

Biotechnology

COURSE OUTLINE

1. **Course Title:** Health Science III
2. **CBEDS Title:** Other health careers course
3. **CBEDS Number:** 4298
4. **Job Titles:**

Quality Control Analyst	Biochemist/Research Assistant
Materials Assistant	Molecular Biologist/Professor
Staff Research Associate	Sales Representative
Lab Assistant/Technician	Molecular Biologist
Plant Biologist	Forensic Scientist
DNA Analyst	Research Scientist

5. **Course Description:**

This course builds upon concepts learned in pre-requisite courses in the areas of genetics, microbiology, biochemistry, and biotechnology. Students will expand their laboratory skills, critical thinking and communication skills currently used in the fields of genetics, microbiology and biotechnology. Students will have the opportunity to work with mentors in the profession and apply their knowledge of chemistry, anatomy, physiology and biotechnology.

6. **Objectives:**

Upon completion of this course, the students will be able to:

- A. Understand the role of biotechnology in society including the risks and benefits.
- B. Understand the basic biological and chemical processes of cells, tissues, and organisms.
- C. Gain a deeper understanding of the significance of biotechnology in pharmaceutical development, agriculture, forensics, genetic testing, industrial products, and scientific research.
- D. Expand laboratory skills used in academic and industrial biotechnology laboratories.
- E. Model the steps involved in the production of a recombinant DNA biotechnology product.
- F. Explore applications in the growing biotechnology fields of pharmacogenetics, environmental and marine biotechnology and biodefense.

Pathway

Recommended Sequence	Courses
Introductory	Biotechnology 1, 2
Skill Building	Biotechnology 3, 4
Advanced Skill	Senior Science Seminar

6. **Hours:** *Students receive up to 160 hours classroom instruction and 20 internship hours*

7. **Prerequisites:** Biotechnology 1, 2, 3, 4

8. **Date (of creation/revision):** July 2011

9. . Course Outline

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Upon successful completion of this course, students will be able to demonstrate the following skills necessary for entry-level employment.				
Instructional Units and Competencies Guaranteed curriculum = regular font Negotiated curriculum = italicized	Course Hours	Model Curr. Standards	CA Academic Content Standards	CAHSEE
I. CAREER PREPARATION A. Career Planning and Management. 1. Know the personal qualifications, interests, aptitudes, knowledge, and skills necessary to succeed in careers. a. Students will identify skills needed for job success b. Students will identify the education and experience required for moving along a career ladder. 2. Understand the scope of career opportunities and know the requirements for education, training, and licensure. a. Students will describe how to find a job. b. Students will select two jobs in the field and map out a timeline for completing education and/or licensing requirements. 3. Know the main strategies for self-promotion in the hiring process, such as completing job applications, resume writing, interviewing skills, and preparing a portfolio. a. Students will write and use word processing software to create a resume, cover letters, thank you letters, and job applications. b. Students will participate in mock job interviews. 4. <i>Develop a career plan that is designed to reflect career interests, pathways, and postsecondary options.</i> a. <i>Students will conduct a self—assessment and explain how professional qualifications affect career choices.</i> 5. <i>Understand the role and function of professional organizations, industry associations, and organized labor in a productive society.</i> a. <i>Contact two professional organization and identify the steps to become a member.</i> b. <i>Understand the past, present and future trends that affect careers, such as technological developments and societal trends, and the resulting need for lifelong learning.</i> a. <i>Students will describe careers in the business industry sector.</i> b. <i>Students will identify work-related cultural differences to prepare for a global workplace.</i> B. Technology. 1. Understand past, present and future technological advances as they relate to a chosen pathway and on selected segments of the economy. 2. Understand the use of technological resources to gain access to, manipulate, and produce information, products and services. 3. Use appropriate technology in the chosen career pathway. C. Problem solving and Critical Thinking. 1. Understand the systematic problem-solving models that incorporate input, process, outcome and feedback components, and apply appropriate problem-solving strategies and critical thinking to work-related issues and tasks.	20 Additional hours are integrated throughout the course.	Finance & Business Industry Sector, Model Curriculum Standards 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0	<u>Language Arts</u> (8) R 1.3, 2.6 W1.3, 2.5, LC 1.4,1.5 1.6 LS1.2, 1.3, (9/10) R2.1,2.3,2 W2.5 LC1.4 LS 1.1, 2.3 (11/12) R2.3 W2.5 LC1.2 <u>Math</u> (7) NS1.2, 1.7 MR 1.1,1.3 2.7,2.8, 3.1	Lang. Arts R 8.2.1 (9/10) R 2.1, 2.3 W2.5 Math (7) NS 1.2, 1.3, 1.7 MR 1.1, 2.1, 3.1

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Italicized text references "negotiated" curriculum; all other text references "guaranteed" curriculum.

<p>2. Use and apply critical thinking and decision making skills to make informed decisions, solve problems, and achieve balance in the multiple roles of personal, home, work and community life.</p> <p>D. Health and Safety.</p> <ol style="list-style-type: none"> 1. Know policies, procedures, and regulations regarding health and safety in the workplace, including employers' and employees' responsibilities. 2. Understand critical elements of health and safety practices related to a variety of business environments. <p>E. Responsibility & Flexibility.</p> <ol style="list-style-type: none"> 1. Understand the qualities and behaviors that constitute a positive and professional work demeanor. 2. Understand the importance of accountability and responsibility in fulfilling personal, community, and workplace roles and how individual actions can affect the larger community. 3. Understand the need to adapt to varied roles and responsibilities. <p>F. Ethics and Legal Responsibilities</p> <ol style="list-style-type: none"> 1. Know the major local, district, state, and federal regulatory agencies and entities that affect the industry and how they enforce laws and regulations. 2. Understand the concept and application of ethical and legal behavior consistent with workplace standards. <ol style="list-style-type: none"> a. <i>Contact a business and obtain a copy of their rules for employment.</i> b. <i>Role play difference ethical scenarios.</i> 3. Understand the role of personal integrity and ethical behavior in the workplace. <p>G. Leadership and Teamwork.</p> <ol style="list-style-type: none"> 1. Understand the characteristics and benefits of teamwork, leadership, citizenship in the school, community, and workplace settings for effective performance and attainment of goals. 2. Understand the ways in which professional associations, such as the Assn. for Financial Professionals (AFP), and competitive career development activities enhance academic skills, career choices, and contribute to promote employability. 4. Know multiple approaches to personal conflict resolution and understand how to interact with others in ways that demonstrate respect for individual and cultural differences and for the attitudes and feelings of others. 				
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Instructional Units and Competencies	Hours	Industry Standards.	CA Academic Standards	CAHSEE
I Introduction A. Class policy B. Syllabus	1	Health Science & Medical Technology Industry Sector Biotech	<u>Language Arts</u> (8) R 1.3, 2.6 W1.3, 2.5. LC 1.4,1.5, 1.6	Lang. Arts R 8.2.1 (9/10) R 2.1,

<p>II. Identifying a Potential Biotechnology Product</p> <p>A. Students will outline the fundamental steps in a genetic engineering procedure and give examples of genetically engineered products.</p> <p>B. Students will describe the mechanism of action and the use of restriction enzymes in biotechnology research and recombinant protein production.</p> <p>C. Students will discuss techniques used to probe DNA for specific genes of interest.</p> <p>D. Students will explain the steps of a bacterial transformation and various selection processes for identifying transformants.</p> <p>E. Students will differentiate transformation, transfection, and transduction.</p> <p>F. Students will discuss the considerations for scaling up the production of transformed or transfected cells, the general cell culture protocol for scale-up, and the importance of complying with standard manufacturing procedures.</p> <p>G. Students will explain the usefulness of plasmid preparations, how they are performed, and how the concentration and purity can be determined with a UV spectrophotometer.</p> <p style="padding-left: 40px;">i. Students will use Internet resources to learn more about the characteristics of bacteriophage lambda and its use in biotechnology and create a paper model of the virus that teaches others about the phage's characteristics.</p> <p style="padding-left: 40px;">ii. Students will visit www.restrictionmapper.org and determine the number of restriction sites in the first 1000 nucleotides of the lambda bacteriophage for the following restriction enzymes, <i>MseI</i>, <i>BamHI</i>, <i>EcoRII</i>, and <i>SmaI</i>.</p>	39	<p>Research & Development Pathway A1.0, 1.1, 1.2, 1.3, 1.4 A2.0, 2.3, 2.4 A3.0, 3.1, 3.2 A5.0 A6.0, 6.3, 6.4</p> <p>Agriculture & Natural Resources Industry Sector Ag Science Pathway C3.0, 3.3, 3.4 C5.0 C11.0</p> <p>Public Services Industry Sector Protective Services Pathway C1.0, 1.1</p>	<p>LS1.2, 1.3, (9/10) R2.1,2.3,2.6 W2.5 LC1.4 LS 1.1, 2.3 (11/12) R2.3 W2.5 LC1.2 <u>Math</u> (7) NS1.2, 1.7 MR 1.1,1.3, 2.7,2.8, 3.1</p>	<p>2.3 W2.5</p> <p>Math (7) NS 1.2, 1.3, 1.7 MR 1.1, 2.1, 3.1</p>
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Instructional Units and Competencies	Hours	Industry Standards.	CA Academic Standards	CAHSEE
<ul style="list-style-type: none"> iii. Students will group in teams of two to four and produce a poster that outlines and illustrates one of the sections of the Code of Federal Regulations for cGMP. iv. Students will visit www.pbs.org/wgbh/harvest/exist and examine the benefits and risks and take a personal position on whether or not the US should grow genetically modified crops. v. NSF Funding Committee activity. Students will decide who receives how much funding and why. 				

<p>III. Bringing a Biotechnology Product to Market</p> <ul style="list-style-type: none"> A. Students will compare and contrast the methods for harvesting intracellular and extracellular proteins. B. Students will define chromatography and distinguish between paper, thin-layer, and column chromatography, giving examples of each procedure. C. Students will discuss the variables used to optimize column chromatography. D. Students will explain how product quality is maintained for key types of biotechnology and pharmaceutical products. E. Students will describe the clinical testing process for pharmaceuticals. F. Students will discuss the final marketing and sales considerations in bringing a product to market. <ul style="list-style-type: none"> i. Students will develop a poster that diagrams the major steps in the R&D, manufacture, purification, and marketing of a rDNA protein product that is destined to become a pharmaceutical. ii. Students will access information about a company's business and scientific interests through obtaining an annual report. iii. Students will work with partners and use the Internet site www.modimes.org and find the list of birth defects/genetic disorders and select 20 to study and chart. 	30			
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<p style="text-align: center;">iv. Students will work individually on a Bioethics activity and record their response in a journal.</p>				
<p>IV. Biotechnology in Agriculture</p> <p>A. Students will describe the role of meristematic tissue in propagating plants by various asexual methods.</p> <p>B. Students will outline and discuss the process of plant tissue culture, including the importance of the different hormones involved, and identify the importance of the different hormones involved, and identify the advantages and challenges of plant tissue culture.</p> <p>C. Students will give specific examples of agricultural and horticultural biotechnology applications, including genetically modified organism (GMO) crops, hydroponics, and plant-made pharmaceuticals.</p> <p>D. Students will explain the fundamental process of genetic engineering and give examples of the following applications: recombinant DNA technology, site-specific mutagenesis, and gene therapy.</p> <p>E. Students will summarize the methods used to produce transgenic plants and explain the selection processes for identifying transformed plant cells.</p> <p style="padding-left: 40px;">i. Students will use a diagram of a plant found on the Internet as a guide and draw the body of a “typical” flowering plan on 11 x 17 paper, including all the plant organs and tissues listed.</p> <p style="padding-left: 40px;">ii. Students will use the Internet to visit http://image.fs.uidaho.edu/vide/spindex.htm to learn more about plant virusus.</p> <p style="padding-left: 40px;">ii. Students will use the Internet to visit http://image.fs.uidaho.edu/vide/spindex.htm to learn more about plant virusus.</p>	30			

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<p>iii. Students will work in teams of four to create a seven-slide PowerPoint presentation with annotated photos and graphics that demonstrates how biotechnology has impacted the livestock industry.</p> <p>iv. Students will use the Internet to learn more about Arabidopsis by finding the requested information, listing the Web site URL and creating a one page fact sheet to distribute to other students.</p> <p>v. Students will examine the benefits and risks and take a personal position on whether or not the United States should grow GMO's.</p>				

<p>VII. Making DNA Molecules</p> <p>A. Students will describe the process of semiconservative DNA replication in cells and compare and contrast this method with DNA synthesis in the laboratory.</p> <p>B. Students will discuss the uses of synthesized oligonucleotides and identify the attributes of good primers.</p> <p>C. Students will explain the steps of PCR and discuss the components and optimization of the process.</p> <p>D. Students will discuss the function of a thermal cycler and how PCR results are visualized.</p> <p>E. Students will describe applications of PCR technology, including uses in the field of forensics.</p> <p style="padding-left: 40px;">i. Students will gather and share information about a known extremozyme.</p> <p style="padding-left: 40px;">ii. Students will visit the Dept. of Forensic and Detective Science, University of Central Lancashire at www.uclan.ac.uk/facs/science/forensic/whatis and complete the three scenarios; list the kinds of evidence presented; list three new things learned about forensics and criminal investigations.</p>	30			
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Instructional Units and Competencies	Hours	Industry Standards.	CA Academic Standards	CAHSEE
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<ul style="list-style-type: none"> iii. Students will learn about how microarrays are made and how they help in disease research by completing the activity on the Affymetrix outreach educator Web site at www.affymetrix.com/corporate/outreach/educator.affx. iv. Students use the Internet and find information about additional gender-selection techniques and examine their own beliefs regarding gender-selection technologies and record in their journal. 				
<p>VIII. Advanced Biotechnology Techniques</p> <ul style="list-style-type: none"> A. Students will discuss the benefits and implications of knowing the DNA sequences of humans and other organisms. B. Students will explain how DNA is sequenced using the Sanger Method and the recent improvements that have increased the efficiency of this process. Students will describe some of the tools used in genomics and the advances made possible by them. C. Students will discuss the field and potential of proteomics and the methods used for protein study D. Students will outline the important application of the growing biotechnology fields of pharmacogenetics, environmental and marine biotechnology, and bioterrorism/biodefense. <ul style="list-style-type: none"> i. Students will use Internet sources to find information about the lambda bacteriophage genome, create a paper model and write an explanation on how the virus infects and controls an <i>E.coli</i> cell. ii. Students will use Internet sources to learn about the new application of nanotechnology, select, read and write a summary of the article. iii. Students will make an “Evolution of Biotechnology Timeline: to show the major biotechnological developments of the past 250 years. 	20			

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iv. Students will weigh the advantages and disadvantages of DNA testing of an entire town's male population to find a murder suspect by visiting www.capecodtoday.com/blogs/index.php/Murder to learn about the circumstances of the murder.				

10. Additional recommended/optional items

a. Articulation: None

b. Academic credit: N/A

c. Instructional strategies:

Methods of Instruction:

- a. Lecture
- b. Audio Visual Materials
- c. Research Readings and Written Presentations
- d. Homework Assignments
- e. Group & Individual Activities
- f. Quizzes, Tests & Final Exam
- g. Internet Exploration
- h. Job Shadowing & Internships

d. Instructional materials: **Biotechnology, Science for the New Millennium**. Ellen Daugherty, MST., San Mateo Biotechnology Career Pathway, Paradigm Publishing, 2007.

Teacher Generated

e. Certificates: CPR