, Lab Manual 8b, pp. 149-152 “Restriction Digestion Used to Verify the pAmylase Plasmid”</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Skills Focus:</strong> producing recombinant DNA</td>
<td>• B-SNM, Lab Manual 8c, pp. 153-156 “Transformation of E. coli with pAmylase”</td>
<td></td>
</tr>
<tr>
<td><strong>Retrieval</strong></td>
<td><strong>Key Assignments:</strong></td>
<td>Biotech SNM, 1.4</td>
<td>5 Days</td>
</tr>
<tr>
<td>Understand recombinant DNA, genetic engineering, monoclonal antibody production, separation and purification of biotechnology products, and bioprocessing. (PS-A3.1)</td>
<td>• Cell Competency and Bacterial Transformation and Selection</td>
<td>Supplemental Resources:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Describe methods by which transformants may be selected including antibiotic resistance, GFP (green fluorescent protein), and GUS (β-glucuronidase gene) activity.</td>
<td>• Key Vocabulary:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Conduct a mini-prep to retrieve plasmids from transformed cells.</td>
<td>exogenous DNA recombinant transformation competency recovery transformant</td>
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<td></td>
<td><strong>Skills Focus:</strong> Select and use appropriate tools and technology to perform tests, collect data, analyze relationships, and display data.</td>
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<td></td>
<td></td>
<td>(IE-1a)</td>
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</tbody>
</table>
### Biotechnology Management

**Content Standards**

<table>
<thead>
<tr>
<th>(CONTENT)</th>
<th>“Students know…”</th>
<th>(SKILL)</th>
<th>“Students are able to…”</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Biotechnology Management</strong></td>
<td>Understand the process of developing biotechnology products in an industrial setting. (PS-A5.1)</td>
<td>Record and report protocols, procedures, results, conclusions, manuals, and reports.</td>
<td>• Write appropriate memos and letters utilizing computer-processing.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Interact with colleagues and supervisors to coordinate tasks.</td>
<td>• Perform self-evaluation of progress, work quality, time management, and interpersonal skills.</td>
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<td></td>
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<td></td>
<td><strong>Skills Focus:</strong> Understand how to organize and structure work individually and in teams for effective performance and the attainment of goals. (FS 9.3)</td>
</tr>
</tbody>
</table>

**Perf. Std. Measures**

How students DEMONSTRATE KNOWLEDGE and SKILL.

**Instructional Support**

**Appx Time**

**Key Assignments:**

- **Suggested:**
  - Sim-Biotech

**Supplemental Resources:**

- Biotech SNM, 1.3-4

- Key Vocabulary:
  - distribution protocol

---

### Bioethics, Communication, and Decision Making in the Biotechnology Industry

**Content Standards**

<table>
<thead>
<tr>
<th>(CONTENT)</th>
<th>“Students know…”</th>
<th>(SKILL)</th>
<th>“Students are able to…”</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ethics for the Biotechnology Industry</strong></td>
<td>Understand the legal and ethical issues regarding the use of biotechnology to cure diseases. (PS-A1.3)</td>
<td>Cite specific examples of how and where biotechnology is used in medical, agricultural, environmental, and industrial applications as well as social or political situations, including criminal investigations, lawsuits, evolutionary studies, etc.</td>
<td>• Illustrate examples of how biotechnology has led to benefits and risks to society and how biotechnical advances affect human lives on a personal level.</td>
</tr>
<tr>
<td></td>
<td>Understand the relationship between morality and ethics in the development of biotechnology health care products. (PS-A6.1)</td>
<td>Identify the rights, interests, and responsibilities of people involved in bioethical issues.</td>
<td>• Formulate opinions about engineered organisms and products based on current scientific evidence.</td>
</tr>
<tr>
<td></td>
<td>Know the differences between personal, professional, and organizational ethics. (PS-A6.2)</td>
<td>Describe the need for and function of regulatory agencies such as those in government, industry, and society.</td>
<td>• Analyze policy-making procedures for products and techniques of biotechnology.</td>
</tr>
<tr>
<td></td>
<td>Understand the need for ethical policies and procedures in institutions engaged in biotechnology research and product development. (PS-A6.4)</td>
<td>Understand the role of personal integrity and ethical behavior in the workplace. (FS 8.3)</td>
<td><strong>Skills Focus:</strong> Research and debate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Investigate a science-based societal issue by researching the literature, analyzing data, and communicating the findings. (IE-1m)</td>
<td></td>
</tr>
</tbody>
</table>

**Perf. Std. Measures**

How students DEMONSTRATE KNOWLEDGE and SKILL.

**Instructional Support**

**Appx Time**

**Key Assignments:**

- **Suggested:**
  - Bioethical Debate

**Supplemental Resources:**

- Biotech SNM, 1.6

- Key Vocabulary:
  - morality ethics bioethical
## Careers in Biotechnology

<table>
<thead>
<tr>
<th>Content Standards (CONTENT)</th>
<th>Perf. Std. Measures (SKILL)</th>
<th>Instructional Support</th>
<th>Appx Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Students know…”</td>
<td>“Students are able to…”</td>
<td>How students DEMONSTRATE KNOWLEDGE and SKILL.</td>
<td></td>
</tr>
<tr>
<td><strong>Making a Living in Biotechnology</strong></td>
<td></td>
<td><strong>Biotech SNM. 1.3,5</strong></td>
<td>5 Days</td>
</tr>
<tr>
<td>Understand how the fields of nanotechnology, bioinformatics, genomics, proteomics, and transcriptomics influence new and emerging career opportunities. (PS-A3.2)</td>
<td>• Elaborate the opportunities for careers in biotechnology in health, medicine, genetics, agriculture, etc. &lt;br&gt;• Present arguments for pursuing careers in biotechnology at differing entry-levels. &lt;br&gt;• Demonstrate knowledge of the vast variety of departments and positions, scientific and non-scientific, at a typical biotechnology company. <strong>Skills Focus:</strong> Know important strategies for self-promotion in the hiring process, such as job applications, resume writing, interviewing skills, and preparation of a portfolio. (FS 3.6) research</td>
<td><strong>Key Assignments:</strong> &lt;br&gt;• Suggested:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Supplemental Resources:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Biotech Portfolio &lt;br&gt;Develop a portfolio that demonstrates proficiency in specific tasks including writing samples and performance-based skills.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Biotech Resume &lt;br&gt;Create an appropriate resume for use in applying for laboratory positions at a biotechnology company.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Key Vocabulary:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>resume, nanotechnology, bioinformatics, genomics, proteomics, transcriptomics</td>
<td></td>
</tr>
</tbody>
</table>

This provides all the pieces needed to construct a good curriculum map with the exception of the essential questions and the order which are best developed by the teacher.
**KEY ASSIGNMENTS / ASSESSMENTS:**

| Laboratories | Students will set up and use their own personal lab notebooks to record and evaluate each major laboratory performed. The notebook entries for each laboratory will include hypothesis, protocols, materials used, raw data, analysis, and a detailed discussion section. Students will be required to understand and use professional best laboratory practices as they pertain to the structure and use of their laboratory notebook. |
| Written tests | These include 4 to 5 essay questions that assess the level of student knowledge and understanding of key concepts. For example, an essay question might ask students to write several paragraphs that discuss the methods used and their understanding of how spectroscopy can be used to measure the concentration of large molecules (i.e., proteins and nucleic acids). In addition, tests would include objective questions that would assess basic knowledge, conceptual understanding, and vocabulary. |
| 1<sup>st</sup> Semester Project | Students will investigate a disease and how biotechnology has developed better ways to prevent, diagnose, and/or treat the disease by conducting an in-depth literature search, reading a minimum of five journal articles and using this information to prepare a 15-minute PowerPoint presentation to be presented to peers. |
| 2<sup>nd</sup> Semester Project | Students develop an independent investigation that incorporates several of the methods that have been used. They will be responsible for the background research needed to develop the experimental design of the investigation as well as the adjustment of methods. They will then carry out the investigation, analyze their data, and prepare a board that communicates their work. |
| Comprehensive Semester Finals | Each semester final includes an objective section, three to four detailed essay questions, and a practical exam section that assesses student knowledge of equipment use, calibration and measurement skills, methods steps, and proper data analysis. The practical portion of the final would ask questions as to the purpose of an instrument, or would require students to use a standard curve to determine the size of an unknown molecule. |

**KEY LABORATORY ACTIVITIES:**

Our district recommends that approximately 40% of instructional time be devoted to hands-on laboratory and project-based activities. Core experiences for this course include detailed laboratories with complete write-ups on the following topics:

**Setting up a Legal Scientific Notebook**

Students will set up their own personal lab notebook that will include hypothesis, protocols, materials used, raw data, analysis as well as a detailed discussion section. They will be required to understand and use best laboratory practices as they pertain to the structure and use of their laboratory notebook.

**Solution and Dilution Preparation**

Students will make appropriate mass per volume, percent mass per volume, molar and serial concentrations of solutions necessary for lab experiments.

**Model Organism Growth / Media Preparation**

Students will prepare and inoculate media plates with model organisms *E. coli* and *Aspergillus* and use sterile technique to grow broth cultures of model organisms.

**DNA Isolation and Indicator Analysis**

Students will isolate DNA from *Salmo* (salmon testes), *Fragaria* (strawberries) and *E. coli*. They will also use the DPA (Diphynlamine) Test to detect the presence of DNA and RNA and the Biuret Test to detect the presence of protein in their extracts.

**Agarose Gel Electrophoresis**

Students will run samples of their *Salmo*, *Fragaria* and *E. Coli* DNA extracts as well as 50 µg/mL samples of yeast DNA, pBR322 DNA (plasmid) and Lambda DNA on 0.8% agarose gels to gain information about the size of the DNA fragments.

**Protein Isolation and Indicator Analysis**

Students will isolate protein from several animal muscle samples and confirm the presence of protein using Biuret reagent. Students will prepare protein samples of a specified concentration using PAGE (polyacrylamide gel electrophoresis) running buffer for analysis using vertical gel electrophoresis.

**Polyacrylamide Gel Electrophoresis**

Students will investigate the structural characteristics of amylase, pectinase, cellulase and lysozyme by running and staining PAGE gels.
Protein and Enzyme Studies / Assays
Students will investigate the action of the protease, cellulase, bovine rennin and pectinase on apple juice production. They will also design a valid experiment that demonstrates the presence of proteases such as papain in sample solutions of meat tenderizer, pineapple juice, or laundry detergents. Students will make Biuret reagent and determine the lowest concentration of protein that can be accurately determined using this reagent.

Amylase Assay Development
Students will perform tests on sample solutions of glucose, maltose and gelatin for the presence of starch using iodine and for the presence of sugars using Benedict’s solution. They will test the activity of both human and bacterial amylase on the digestion of serial starch solutions using glucose test strips, Benedict’s solution and Lugol’s Iodine. They will then apply this to search for amylase-producing bacteria from plant, soil and surface area samples using 2% starch/LB agar and observing plates for characteristic “halos” where starch has been digested.

Peroxidase Assay Development
Students will test animal (beef liver, chicken muscle) and plant (apple, potato, onion, carrot, horseradish root) for peroxidase activity. They will then isolate horseradish peroxidase (HRP) from horseradish root extract and assay for its presence using a PAGE. Students will also test for the presence of HRP in horseradish root extracts using the indicator TMB (3,3',5,5'-tetramethylbenzidine).

pH meter use
Students will use both pH paper and pH meters to determine the acid or alkaline properties of buffer solutions.

Using Spectrophotometry to Study Molecules
Students will determine the absorption spectrum for amylase (+Bradford protein reagent) and the lambdamax for the amylase (+Bradford protein reagent) mixture.

Protein Concentration Assays
- Students will determine the concentrations of two unknown amylase solutions.
- Students will plan and execute trials to compare the concentration sensitivities of both a Bradford assay and a BCA (bicinchoninic acid) assay on amylase solutions using a UV/VIS spectrophotometer.
- Students will prepare absorbance spectra for different concentrations of a colorless protein and determine the lambdamax for this same protein.

Restriction Digestion / Enzyme Mapping with Agarose Gel Electrophoresis Analysis
Students will perform a lambda DNA/HindIII restriction digestion and evaluate the digestion on an agarose gel and compare with commercially available Lambda DNA + HindIII standard markers.

Recombinant Plasmid / Cloning Vectors
Students will learn about restriction endonuclease enzymes, their use in making recombinant plasmid vectors and how these cloning vectors may be cloned.

Cell Competency and Bacterial Transformation and Selection
Students will transform E. coli cells with a recombinant pAmylase plasmid containing a gene for ampicillin resistance and a gene for amylase production and select for transformed cells using 2% starch LB agar/ampicillin media. They will then confirm genetically engineered E. coli cells have been transformed with the correct DNA by performing a miniprep procedure to extract plasmids. Then they will use UV spectroscopy to determine the concentration of plasmid DNA and run samples on a 1% agarose gel to confirm that the plasmid is pAmylase. Students will transform E.coli cells with a recombinant pGLO plasmid containing a gene for GFP (green fluorescent protein), a gene for ampicillin resistance and gene regulation system for the expression of GFP. Following transformation, the E.coli cells will be selected for transformed cells using LB agar/ampicillin/arabinose media. Transformed cells will be observed using UV light and transformation efficiency will be determined.

Protein Product Purification and Testing
Students will harvest GFP using HIC (hydrophobic interaction chromatography) columns. They will also use spectroscopy methods to determine the concentration of GFP extracted from E. coli cells.
INSTRUCTIONAL METHODS AND/OR STRATEGIES:
A variety of instructional strategies will be utilized to accommodate all learning styles:

Biotechnology-specific:
1. lectures, videos, and demonstrations
2. readings from texts, journals, and internet sites
3. laboratory experiments and detailed written laboratory reports that emphasize experimental analysis
4. pre- and post-lab discussions
5. oral PowerPoint presentations
6. field trips, guest speakers
7. long-term research projects and written report using standard journal outlines
8. on-line databases for molecular modeling and bioinformatics

Lesson Design & Delivery: Teachers will incorporate these components of lesson design during direct instruction and inquiry activities. The order of components is flexible, depending on the teacher's vision for the individual lesson. For instance, the objective and purpose, while present in the teacher's lesson plan, are not made known to the students at the beginning of an inquiry lesson.

Some components may occur once in a lesson, but others will recur many times. Checking for understanding occurs continually; input, modeling, guided practice and closure may occur several times. There may even be more than one anticipatory set when more than one content piece is introduced.

Active Participation: Teachers will incorporate the principles of active participation and specific strategies to ensure consistent, simultaneous involvement of the minds of all learners in the classroom. This allows for broad monitoring of student understanding and rapid adjustment of instruction. Teachers should include both covert and overt active participation strategies, incorporating cooperative learning structures and brain research. Some of the possible active participation strategies include:

<table>
<thead>
<tr>
<th>COVERT</th>
<th>OVERT (Oral)</th>
<th>OVERT (Written)</th>
<th>OVERT (Gestures)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recall</td>
<td>Pair/Share</td>
<td>Restate in Journals / Notes</td>
<td>Hand Signals</td>
</tr>
<tr>
<td>Imagine</td>
<td>Idea Wave</td>
<td>Response Boards</td>
<td>Model with Manipulatives</td>
</tr>
<tr>
<td>Observe</td>
<td>Choral Response</td>
<td>Graphic Organizers</td>
<td>Stand up/ Sit down</td>
</tr>
<tr>
<td>Consider</td>
<td>Give One, Get One</td>
<td>Folded Paper</td>
<td>Point to Examples</td>
</tr>
<tr>
<td></td>
<td>Socratic Seminar</td>
<td>Ticket Out of Class</td>
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</tr>
<tr>
<td></td>
<td>Cooperative Discussion</td>
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</tr>
<tr>
<td></td>
<td>Groups (i.e. Talking Chips, Gambit Chips)</td>
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</tbody>
</table>

Baldridge Quality Tools: Students can become more positively involved in their education through goal setting, self-assessment, and data tracking and analysis by making use of the following strategies:

<table>
<thead>
<tr>
<th>BALDRIDGE TOOL</th>
<th>PURPOSES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affinity Diagram</td>
<td>– finding consensus, organizing complex information</td>
</tr>
<tr>
<td>Flowchart</td>
<td>– describing a process, planning a project, identifying problem steps in a process</td>
</tr>
<tr>
<td>Force Field Diagram</td>
<td>– identifying obstacles, finding causes and solutions to problems</td>
</tr>
<tr>
<td>Issues / Ideas Bin</td>
<td>– handling individual questions/requests without stopping a group activity, providing anonymous input, obtaining diverse input in specific areas.</td>
</tr>
<tr>
<td>Data Folder</td>
<td>– tracking goals and actual results</td>
</tr>
<tr>
<td>Plus / Delta</td>
<td>– tracking improvement efforts, identifying opportunities for change, finding out what's working and what's not working in a process, procedure, activity, etc.</td>
</tr>
<tr>
<td>Class Data Graphs</td>
<td>– displaying trends for goal setting</td>
</tr>
</tbody>
</table>
Learning styles and learning challenges of your students may be addressed by implementing combinations of the following:

Learning styles of students may be addressed by implementing combinations of the following:

**Significant, Proven Strategies for ALL Students**

- Hands-On Lab's
- Inquiry Activities
- Short/Long-term projects
- Student Presentations
- Peer Teaching
- Summarization
- Essential Questions
- Thematic Units
- Field Experiences
- Career Choices
- Field Experiences
- Guest Speakers

**Reading Strategies in Science**

- Learning Logs
- Pre-teaching
- Vocabulary
- Pre-reading
- Text Structures
- Trail Markers
- Reciprocal Teaching
- Functional Text

**SDAIE Strategies for English Learners**

- Tapping/Building Prior Knowledge (Graphic Organizers, Schema)
- Grouping Strategies
- Multiple Intelligences
- Adapt the Text
- Interactive Learning (Manipulatives, Visuals)
- Acquisition Levels
- Language Sensitivity
- Lower the Affective Filter (including Processing Time)
- Home/School Connection (including Cultural Aspects)

**Differentiation for Advanced Learners**

- Curriculum Compacting
- Tiered Assignments
- Flexible Grouping
- Acceleration
- Depth and Complexity
- Independent Study

Please note that these strategies often overlap and should not be limited to specifically defined courses or student populations.

**TEXTBOOKS:**

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Read in entirety over 4 sem course 1/2-3/4 sequence</td>
<td>Exclude used</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th></th>
<th></th>
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<td>Exclude used</td>
</tr>
<tr>
<td>Read in entirety</td>
<td>Exclude used</td>
</tr>
</tbody>
</table>

| Safety Equipment: | Fire extinguisher, eye wash station, goggles |
| Measuring Devices: | Centigram balances, analytical balance, pipettes, micropipettes, volumetric graduated cylinders, colony counters, thermometers, pH meters |
| Other Laboratory Equipment: | Microscopes, Bunsen burners, electrophoresis equipment, spectrophotometer, water baths, incubators, autoclave, DI water system, hot plates, microwave oven, refrigerator, centrifuge, laminar flow hood, pipette pumps, standard equipment comparable to a professional or college laboratory |
| Laboratory Supplies: | Chemical reagents, petri dishes, filter paper, chromatography paper, test tubes, nicksome loops, microtubes, pipette tips |
| Other: | Word processing, spreadsheet, and presentation programs. |

- Some generic items are shared in your science department or may be available through Science/Math Resource Center (SMRC).
RESOURCES:

**Documents**
- Science Safety Handbook for CA Public Schools (1999) [can be ordered Science Curriculum Office](http://www.lbusd.k12.ca.us/curriculum/Curriculum%20Services/Science/science.htm)
- LBUSD Approved Chemicals List, Chemical Hygiene Plan, and Science Fair Resources: [http://www.lbusd.k12.ca.us/curriculum/Curriculum%20Services/Science/science.htm](http://www.lbusd.k12.ca.us/curriculum/Curriculum%20Services/Science/science.htm)

**District Offices**
- Science Curriculum Office (562) 997-8000 (ext. 2963)
  - K-12 science standards, curriculum, professional development, science fair
- Science / Math Resource Center (562) 997-8000 (ext. 2964)
  - Hands-on materials, consumable material orders, alternative standards-based curriculum packets
- Office of Multimedia Services (OMS) (562) 997-8000 (ext. 7145)
  - Videos for check out to fit the curriculum (see your librarian for current catalogs)
  - District TV channels programming
- PALMS Office (562) 997-8000 (ext. 8031)
  - Program Assistance for Language Minority Students
  - Technical assistance and professional development for English Language Development (ELD) and Specially Designed Academic Instruction in English (SDAIE)
  - Assistance in the implementation and maintenance of programs addressing the needs of English Language Learners (ELLs)

**ASSESSMENT METHODS AND/OR TOOLS:**
Student achievement in this course will be measured using multiple assessment tools including but not limited to:

**Suggested Evaluation Tools:**

<table>
<thead>
<tr>
<th>Source</th>
<th>Diagnose</th>
<th>Monitor</th>
<th>Evaluate</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMC Paradigm: Biotechnology: SNM</td>
<td>Skills evaluation</td>
<td>Notebook Checks</td>
<td>Tests</td>
</tr>
<tr>
<td>Teacher Developed Assessments</td>
<td>Quizzes</td>
<td>Formal laboratory reports</td>
<td>Written, oral, performance-based, and lab. practical examinations</td>
</tr>
<tr>
<td></td>
<td>Active Participation strat’s</td>
<td>Monthly eval of legal scientific notebook</td>
<td></td>
</tr>
</tbody>
</table>

Learning styles of students will be best assessed by implementing combinations of the following:
- laboratory-based performance tasks
- long-term projects and inventions
- portfolios
- model-building
- research projects using primary source
- written reports with oral presentations
- cooperative group assessment
- homework assessment
- notebook organization and note-taking skills
- peer evaluation
- rubric scoring
- open-ended written assessment
- single-response testing

**Performance Standards:**
Defines how good is good enough on which measures to demonstrate achievement of content standards.

**Classroom Performance Standards:**
Students must pass all exams with a score of 80% or higher. Students who score lower than 80% on any examination will be assigned mandatory tutorial sessions during their free period.
Students must maintain a complete and accurate scientific notebook.
SUGGESTED GRADE WEIGHTING:
(with some possible examples)

1. **Assessment** ~30%
   - objective tests including comprehensive finals
   - performance tasks (rubric scored)
   - open-ended questions (rubric scored)
   - portfolios
   - peer evaluations

2. **Homework** ~10%
   - discovery assignments
   - assignments reinforcing class lesson
   - essays
   - organization

3. **Labs** ~30%
   - lab reports
   - active participation
   - safety practices

4. **Projects** ~20%
   - science fair projects
   - research-based reports and projects

5. **Classwork** ~10%
   - preparation (work environment)
   - interpersonal skills

STANDARD GRADING SCALE:

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Proficient</td>
<td>A 90 – 100%</td>
</tr>
<tr>
<td>Proficient</td>
<td>B 80 – 89%</td>
</tr>
<tr>
<td>Partial Proficient</td>
<td>C 70 – 79%</td>
</tr>
<tr>
<td>Not Proficient</td>
<td>D 60 – 69%</td>
</tr>
<tr>
<td></td>
<td>E 50 – 59%</td>
</tr>
<tr>
<td></td>
<td>F 0 – 59%</td>
</tr>
</tbody>
</table>

Submitted by:       C. Bater / K. O’Neill
School/Office:     CAMS
Original Date:     8/18/2009
Revised Date:      6/11, A. Gonzales
Board Date:        7/18/11