Course Description

A. COVER PAGE

Date of Submission October 13, 2006

1. Course Title
Biotechnology 1,2

2. Transcript Title(s) / Abbreviation(s)
Biotechnology 1,2

3. Transcript Course Code(s) / Number(s)

4. ~~School~~/PROGRAM
Los Angeles County ROP (and its member districts)

5. District
LACOROP member districts

6. City
Downey

7. School / District Web Site
www.lacorop.org

8. School Course List Contact

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9. Subject Area

- [ ] History/Social Science
- [ ] English
- [ ] Mathematics
- [x] Laboratory Science
- [ ] Language other than English
- [ ] Visual & Performing Arts
  - [ ] Intro [ ] Advanced
- [ ] College Prep Elective

10. Grade Level(s) for which this course is designed

[ ] 9 [x] 10 [x] 11 [x] 12

11. Seeking "Honors" Distinction?

[ ] Yes [x] No

12. Unit Value

- [ ] 0.5 (half year or semester equivalent)
- [x] 1.0 (one year equivalent)
- [ ] 2.0 (two year equivalent)
- [ ] Other: _____

13. Is this an Internet-based course? [ ] Yes [x] No

If "Yes", who is the provider? [ ] UCCP [ ] PASS/Cyber High [ ] Other _____

14. Complete outlines are not needed for courses that were previously approved by UC. If course was previously approved, indicate in which category it falls.

- ☐ A course reinstated after removal within 3 years. Year removed from list? _____
  - Same course title? ☐ Yes ☐ No
  - If no, previous course title? _____
- ☐ An identical course approved at another school in same district. Which school? _____
  - Same course title? ☐ Yes ☐ No
  - If no, course title at other school? _____
- ☐ Year-long VPA course replacing two approved successive semester courses in the same discipline
- ☐ Approved Advanced Placement (AP) or International Baccalaureate (IB) course
- ☐ Approved UC College Prep (UCCP) Online course
- ☐ Approved CDE Agricultural Education course
- ☐ Approved P.A.S.S./Cyber High course
- ☐ Approved ROP/C course. Name of ROP/C? _____
- ☐ Approved A.V.I.D. course
- ☐ Approved C.A.R.T. course
- ☐ Approved Project Lead the Way course
- ☐ Other. Explain: _____

15. Is this course modeled after an UC-approved course from another school outside your district? ☒ Yes ☐ No

If so, which school(s)? San Mateo High School

Course title at other school Biotechnology 1, 2

16. Pre-Requisites

Biology

17. Co-Requisites

Algebra 1

~~Chemistry (or currently enrolled)~~ (removed 4/07)

18. Is this course a resubmission? ☒ Yes ☐ No

If yes, date(s) of previous submission? February 2006

Title of previous submission? Biotechnology

19. Brief Course Description

The Biotechnology course instructs students in laboratory concepts, techniques, and methods using critical thinking, communications, technical reading, and writing skills required in the fields of genetics, microbiology, and biotechnology.
Instruction in DNA theory, ethics, and technology and society will be covered to acquaint students with the challenges of this emerging field.
This course also includes laboratory experience in utilizing gel electrophoresis, plating and culturing bacteria, manipulating, fingerprinting, mapping DNA, and microscopic techniques (e.g. oil-emersion and staining of tissues).
Students will research, analyze, write, and present technical papers recording the progress and results of their work.
Parameters of instruction include, classroom theory, laboratory applications with individual and group projects, and assisting in community biotechnology research and development.
Opportunities for post-secondary education and employment will be explored allowing students to gain a broad awareness of both scientific and technological career paths.

B. COURSE CONTENT

Please refer to instructions

20. Course Goals and/or Major Student Outcomes:

Students will:

- Demonstrate ability to solve problems and think critically by completing challenging group and individual projects and assignments effectively.
- Demonstrate the ability to solve mathematical and scientific concepts related to biotechnology.
- Demonstrate the ability research, analyze, synthesis, and evaluate information from multiple sources.
- Demonstrate technical writing skills.
- Accept personal responsibility for decisions and actions.
- Understand the role of biotechnology in society including the risks and benefits.
- Understand the basic biological and chemical processes of cells, tissues, and organisms.
- Gain a deeper understanding of the significance of biotechnology in pharmaceutical development, agriculture, forensics, genetic testing, industrial products, and scientific research.
- Learn basic laboratory skills used in academic and industrial biotechnology laboratories.
- Learn how a biotechnology company works and the roles of its employees.
- Model the steps involved in the production of a recombinant DNA biotechnology product.
- Gaining an understanding and exposure to assorted topics/concepts in biotechnology.

21. Course Objectives for Biotechnology 1, 2

Students will cover the following California Standards:

- California Science Content Standards:
  - B=Biology/Life Science, C=Chemistry, IE=Investigation and Experimentation)
- California Career and Technical Standards (CTE):
  - BP=Biotechnology Research and Development Pathway, Foundation Standards: Academic (Math and Language Arts), Communication (reading, writing, and listening), Career Planning and Management (Effective decisions, use career information, and manage personal career plans), Technology (use contemporary and emerging technology resources in diverse and changing personal, community and workplace environment), Problem Solving and Critical Thinking (Create alternative solutions by using critical and creative thinking skills, such as logical reasoning, analytical thinking, and problem-solving techniques)

Introduction to Biotechnology

Students will:

1. Describe major historic developments in biotechnology fields (e.g. pharmaceutical development, agriculture, forensics, genetic testing, diagnostics, industrial products, instrumentation, and scientific research).
2. Understand the role of biotechnology in society including the risks, benefits, and its impact on society.
3. Prepare a written report on the role of biotechnology product development in curing genetic, environmental, and behavioral diseases.
4. Identify major scientific discoveries that lead to recombinant DNA technology.
5. Outline steps in production and delivery of product made through recombinant DNA technology. (B5-c)
6. Use scientific method to conduct a valid experiment. (IE-1f) Prepare written research reports showing the ability to apply the scientific method to solutions of biotechnical problems.
7. Develop scientific questions, hypotheses, and experimental plans. (IE-1f)
8. Create data tables and graphs using spreadsheets (Excel) for the purpose of collecting and analyzing data. (IE-1e)
9. Interpret and critically analyze quantitative and qualitative data.
10. Compose a concluding statement outlining the results of an experiment using evidence, explanations, error analysis, and practical applications. (IE-1b, 1c)

11. Organize and communicate scientific findings both orally and in written form and produce clear, concise written and oral reports. (IE-1n)
12. Evaluate the validity of results obtained during experimentation and product development. Evaluate scientific reports with well-supported, clearly presented opinions. (IE-1n)
13. Use the internet and www to collect, analyze, and share scientific information.
14. Use a variety of methods including literature searches, in libraries, in computer databases, and on-line, for gathering background information, making observations, and collecting and organizing data. (IE-1m)
15. Work effectively in teams and individually. Demonstrate the principles of confidentiality.
16. Understand the role of the biotechnology industry and biotechnology product development in curing diseases. (BP-A1.0)

Characteristics of Common Organisms Used in Biotechnology

Students will:

1. Distinguish between prokaryotic cells, eukaryotic cells, and viruses. (B-1c)
2. Outline the life cycle and characteristics of model organisms used in the biotechnology industry, including various bacteria (*E. coli)* and fungi (yeasts and *Aspergillus*. (B-10d)
3. Use various methods to monitor the growth of cell cultures.
4. Describe conditions that promote cell growth under aseptic conditions in the laboratory and workplace.
5. Explain how environmental factors affect the growth of model organisms in the laboratory.
6. List and describe the structure and function of cellular organelles. (B-1a, B-1e, B-1f, B-1g)
7. Discuss the structure and function of the macromolecules that compose cells, including carbohydrates, lipids, DNA, RNA, and protein molecules. (C-10a, C-10b, C-10c, C-10f)
8. Conduct indicator tests (Benedict's, Iodine, Biuret) for the common macromolecules of the cell.
9. Explain the basic concepts of cell growth and reproduction, DNA replication, mitosis, meiosis, and protein synthesis.

Laboratory Operating Procedures

Students will:

1. Set-up and maintain a legal scientific notebook that includes an account of all laboratory procedures, data, and reflections.
2. Recognize laboratory safety hazards and avoid them. Identify the location and use of emergency equipment.
3. Properly and safely use and monitor a variety of scientific equipment, including pH meters, microscopes, spectrophotometers, pipets, micropipets, balances, etc.
4. Measure mass using electronic and analytical balances.
5. Measure volume using graduated cylinders, pipets, and micropipets.
6. Calculate how to prepare solutions based on mass/volume, % mass/volume, and molar concentrations. (C-3b, C-3c, C-3d, C-6a)
7. Prepare solutions of any volume and concentration. (C-3b, C-3c, C-3d, C-6a)
8. Prepare dilutions of concentrated solutions.
9. Outline the steps in cell culture, sterile technique, and media preparation.
10. Prepare and maintain plate and broth cultures of bacteria.
11. Determine which equipment is appropriate to use for a given task and what units of measurement are used. Use laboratory apparatus, materials, and technology in an appropriate and safe manner.
12. Follow written protocols and oral directions to perform a variety of laboratory and technical tasks.
13. Perform a variety of biological tests and chemical assays, collect data, perform calculations and statistical analysis.
14. Prepare and aliquot samples, reagents and buffers. Perform chemical reactions and purification procedures similar to those used in product development, testing, and manufacture.
15. Perform specimen collection, label samples, and prepare samples for testing. Handle, transport, and store samples.
16. Demonstrate the fundamentals of mathematical and scientific concepts related to biotechnology. (BP-A2.0)

17. Demonstrate the mathematical concepts relate to the field, such as the calculation of percentages, ratios, and differences between standard deviation and various measures of central tendency.
18. Understand the principles of solution preparation, contamination control, measurement and calibration, and emergency laboratory response. (BP-A4.0)
19. Master the skills necessary to perform molecular biology laboratory techniques as well as the master of the applications and implications of those techniques.

DNA Structure, Function, Isolation and Analysis
Students will:
1. Describe the relationship between nitrogen bases, nucleotides, and nucleic acids. (B-5a)
2. Recognize nucleotides on a DNA double helix model.
3. Explain how the structure of DNA affects its function.
4. Describe the role of DNA, RNA, and ribosomes in protein synthesis (The Central Dogma). (B-1d, B-4a, B-4b, B-5a))
5. Explain how the structure of DNA affects its isolation from cells and solutions.
6. Isolate genomic DNA from cells and analyze its purity and concentration.
7. Isolate plasmid DNA from cells (mini-preparation) and analyze its purity and concentration.
8. Explain the principles involved in agarose gel electrophoresis.
9. Prepare, load, run, visualize, and analyze DNA samples on an agarose gel.
10. Describe the differences in samples of eukaryotic and prokaryotic DNA samples on a gel.

Protein Structure, Function, Isolation and Analysis
Students will:
1. Identify eight groups of protein based on their functions, citing specific examples of proteins in each group. (B-1b, B-10b)
2. Explain the relationship between amino acids, peptides and proteins. (B-4e, B-4f)
3. Describe primary, secondary, tertiary, and quaternary structure in proteins.
4. Use the Internet to find information about the structure and function of specific proteins. (B-10b)
5. Prepare protein solutions and dilutions at specific concentrations and pH.
6. Use protein indicator solutions to identify the presence and concentration of protein in solution.
7. Explain the principles involved in polyacrylamide gel electrophoresis.
8. Prepare, load, run, visualize, and analyze protein samples on a polyacrylamide gel.
9. Describe the meaning in differences in peptide band seen on polyacrylamide gels. (B-4e, B-4f)
10. Explain the function of enzymes and how their activity is affected by temperature and pH. (B-1b)
11. Perform enzyme activity assays.

The Products and Applications of Modern Biotechnology
Students will:
1. Compare and contrast pure and applied scientific research in the field of biotechnology. (B-5c)
2. Identify several local biotechnology companies specializing in the production of pharmaceuticals, agricultural products, industrial products, and research instruments and reagents. (B-5c)
3. Describe the major steps in a product's move through a company's product pipeline. (B-5c)
4. Explain how companies decide on the research and development targets and potential products.
5. Identify several products obtained through recombinant DNA technology. (B-5c)
6. Cite examples of plant parts or extracts used as pharmaceuticals.
7. Use the Internet to find information about herbal remedies, traditional pharmaceuticals, and recombinant pharmaceuticals.
8. Produce and test plant extracts for anti-microbial activity.
9. Collect and test native bacteria for amylase production.

Assays and Assay Development

Students will:

1. Design an assay that shows the presence and activity of an enzyme.
2. Compare and contrast the use of different assays used in research and production of protein products.
3. Explain how Benedict's Solution and Lugol's Iodine are used in glucose and starch testing.
4. Describe how assays for reactants or products can indicate the presence or activity of an enzyme.
5. Illustrate how an ELISA assay works, the role of antibodies in an ELISA, and how it may be used in industry. (B-10b)
6. Conduct and ELISA assay to test for the presence of a specific protein.
7. Identify the common parts found on visible spectrophotometers and describe their function.
8. Elucidate the relationship between wavelength and the color of light.
9. Cite the colors of different wavelengths of light.
10. Outline the steps of using a visible spectrophotometer.
11. Describe the relationship between light transmittance and light absorbance in a sample.
12. Use a visible spectrophotometer to produce absorbance spectra.
13. Discuss the difference between acids, bases, and neutral solutions. (C-5a, C-5b, C-5c)
14. Use pH paper and pH meters to measure and adjust pH. (C-5d)
15. Define the function of a buffer and give examples of buffers used in a biotechnology lab.
16. Make several buffers at various volumes, concentrations, and pH.
17. Describe how pH affects protein structure and function. (B-1b)
18. Prepare a serial dilution of protein and measure their absorbance at a given wavelength.
19. Use a standard curve to determine the concentration of an unknown protein solution. (IE-1a)
20. Using Excel®, do a linear regression to calculate protein concentration. (IE-1a)
21. Use statistical analysis including the standard deviation, to determine the validity of data. (IE-1b, IE-1c)

Recombinant DNA and Genetic Engineering

Students will:

1. Discuss methods to isolate DNA and specific genes for engineering purposes. (B-5c, B-5d)
2. Enumerate the activities and uses of restriction enzymes. (B-5d)
3. Conduct a restriction digestion of a plasmid. (B-5d)
4. List the steps in the production of a recombinant DNA molecule. (B-5c)
5. Cite examples of vectors used in transformation, transduction, and transfection. (B-5d, B-5e)
6. Describe the steps in a bacterial transformation including competency, recovery, and selection. (B-5c, B-5e)
7. Conduct a bacterial transformation and select for transformants. (B-5e)
8. Describe methods by which transformants may be selected including antibiotic resistance, GFP and GUS activity. (B-5e)
9. Conduct mini-prep to retrieve plasmids from transformed cells.
10. 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. (BP-A3.0)
11. Recombinant DNA, genetic engineering, monoclonal antibody production, separation and purification of biotechnology products, and bioprocessing.
12. Develop a strong academic foundation in genetics to prepare for post-secondary education in biology, biochemistry, genetics, microbiology, or immunology.

Bringing the Products of Biotechnology to Market

Students will:

1. Outline the steps in product production, recovery, and purification.
2. Describe the characteristics of proteins that allow for their purification after cloning transformed cells.
3. Compare and contrast the processes of paper, thin-layer, and column chromatography. (C-6f)
4. Explain how PAGE is used with column chromatography to monitor protein product.

5. Describe the steps in harvesting protein product from fermentation cell culture.
6. Test for the presence and concentration of proteins in processed samples.
7. Cite the steps in buffer exchange and dialysis as used in protein processing.
8. Compare and contrast the mechanism of gel filtration, ion exchange and affinity chromatography.
9. Conduct an ion exchange chromatography to isolate proteins of different charge.
10. Explain the function and use of FPLC and HPLC in research and production.
11. Confirm the results of a column chromatography using spectrophotometry and PAGE.
12. Summarize the steps in clinical testing and FDA approval for new drugs produced through genetic engineering.
13. Inspect and verify inventory and integrity of products.
14. Discuss techniques of product packaging and distribution.
15. Record and report protocols, procedures, results, conclusions, manuals, reports and write memos and letters utilizing computer -processing.
16. Interact with colleagues and supervisors and coordinate tasks.
17. Understand biotechnology product design and development, laboratory procedures, product licensure, and the regulatory process for product development and clinical trials. (BP-A5.0)

Bioethics, Communication and Decision Making in the Biotechnology Industry
Students will:
1. 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. (IE-1m)
2. Illustrate examples of how biotechnology has lead to benefits and risks to society and how biotechnical advances affects human lives on a personal level. (IE-1m)
3. Identify the rights, interests, and responsibilities of people involved in bioethical issues.
4. Describe the need for and function of regulatory agencies such as those in government, industry, and society.
5. Analyze policy-making procedures for products and techniques of biotechnology.
6. Formulate opinions about engineered organisms and products based on current scientific evidence.
7. Understand the ethical, moral, legal, and cultural issues related to the use of biotechnology research and product development. (BP-A6.0)
8. Research and discuss/debate the ethical, moral, legal, and cultural issues related to the use of biotechnology research and product development.

Careers in Biotechnology and Career Essentials
Students will:
1. Elaborate the opportunities for careers in biotechnology in health, medicine, genetics, agriculture, etc.
2. Present arguments for pursuing careers in biotechnology at differing entry-levels.
3. Develop a portfolio that demonstrates proficiency in specific tasks including writing samples and performance-based skills.
4. Create an appropriate resume for use in applying for laboratory positions at a biotechnology company.
5. Demonstrate knowledge of the vast variety of departments and positions, scientific and nonscientific, at a typical biotechnology company.
6. Demonstrate ability to solve problems and think critically by completing challenging group and individual projects and assignments effectively.
7. Demonstrate the ability to solve mathematical and scientific concepts related to biotechnology.
8. Demonstrate the ability research, analyze, synthesis, and evaluate information from multiple sources.
9. Demonstrate technical writing skills.
10. Accept personal responsibility for decisions and actions.

22. Course Outline & 24. Key Assignments

Scope and Sequence of Biotechnology

Concepts/lectures/reading	Activities and Lab
1. Biotechnology	*Setting Up a Legal Scientific Notebook *Safety in the Biotech Laboratory *Internet Research, Word, Excel, PowerPoint *Scientific Methodology Laboratory *Model Organism Growth/Media Preparation *Sterile Technique/Cell Culture *Solution and Dilution Preparation
2. DNA and Protein Structure/Function	*DNA Isolation *Agarose Gel Electrophoresis *DNA Synthesis and PCR *Protein Isolation *Polyacrylamide Gel Electrophoresis (PAGE) *Protein and Enzyme Studies/Assays

Scope and Sequence of Biotechnology 2

Concepts/lectures/reading	Activities and Lab
3. Assay Development	*Amylase Assay *Spectrophotometry to Study Molecules *Protein Concentration Assays
4. Recombinant DNA Technology	*Recombinant Plasmid/Cloning Vectors *Restriction Digestion and Restriction Enzyme *Gene Mapping *Agarose Gel Electrophoresis DNA Analysis
5. Transformation/Genetic Engineering	*Cell Competency *Bacterial Transformation and Selection
6. Scale-up, Manufacturing, and Marketing	*Cell Culture, Growth and Monitoring *Protein Product Purification and Testing *Product Pipelines and Industry Applications *Disease and Medicine *Clinical Testing and Regulations *Bioethics and Decision-Making
7. Careers in Biotechnology and Career Essentials	*Resume Writing *Discussion and self assessment of employability skills *Internet search and oral presentation of Biotechnical careers

23. Texts & Supplemental Instructional Materials

Primary Text:

Daugherty, Ellyn, *BIOTECHNOLOGY: Science for the New Millennium, 2006.*

Supplemental Instructional Materials:

1. Ausable, Wiles, *Short Protocols in Molecular Biology*
2. Barnum, S., Biotechnology: An Introduction, 2005 - this is the book we used last year
3. Clark and Russell, *Molecular Biology Made Simple and Fun*
4. Sideman/Moore, *Basic Laboratory Methods in the Biosciences, Prentice Hall, 1999.*
5. Micklos and Freyer, *DNA Science: A First Course in Recombinant DNA Technology*
6. *Gateway to the Future: Skill Standard for Bioscience Industry, Education Development Center, Cambridge, Massachusetts*
7. Kreutzer and Massey, *Recombinant DNA and Biotechnology*

8. Marko its, Paul S. *Biotechnology Unit for Secondary Students. The Biotechnology Education Project, St. Louis Mathematics and Science Education Center, Monsanto Fund & National Science Foundation, St. Louis.*
9. Moore, Randy, *Writing to Learn Biology, University Press*
10. Potter, Robert A., *editorial direct, "Howard Hughes Medical Institute Biomedical Report Series" #1-5, Chevy Chase, Maryland*
11. Stele, David B., *Biotechnology in Perspective, Industrial Biotechnology Association (BIO), Washington, D.C.*
12. *Sourcebook Biotechnology Activities, National Association of Biology Teachers*

Websites: various websites not limited to the following

1. www.bio.org
2. www.accessexcellence.org
3. http://www.ncbi.nih.gov/
4. http://www.cato.com/biotech/
5. http://sciencecareers.sciencemag.org/
6. www.whybiotech.com/
7. http://biotech.icmb.utexas.edu/
8. http://www.biotech.iastate.edu/
9. http://www.bioethics.iastate.edu/activities/biotechnology_ethics.html
10. http://www.science.subaru.com/
11. http://www.skipwagner.net/smbiotech/bioteched.htm
12. http://www.bio.org/speeches/pubs/er/statistics.asp
13. http://www.sargentwelch.com/article.asp?ai=288
14. http://www.biotechinstitute.org/

Resources and Laboratory Materials

1. Carolina Biological Supply Company
2. Sergeant-Welch VARY Scientific
3. Cal State SF – Department of Teacher Education in Biology
4. Pasadena City College Biotechnology Partnership Grant
5. Lawrence Hall of Science STEP Program
6. AMGEN kit for many DNA experiments and bacterial transformation experiments
7. Occidental's TOPS kit for Spectrophotometers and Gas Chromatography experiments, and PAGE for protein
8. Laboratory supplies and equipment
    a. Agars Gel Electrophoresis
    b. Micro-centrifuges
    c. Micropipettes
    d. Pipette pumps and tri bulbs
    e. Electroporator
    f. Incubation and microwave ovens
    g. Water baths
    h. Vertical electrophoresis
    i. ELISA Testing
    j. Gel Dryer
    k. Computers for DNA analysis
    l. Gel imagers
    m. Cooler

24. Key Assignments – see Section 22. Course Outline

25. Instructional Methods and/or Strategies

Instructional methodologies include but are not limited to:

lectures, demonstrations, return demonstrations, guest speakers, library research, Internet research, audio-visual, student presentations, peer teaching, jig saw and popcorn reading, games, computer assignments, PowerPoint, use of biotechnology equipment and supplies, homework assignments, graphic organizers, cooperative learning, frequent assessment and feedback, journals, group and individual projects/assignments/work, student portfolio, discussion, field trips, industry interviews and industry mentors.

26. Assessment Methods and/or Tools

Assessment methods include but are not limited to:

exams, quizzes, papers, homework assignments, individual/group projects, class/lab participation, performance based assessment and competency in the lab exercises and activities, portfolio and journal entries, use of technology to develop reports and research projects, submission of activity sheets, data notebooks, scientific reports, student folders, and attendance.

C. HONORS COURSES ONLY

Please refer to instructions

27. Indicate how this honors course is different from the standard course.

D. OPTIONAL BACKGROUND INFORMATION

Please refer to instructions

28. Context for Course (optional)

29. History of Course Development (optional)

The Los Angeles County ROP, its member districts, and Pasadena City College were awarded a "SB-70 Quick Start Career Tech Education Grant that began June 1, 2006. One major part of this grant is to train our teachers in the curriculum of the PCC program and create an opportunity for them to teach PCC courses at the high schools where the students will receive PCC credit. Student will then be able to matriculate to PCC to finish the certificate program or enter a university with a skills-based resume. This would create a seamless 10-14 career path. PCC, through the Los Angeles/Orange County Biotechnology Center, also provides our programs with supplies, equipment, and connections to the biotechnology industry and vendors. PCC is a member of our annual advisory committee to review and revise our curriculum. The biotechnology course of study, course objectives, scope, and sequence of classes takes into account the knowledge and skill sets currently needed in the biotech industry. This program models its self after the excellence demonstrated in the San Mateo Biotechnology Career Pathway developed and written by Ellyn Daugherty. Our Instructors will be participating in Ellyn Daugherty's instructors training and workshops.

Biotechnology

Semester 1

The lecture is extremely important. It is the basic source of material for the course. It is where you will be introduced to new information, be involved in discussions with your instructor and peers, and have the opportunity to ask questions. **Attendance is therefore important!**

Week	Semester 1 Lecture Topics	Key Lab Skill Objectives/Lab Activities Reading Assignments in ED's Biotechnology Textbook
1	**Introduction** 1. Classroom procedures and grading 2. Laboratory Safety a. Review Safety Rules b. Emergency guidelines c. Lab procedures and equipment 3. Introduction to Biotechnology a. What is Biotechnology? b. History of Biotechnology c. Careers in Biotechnology	1. Lab Safety Rules Exam 2. Learn how to maintain a scientific notebook Read ED Ch. 1 pages 1-29 * ED = Ellyn Daugherty Textbook
2-3	1. Scientific Methodology: Bleach Lab/Cheese Production 2. Setting up a standard curve: Amylase Lab ▪ Independent variables ▪ Dependent variables ▪ Use of Spectrophotometer	1. Conduct controlled experiment; analyze and report data • Bleach Lab • Cheese Production • Amylase Lab – TOPS* Read ED Ch. 1.4 pages 19-23
4-5	**Review of Chemistry related to class** 1. Atoms and molecular structure 2. Chemical bonds 3. Properties of acids and bases 4. Organic compounds and macromolecules of life 5. Cellular Organization and Processes	1. ED Lab 2a Dissecting a Cell and its components- test for proteins, carbohydrates, and lipids 2. ED Lab 2b Model Organisms 3. ED Lab 6b Amylase Lab – test for disaccharides, maltose (ED) 4. ED Lab 2c Gram Staining and Use of Microscope Read ED Ch 2.1-2.4 pages 37-58
6	**The Basic Skills of the Biotechnology Workplace** 1. Measuring Volumes 2. Making Solutions: Mass/Volume, % Mass/Volume 3. Unit Conversions and Molar Concentrations 4. Material Safety Data Sheet	1. Measuring Volumes, Mass, % Mass/Volume Solutions, and Molar Solutions • Math problems • ED Labs 3a-3d Pipetting Accuracy Read ED Ch 3.1-3.6 pages 67-87
7	**DNA Structure and Function: Prokaryotic, Eukaryotic, Viral** 1. Physical and chemical properties 2. Universality of DNA 3. DNA Synthesis – Replication 4. Recombinant DNA Technology	1. DNA model 2. Computer simulations 3. Labs on DNA Extraction and Isolation, ED Labs 4a-4b • DNA from strawberries • DNA from cheek cells 4. ED Labs 4e-4g Sterile Techniques/Pouring Plates Read ED Ch. 4.1- 4.3 page 99-115

8	**Using Gel Electrophoresis to Study Molecules** 1. Components of gel electrophoresis 2. Properties used for Separation of Molecules	1. Amgen Lab1 Microvolumetric pipetting exercise 2. ED Lab 4i Prepare gel agarose Read ED Ch. 4.4 pgs 118-120; Amgen Manual Lab1
9	**The "New" Biotechnology – Genetic Engineering** 1. Overview of Genetic Engineering 2. Recombinant DNA Technology	**USE OF AMGEN KIT 4 WEEKS* (Can use BioRad pGLO)** 1. Amgen Lab1 Gel Electrophoresis Amgen Manual Lab1, ED Lab 4j
10	3. Restriction Digest of Plasmid – Single Digest, HindIII 4. Ligation of Restriction Fragments	1. Lab2 Restriction digest of pDRK and pGRN 5. Lab3 Construction of rpGLO – digestion and ligation of plasmids, *gfp* gene into vector Read Amgen Manual Lab2 and Lab3
11	5. Transformation 6. Gene Expression	1. Lab4 Confirmation of Restriction and Ligation 2. Lab5 Transformation of *E. coli* with rpGLO Read Amgen Manual Lab4 and Lab5
12	7. Protein Synthesis - Transcription, Translation 8. Properties of Proteins	1. Isolation and screening of transformed *E. coli* 2. Lab6 Preparing overnight *E. coli* culture for GFP expression Read Amgen Manual Lab6; ED pgs 131-142
13	9. Protein Isolation with Column Chromatography	1. Lab7 Isolation of GFP using Affinity Column Chromatography Read Amgen Manual Lab7; ED Ch 9.1 pgs 241-244
14	**Review Genetic Engineering: Transformation** 1. Competent cells – HB101 2. Transformation Efficiencies 3. Media Screen	1. Calculate and compare transformation efficiencies. 2. Bacterial mid-log culture: spectrophotometry 3. Streak LB/Amp/ARA for isolation 4. Math Problems
15-16	**Introduction to Studying Proteins** 1. The Structure and Function of Proteins 2. Enzymes 3. Studying Protein	1. ED Lab 5d Testing for Protein in Solution 2. Catalase Lab – Testing for presence of proteins; to study structure and function. 3. Amylase (TOPS) Lab – Factors affecting rate of enzymatic reaction 3. ED Lab 5e-5f PAGE – Polyacrylamide Gel Electrophoresis to analyze proteins Read ED Ch 5.1-5.5 pages 131-153
17	**Other Techniques in Biotechnology: PCR** 1. Polymerase Chain Reaction 2. Applications - Diagnostics, Forensics, GMO **(Optional: If time permits)**	1. Amgen Lab8 Amplification of the tPA Locus 2. BioRad DNA Fingerprinting Read Amgen Manual Lab8; ED Ch 13 pgs 343-361
18-19	**Biotechnology and Medicine** 1. Human Genome Project 2. Future directions and potential 3. Ethical Issues and social issues 4. Use of biotechnology/genetic engineering in the diagnosis and treatment of genetic disorders.	1. Presentation on Stem Cells 2. Research Project on Genetic Disorders – written report and power point presentation
20	**Final Exam**	Student Power Point Presentations

* Bruce-Wallace Amgen Lending Program under Marty Ikkanda
http://www.bwbiotechprogram.com/

* TOPS- Teachers + **Occidental College**= Partnership in Science (**TOPS**) programs
http://departments.oxy.edu/tops/

Biotechnology

Semester 2

The lecture is extremely important. It is the basic source of material for the course. It is where you will be introduced to new information, be involved in discussions with your instructor and peers, and have the opportunity to ask questions. **Attendance is therefore important!**

Week	Semester 2 Lecture Topics	Key Lab Skill Objectives/Lab Activities **Reading Assignments in ED's Biotechnology Textbook**
1-2	**Introduction** 1. Classroom procedures and grading 2. Safety Unit d. Review Safety Rules e. Emergency guidelines 3. Bioethics – Using Animals in Science and Industry, Embryonic Stem Cell	**Bioethics Speaker: Topics of Discussion** 1. Defining Bioethics 2. Defining Human Dignity 3. Basic Principles of Bioethics 4. Where does life begin? Class Debate on Animal Use and Stem Cell Research HW: Read ED Ch 1 page 34, Ch 2 page 65
3	**Review Lab Procedures** 1. How to set up a Scientific Notebook 2. Scientific Method Volume	1. Scientific Notebook – ED Lab1a,1b 2. Making solutions of differing concentrations
4	**Review Basic Skills in the Biotech Workplace** 1. Making Solutions 2. Making Dilutions of Concentrated Solutions	1. Math Problems 2. Checking Accuracy of Micropipets- ED Lab 3d 3. Measuring pH – pH paper vs. pH meter
5-6	**Growth of Model Organisms** • E. coli • Sacchromyces cervesiae – yeast 1. Review Gram Stain, Use of Microscope Uses of Yeast – Fermentation	1. Growing E. coli – ED Lab 2b 2. Bacterial Cell Culture –ED Lab 4g 3. Gram Staining Lab to Identify unknown organisms – bacteria, yeasts, mold 4. TOPS Yeast Fermentation Lab* 5. DNA Extraction from E. coli – ED Lab 4h, Lab 4d
7-8	**Biotechnology and Industry - Assay Development** **1. How do you know when you have a product?** • Protein product – Amylase • The use of Assays	1. Assaying for Amylase Activity – ED Lab 6c 2. Testing for Potential Medicine – ED Lab 6d 3. Testing for Hydrogen Peroxidase – ED Lab 6f 4. Isolation of HRP – ED Lab 6g 5. Testing for Peroxidase using TMB – ED Lab 6h Read ED Ch 6.1-6.4 pgs 161-174
9-10	**2. Detecting Molecules by** • Spectrophotometer – use standard curve • pH meter – buffers, calibration • PAGE for Proteins	1. Spectrophotometric protein assay – ED Lab 7a, Lab 7b 3. Measuring pH of Solutions ED Lab 7c 4. TOPS Amylase Lab* – use of standard curve to find conc **4. TOPS Protein electrophoresis* by SDS PAGE 5. BioRad Antigen/Antibody Assay by ELISA** Read ED Ch 7.1-7.4 pgs 189-201

11	**3. Production of a Recombinant Protein** • Construction of recombinant DNA	**USE OF AMGEN KIT – 4 WEEKS (Amgen Red Manual)*** 1.Amgen Lab2 Restriction enzyme and digestion of pAra and pKan with HindIII and BamHI 2. Amgen Lab3 DNA ligation to construct rpARA 3. Amgen Lab4 Confirmation of by gel electrophoresis Read Amgen Red Lab2-Lab4; ED Ch 8.1-8.3 pgs 209-226 * Can do ED Labs 8a-8e
12	• Bacterial transformation with recombinant DNA	1.Amgen Lab5 Transformation of *E. coli* with rpARA Read Amgen Red Lab5; ED Ch 8.1-8.3 pgs 209-226
13	• Isolating Protein Products – Chromatography	1.Amgen Lab 6/7 MFP (mutant Fluorescent Protein) isolation using column chromatography Read Amgen Red Lab6-Lab7
14	• Scale Up Process • Fermentation	1. PAGE to analyze MFP ED Ch 8.4 pgs 226-233; ED pgs 147-150
15	• Applications of PCR	1. Amgen Lab8 DNA amplification by PCR – Alu genotyping 2. BioRad DNA Fingerprinting Read Amgen Red Lab8; ED Ch 13.1-13.4 pgs 343-361
16	**4. Bringing a Biotechnology Product to Market** • Harvesting Product – by chromatography • Quality Control • Marketing and Sales	1. TOPS Yeast Fermentation Lab* – use of distillation to isolate product and Gas Chromatography to analyze concentration and purity 2. Power point presentation by students Read ED Ch 9.1-9.5 pages 241-259
17	**Plant Biotechnology** • Applications of Biotech	1. ED Lab 10a Flower Dissection 2. Mitosis Lab – look at onion root tip cells 2. BioRad – GMO by PCR Read ED Ch 10.1-10.5 pages 267-289
18	**Advance Biotechnology Techniques** • DNA Sequencing • Genomic • Advanced Protein Studies • Applications of Biotech	1. Introduction to NCBI/BLAST – to study DNA sequences of various species Read ED Ch 14.1-14.4 pages 369-389
19	**Career Exploration**	• Resumes • Student PowerPoint Presentations on Career Exploration
20	**Final Exam**	Student Power Point Presentations

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