Subject:	BIOL
Course Number:	76
Descriptive Title:	Introduction to Biotechnology Laboratory
Division:	Natural Sciences
Department:	Biology
Course Disciplines:	Biology, Biotechnology
Catalog Description:	This laboratory is a general examination of biology as it relates to the field of biotechnology. The laboratory addresses basic skills and techniques common to the biotechnology industry. Topics include the measurement of activity and quantity of proteins, growth and manipulation of bacteria, genetic engineering and antibody methods.
Prerequisite:	Biology 75 with a minimum grade of C or concurrent enrollment.
Co-requisite:	
Recommended Preparation:	Beginning algebra or higher or placement by appropriate assessment
Enrollment Limitation:	None
Hours Lecture (per week):	0
Hours Laboratory (per week):	3
Outside Study Hours:	0
Total Course Hours:	54
Course Units:	1
Grading Method:	Letter Grade only
Credit Status:	Credit, degree applicable
Transfer CSU:	Yes
Effective Date:	Fall 2023
Transfer UC:	Yes
Effective Date:	Pending
General Education ECC:	Area 1 - Natural Sciences
Term:	
Other:	
CSU GE:	Area B3 - Physical Universe and its Life Forms: Laborator Activity
Term:	
Other:	
IGETC:	Area 5C - course that incorporate a laboratory
Term:	
Other:	

Student Learning Outcomes:	**1. SLO #1 Knowledge:** Student will be able to understand and correctly operate laboratory equipment. **2. SLO #2 Scientific Communication:** Student will properly maintain a laboratory notebook and demonstrate proficiency in following standard operating procedures (SOPs). **3. SLO #3 Career Proficiency:** Demonstrate an understanding of and follow workplace safety guidelines.
Course Objectives:	1. Evaluate laboratory scenarios for safety compliance. 2. Compare MSDS, SDS, Global Harmonizing Systems, and the regulations governing the biological laboratory 3. Utilize the scientific method in laboratory experiments. 4. Prepare SOPs. 5. Assemble a properly maintained laboratory notebook. 6. Analyze and graph data from laboratory experiments. 7. Convert measurements from one unit to another. Choose the correct units of measurement. 8. Distinguish between accuracy and precision 9. Contrast qualitative and quantitative data 10. Measure and dispense volumes and mass as required by the procedures used in the laboratory 11. Measure transmittance and absorbance with the spectrophotometer 12. Analyze data and construct appropriate graphs 13. Select proper techniques including aseptic technique, proficiency using the Brightfield microscope, appropriate culture methodologies, and solution preparation including serial dilutions. 14. Measure and adjust solution pH while using the pH meter. Prepare and use buffer solutions. 15. Experiment with biomolecules including PCR, restriction enzyme digest of DNA, analysis of DNA fragments in agarose gel, and purification of proteins by column chromatography and dialysis 16. Clone a gene into a plasmid vector. Introduce the plasmid into bacteria. 17. Fraction cells 18. Evaluate the purity of a protein obtained in the laboratory 19. Analyze proteins after polyacrylamide gel electrophoresis 20. Evaluate the steps of the typical ELISA diagnostic test 21. Assess the mechanism of color development in an immunochromatography diagnostic test
Major Topics:	A minimum of 80% of lab hours involve hands-on activities. **I. Laboratory Overview (2 hours, lab)** A. Laboratory safety B. Regulations governing the biological laboratory C. MSDS (Material Safety Data Sheets), SDS (Safety Data Sheets), Global Harmonizing System D. Careers in biotechnology

II. Lab Skills and GLPs (Good Laboratory Practices) (4 hours, lab)

A. The scientific method
B. Documentation
C. Keeping a laboratory notebook
D. Data analysis and graphing of experimental results

III. GMPs (Good Manufacturing Practices) (4 hours, lab)

A. Quality Management Systems (QMS)
B. Standard Operating Procedures (SOPs)
C. Quality Assurance
D. Quality Control
E. Statistical Process Control
F. Corrective and Preventative Actions (CAPA)

IV. Metric System and Measurements (Incorporated throughout Laboratory Experiments) (1 hour, lab)

A. Metric units
B. Unit conversions
C. Accuracy and precision
D. Quantitation vs. qualitation

V. Metrology (Incorporated Throughout Laboratory Experiments) (6 hours, lab)

A. Use of graduated cylinders, pipets, and micropipettes for measuring volumes
B. Use of analog and digital balances for measuring mass
C. Use of spectrophotometers
D. Use of various laboratory instruments for obtaining measurements

VI. Basic Microbiology (6 hours, lab)

A. Sterile technique
B. Liquid/broth culture techniques
C. Solid medium (agar containing media) culture techniques
D. Use of the brightfield microscope

VII. Chemistry for Biologists (8 hours, lab)

A. Preparation of solutions used in the biological laboratory
B. Concentrations of serial dilutions
C. pH meters and buffers
D. Biomolecule detection

VIII. Recombinant DNA Technology (12 hours, lab)

A. Polymerase chain reaction (PCR)
B. DNA extraction methods
C. Agarose gel electrophoresis
D. Restriction enzyme digest and ligation
E. Cloning a gene into a plasmid vector

	F. Bacterial transformation and selection of recombinant DNA **IX. Protein Techniques (8 hours, lab)** A. Introduction to enzymes B. Cell fractionation C. Protein purification D. Determination of protein concentration E. Dialysis F. Column chromatography G. Polyacrylamide gel electrophoresis **X. Antibody Methodologies (3 hours, lab)** A. One or more of the following: ELISA, Immunochromatography (EX. home pregnancy or Strep A test)
Total Lecture Hours:	0
Total Laboratory Hours:	54
Total Hours:	54
Primary Method of Evaluation:	3) Skills demonstration
Typical Assignment Using Primary Method of Evaluation:	**PCR EXPERIMENT EXAMPLE:** Set up PCR reactions designed to amplify a gene from yeast encoding an enzyme known as Glutaminyl cyclase (QC). In mammals this enzyme is responsible for the cyclization of N- terminal glutamine residues to pyroglutamic acid in biologically active peptides such as thyrotropin releasing hormone and corticotropin releasing hormone. The source of DNA will be yeast (Saccharomyces cerevisiae) genomic DNA. It will be supplied to you at a concentration of 10 ng/µL. The primers will be supplied at 100 ng/µL and the Taq Polymerase will be supplied at 5 Units/µL. Each group is to set up one reaction as follows: 3 µl + primer 3 µl – primer 2 µl yeast DNA 1 µl Taq DNA Polymerase 5 µl dNTP mix 10 µl buffer 26 µl sterile water 50 µl total The tubes will be placed in the thermal cycler and the following set of conditions will be used: 1 min denaturation (92oC) 1 min annealing (55oC) 1 min extension (72oC) Repeat these conditions for a total of 30 times. Following that, a final 10-minute extension step will be used to allow the polymerase to completely finish extending all PCR products. The samples will be stored at –20OC or immediately run on an agarose gel.

Critical Thinking Assignment 1:	**Part 1 - EXPERIMENT:** Amplify a 798 base fragment of DNA from a vector. The 3' end of the fragment to be modified will anneal with the primer (5'-CTG CCG CAA GCC GCC CCA GAG-3') and the 5' end of the fragment will anneal with (5'-ATG GTA GTG TTC AAT GGC CTT-3'). **Please be careful not to contaminate any of the solutions that you will use for this assay.** You should use a fresh tip whenever you change solutions to be used. Furthermore, add reagents in order indicated to insure stability of your DNA and efficient amplification of the target DNA. You can consult the additional handout for more detailed information on PCR reagents and frequently encountered problems. Add following reagents into a sterile 0.2 mL PCR tube: [see file 1 for image] It is important to add DNA polymerase last and just before the cycles are started because polymerase has exonuclease activity and can degrade the primers. Note that all reagents are sterile and proper precautions should be taken to keep them this way. The protocol for amplifying this target DNA has been perfected and thus the PCR thermacycler has been preprogrammed for this method. When all groups are prepared to begin the PCR reaction, your instructor will assist you in loading your samples into the apparatus. Before this step, be sure to gently mix and spin down your reaction mixture. Once all groups' samples are loaded, the program will be started. Any questions regarding programming the Perkin Elmer GeneAmp PCR system 2400 can be answered by your instructor or the instrument manual. The preprogrammed cycle is as follows: [see file 2 for image] Remove your samples, and you will analyze them during the next class period.
Critical Thinking Assignment 2:	**Part 2 - ANALYZE:** Explain the PCR principle and create primers for amplifying a known sequence of DNA. In addition, explain why a PCR reaction may not have worked based upon your gel results.
Other Evaluation Methods:	Completion, Other Exams, Homework Problems, Laboratory Reports, Matching Items, Multiple Choice, Quizzes, Reading Reports, Term or Other Papers, True/False, Written Homework
If Other:	
Instructional Methods:	Demonstration, Discussion, Field trips, Group Activities, Guest Speakers, Lab, Lecture, Multimedia presentations, Role play/simulation
If other:	
Work Outside of Class:	Answer questions, Problem solving activity, Required reading, Skill practice, Study, Written work (such as essay/composition/report/analysis/research)
If Other:	
Up-To-Date Representative Textbooks:	Orange County Biotechnology Education Collaborative. Lab Manual: Introduction to Biotechnology. ASCCC Open Education Resources Initiative. (January 2021 web update), https://bio.libretexts.org/@go/page/36736 . Licensed under CC by 4.0 Investigating Biology Laboratory Manual, 9th edition, Morgan & Carter, Pearson 2017, ISBN-13: 9780137538256
Alternative Textbooks:	None

Required Supplementary Readings:	None
Other Required Materials:	None
Requisite	Prerequisite
Category	sequential
Requisite course:	Biology 75
Requisite and Matching skill(s): Bold the requisite skill. List the corresponding course objective under each skill(s).	**Understanding of basic human physiology principles within Biotechnology** BIOL 75 - Analyze the structures of atoms, ions, and isotopes. BIOL 75 - Distinguish between ionic bonds, covalent bonds, and hydrogen bonds. BIOL 75 - Examine the structural formula for basic biological molecules. BIOL 75 - Compare and contrast the morphological differences between prokaryotic and eukaryotic cells. Diagram the distribution and function of organelles found in eukaryotic cells. BIOL 75 - Diagram a DNA molecule including the backbone and nucleotides. Explain DNA replication and how the genetic material of inheritance is encoded in DNA and expressed through the processes of transcription and translation. BIOL 75 - Contrast cell reproduction in prokaryotes and eukaryotes. BIOL 75 - Compare and contrast mitosis and meiosis. BIOL 75 - Evaluate the molecular aspects of genes and mutation including the patterns of inheritance. BIOL 75 - Analyze basic human physiology principles including homeostasis, immune and nervous system function, and cellular processes leading to energy production. BIOL 75 - Evaluate a diagnostic test made possible by biotechnology.
Requisite Skill:	None
Requisite Skill and Matching skill(s): Bold the requisite skill(s). if applicable	None
Requisite course:	Taken beginning algebra or be placed into equivalent or higher by assessment.
Requisite and Matching skill(s): Bold the requisite skill. List the corresponding course objective under each skill(s).	**Using algebraic methods.** Setting up and solving application problems. Identify different types of equations and solve them by applying the appropriate algebraic methods. **Applying graphing techniques.** Graph equations by applying different graphing techniques.
Requisite Skill:	None
Requisite Skill and Matching skill(s): Bold the requisite skill. List the corresponding course objective under each skill(s). if applicable	None

Enrollment Limitations and Category:	None
Enrollment Limitations Impact:	None
Course Created by:	Mia Dobbs
Date:	December 7th, 2021
Board Approved:	6/20/2022