COURSE OUTLINE : BIOL 142
D Credit – Degree Applicable
COURSE ID 010549
Created: February 2021

COURSE DISCIPLINE : BIOL

COURSE NUMBER : 142

COURSE TITLE (FULL) : Applied Biotechnology II with Laboratory

COURSE TITLE (SHORT) : Applied Biotech II

CALIFORNIA STATE UNIVERSITY SYSTEM C-ID : BIOT 220X - Methods in Protein Purification

CCC ACADEMIC SENATE DISCIPLINE: Biological Science and Biotech

CATALOG DESCRIPTION
BIOL 142 is the second course in the Applied Biotechnology series. It introduces advanced concepts and laboratory techniques in biotechnology. Building on the basic skills established in BIOL 141, students will learn methodology in large-scale protein production and protein purification techniques, including sample preparation. It provides hands-on training with chromatography systems and assays used in industry and research laboratories. This course also covers methods utilized for eukaryotic cell culture protein purification. Application of current Good Manufacturing Process (cGMP), Good Laboratory Practice (GLP), and Standard Operating Procedures (SOP's) in relation to these techniques will be addressed. Good communication, collaborative work and work-readiness skills are emphasized. This course is intended for, but not limited to, students preparing for a career in biotechnology.

Total Lecture Units: 2.00

Total Laboratory Units: 2.00

Total Course Units: 4.00

Total Lecture Hours: 36.00

Total Laboratory Hours: 108.00

Total Laboratory Hours To Be Arranged: 0.00

Total Contact Hours: 144.00

Total Out-of-Class Hours: 72.00

Prerequisite: BIOL 141 or BIOL 298. Recommended Preparation: BIOL 140, BIOL 101, or BIOL 122 and CHEM 101.

ENTRY STANDARDS

	Subject	Number	Title	Description	Include
1	BIOL	101	General Biology I	Identify the properties of lipids, carbohydrates, proteins, and nucleic acids;	Yes
2	BIOL	101	General Biology I	describe the structure of prokaryotic and eukaryotic cells;	Yes
3	BIOL	101	General Biology I	explain cell respiration and photosynthesis;	No
4	BIOL	101	General Biology I	describe and identify the different stages in mitosis;	Yes
5	BIOL	101	General Biology I	describe the relationships between meiosis and Mendelian genetics;	No
6	BIOL	101	General Biology I	solve Mendelian genetics problems, including autosomal, X-linked genes and dihybrid crosses;	No
7	BIOL	101	General Biology I	describe the processes of DNA replication, transcription, and translation;	Yes
8	BIOL	101	General Biology I	explain the basic mechanisms of gene regulation in prokaryotes and eukaryotes.	Yes
9	BIOL	101	General Biology I	demonstrate proper use of laboratory equipment including the microscope, spectrophotometer, and micropipettes;	Yes
10	BIOL	101	General Biology I	demonstrate proficiency with data collection, analysis, and graphical representation.	Yes
11	BIOL	112	Microbiology	demonstrate general knowledge of the physical and chemical structure of prokaryotes and eukaryotes	Yes
12	BIOL	112	Microbiology	demonstrate an understanding of the biochemical processes of the cell, including cell respiration, DNA replication, genetic recombination, transcription, translation, and cellular transport	Yes
13	BIOL	112	Microbiology	demonstrate an understanding of the physical and chemical methods and mechanisms used to control microbial growth	Yes
14	BIOL	112	Microbiology	demonstrate an understanding of the disease process of various microorganisms	No
15	BIOL	112	Microbiology	demonstrate proper aseptic techniques and proficiency in performing various staining procedures and biochemical tests on microorganisms	Yes
16	BIOL	122	Introduction to Biology	Describe the structure of atoms, the properties of water and structure and function of biological macromolecules;	Yes

17	BIOL	122	Introduction to Biology	describe the flow of information from DNA to protein;	Yes
18	BIOL	122	Introduction to Biology	describe the mechanisms of evolution including natural selection;	No
19	BIOL	122	Introduction to Biology	describe basic ecological principles and the impact of humans on the environment;	No
20	BIOL	122	Introduction to Biology	identify the defining characteristics of major groups of organisms;	No
21	BIOL	122	Introduction to Biology	compare prokaryotic and eukaryotic cells, and describe the structure and function of eukaryotic organelles;	Yes
22	BIOL	122	Introduction to Biology	describe the principles of inheritance and solve basic Mendelian genetics problems;	No
23	BIOL	122	Introduction to Biology	describe basic principles of mammalian physiology.	No
24	BIOL	298	Undergraduate Research in Microbiology and Molecular Biology	Demonstrate aseptic laboratory techniques and safe laboratory practices;	Yes
25	BIOL	298	Undergraduate Research in Microbiology and Molecular Biology	communicate effectively in a collaborative work environment;	Yes
26	BIOL	298	Undergraduate Research in Microbiology and Molecular Biology	apply chemical formulas to make appropriate media;	Yes
27	BIOL	298	Undergraduate Research in Microbiology and Molecular Biology	troubleshoot problems when carrying out experiments;	Yes
28	BIOL	298	Undergraduate Research in Microbiology and Molecular Biology	keep meticulous daily records of lab activities, experimental procedures, outcomes of experiments, and creative thoughts in a lab notebook;	Yes
29	BIOL	298	Undergraduate Research in Microbiology and Molecular Biology	demonstrate competence in use and application of various equipment and techniques used in molecular biology and microbiology;	Yes
30	BIOL	298	Undergraduate Research in Microbiology and Molecular Biology	read and analyze peer-reviewed articles in the field of study;	Yes
31	BIOL	298	Undergraduate Research in Microbiology and Molecular Biology	present results of project to student peers and professors;	No

32	BIOL	298	Undergraduate Research in Microbiology and Molecular Biology	write a peer-reviewed article using proper citation format and documentation style.	No
33	CHEM	101	General Chemistry	evaluate past and present atomic theories with respect to experimental observations	No
34	CHEM	101	General Chemistry	describe chemical processes in terms of chemical equations and be able to use the equations to answer quantitative questions concerning the process described	No
35	CHEM	101	General Chemistry	analyze modern theories of atomic motion, especially as they apply to gasses	No
36	CHEM	101	General Chemistry	use quantum theory to predict electronic structures of the atom	No
37	CHEM	101	General Chemistry	analyze the properties of the elements and develop algorithms for the classification of the elements into logical groups	No
38	CHEM	101	General Chemistry	describe the relationship between matter and energy and the inter-conversion of the two	No
39	CHEM	101	General Chemistry	utilize bonding theories to describe the chemical nature of ions and molecules	Yes
40	CHEM	101	General Chemistry	demonstrate the proper use of laboratory equipment and the ability to handle chemicals safely	Yes
41	CHEM	101	General Chemistry	describe the scientific method and apply it to the development of the science of chemistry	Yes
42	CHEM	101	General Chemistry	demonstrate an understanding of intermolecular forces and apply those forces to the nature of solids and liquids	No
43	BIOL	140	Introduction to Biotechnology	List the morphologic and chemical differences between prokaryotic and eukaryotic cells	Yes
44	BIOL	140	Introduction to Biotechnology	Define and distinguish among atoms, molecules, compounds, chemical bonds, mechanisms of chemical bond formation, and components of biological molecules	Yes
45	BIOL	140	Introduction to Biotechnology	Construct the flow diagram of gene expression from DNA to protein	Yes
46	BIOL	140	Introduction to Biotechnology	Translate the triplet code of DNA into primary protein structure	Yes

47	BIOL	140	Introduction to Biotechnology	Assess the role of basic Mendelian genetics	Yes
48	BIOL	140	Introduction to Biotechnology	Compare and contrast current applications of biotechnology to the areas of medicine, agriculture, diagnostics, and the environment	Yes
49	BIOL	140	Introduction to Biotechnology	Explain evolution from a genetic perspective	No
50	BIOL	140	Introduction to Biotechnology	Evaluate a recent development in the field of biotechnology from an ethical perspective	Yes
51	BIOL	140	Introduction to Biotechnology	Demonstrate pipetting skills	Yes
52	BIOL	140	Introduction to Biotechnology	Explain the importance of Good Laboratory Practices and record keeping	Yes
53	BIOL	140	Introduction to Biotechnology	Prepare and analyze graphs	Yes
54	BIOL	140	Introduction to Biotechnology	Explain how an antibody-based assay works (e.g. ELISA)	Yes
55	BIOL	140	Introduction to Biotechnology	Perform bacterial transformation	Yes
56	BIOL	140	Introduction to Biotechnology	Use of aseptic techniques in lab procedures, such as handling of bacteria, microbiology and molecular biology work.	Yes
57	BIOL	140	Introduction to Biotechnology	Demonstrate proficiency in basic molecular techniques (e.g. DNA and protein analysis techniques)	Yes
58	BIOL	140	Introduction to Biotechnology	Identify parts of a microscope	Yes
59	BIOL	140	Introduction to Biotechnology	Use a microscope to view specimens	Yes
60	BIOL	140	Introduction to Biotechnology	Employ a lab protocol and explain deviations from the protocol	Yes
61	BIOL	141	Applied Biotechnology I with Laboratory	Describe cell structure	No
62	BIOL	141	Applied Biotechnology I with Laboratory	Apply principals of basic chemistry of buffers and pH to biological molecules	Yes

63	BIOL	141	Applied Biotechnology I with Laboratory	Define and distinguish among biological molecules	No
64	BIOL	141	Applied Biotechnology I with Laboratory	Construct the flow diagram of gene expression from DNA to protein	No
65	BIOL	141	Applied Biotechnology I with Laboratory	Explain recombinant DNA	Yes
66	BIOL	141	Applied Biotechnology I with Laboratory	Be able to convert between metric units	Yes
67	BIOL	141	Applied Biotechnology I with Laboratory	Be able to perform basic dilutions	Yes
68	BIOL	141	Applied Biotechnology I with Laboratory	Perform calculations related to reagents, solutions and media formulations	Yes
69	BIOL	141	Applied Biotechnology I with Laboratory	Demonstrate Good Laboratory Practices and record keeping in a laboratorynotebook	Yes
70	BIOL	141	Applied Biotechnology I with Laboratory	Prepare and analyze graphs	Yes
71	BIOL	141	Applied Biotechnology I with Laboratory	Grow cells using aseptic techniques	Yes
72	BIOL	141	Applied Biotechnology I with Laboratory	Demonstrate ability to use measurement instrumentation properly	Yes
73	BIOL	141	Applied Biotechnology I with Laboratory	Perform a concentration assay for DNA or Protein	Yes
74	BIOL	141	Applied Biotechnology I with Laboratory	Successfully perform a basic bio-separation technique such as column chromatography	Yes
75	BIOL	141	Applied Biotechnology I with Laboratory	Perform a molecular technique such as DNA sizing electrophoresis	Yes

EXIT STANDARDS

1 Correctly perform laboratory calculations.
2 Correctly use precision measuring devices.
3 Describe the principles of commonly used protein assays.
4 Perform chromatography and other separation methods for protein purification.
5 Describe and/or demonstrate techniques for isolation of proteins from cells and tissue.
6 Perform standard column chromatography techniques.
7 Correctly record procedures and maintain an organized laboratory notebook.
8 Describe biological concepts related to basic DNA recombinant technology and proteinisolation and analysis that are routinely used in the biotechnology laboratory.
9 Use purification analysis data to improve purification procedure.
10 Demonstrate work-readiness skills

STUDENT LEARNING OUTCOMES

1 Manufacture proteins by transforming cells with recombinant plasmids and isolate, purify, and analyze the quantify and quality of the protein.
2 Demonstrate industry standards of Good Manufacturing Practice (GMP), Good Documentation Practice (GDP), and Standard Operating Practice (SOP) while carrying out the laboratory procedures and experiments.

COURSE CONTENT WITH INSTRUCTIONAL HOURS

	Description	Lecture	Lab	Total Hours
1	Overview of cell biology and genetics • Overview of prokaryotic and eukaryotic cell structures • Overview of gene structure and gene expression in prokaryotes and eukaryotes	6	0	6
2	Cloning strategies • Protein structure and modification in prokaryotes and eukaryotes • Cloning strategies for inducible protein expression • DNA analysis (restriction enzymes, gel electrophoresis, spectrophotometer for quantification)	7	0	7
3	Concentration and dilution calculations and generation of standard curve for protein analysis	2	0	2
4	Preparation of buffers, resins, and reagents used in protein purification	3	0	3

5	Correct use of equipment used for protein purification techniques	3	0	3
6	Basic column Chromatographic methods • Column chromatography • HPLC (High Performance Liquid Chromatography)	2	0	2
7	Quantitative analysis of chromatographic fractions and purified protein • SDS-PAGE (sodium dodecyl sulfate polyacrylamide gel electrophoresis) • Activity assay • Western blot	2.5	0	2.5
8	Principles of separation methods including centrifugation, chromatography (e.g., ion exchange, size exclusion, hydrophobic interaction, affinity), electrophoresis and filtration as related to protein purification and product analysis	3.5	0	3.5
9	Sample preparation (harvest, cell disruption, etc.)	1	0	1
10	Purification strategy design and data analysis	2	0	2
11	Contaminants and impurities	1	0	1
12	Industry practices • GLP (Good Laboratory Practice) • cGMP (Current Good Manufacturing Practice) • SOP's (Standard Operating Procedures) • Use of lab notebooks or other laboratory documentation methods (e.g. e-notebook, Benchling)	3	0	3
13	Perform calculations for preparation of solutions, buffer, media • for growth and maintenance of cell cultures • for protein purification • for gel electrophoresis	0	9	9
14	Upstream processing: genetic cloning and cell culture • Growth of cryogenic cells • Transformation of E. coli with reporter gene (e.g. GFP or lacZ)	0	4.5	4.5
15	Upstream processing: genetic cloning and cell culture • Growth of cells in large volume • Introduction to use of bioreactor • Maintenance of bioreactor	0	8	8

16	Upstream processing: genetic cloning and cell culture • Spectrophotometry, measurement of cell density	0	6	6
17	Downstream processing: preparation of samples for protein purification • Protein extraction	0	8	8
18	Downstream processing: preparation of samples for protein purification • Analyze yield, protein quantification	0	8	8
19	Downstream processing: preparation of samples for protein purification • Protein purification: chromatography	0	9	9
20	Downstream processing: preparation of samples for protein purification • Protein purification: HPLC	0	9	9
21	Downstream processing: preparation of samples for protein purification • Protein purification: gel electrophoresis, SDS-PAGE	0	8	8
22	Downstream processing: preparation of samples for protein purification • Protein purification: Western blot	0	8	8
23	Perform calculations for data analysis	0	9	9
24	Write Standard Operating Procedures (SOPs)	0	5	5
25	Follow Good Documentation Practice (GDP) • Record keeping in organized lab notebooks or e-notebook. • Record and maintain documents in binders (batch record, media/buffer prep sheets, validation forms. • Record Data analyses.	0	9	9
26	Introduction to Good Manufacturing Practices (GMP) • GMP popcorn lab	0	3	3

27	Industry expert and career counselor workshops • Resume writing • Interview skills • Job searching	0	4.5	4.5
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OUT OF CLASS ASSIGNMENTS

1 Field trip;
2 Read relevant research articles;
3 Maintaining lab notebook that contains laboratory protocols (e.g. a written protocol that includes the title, purpose, materials needed, procedures, and expected results);
4 Lecture homework assignment to understand lecture concept;
5 Pre-lab quizzes;
6 Written lab report.

METHODS OF EVALUATION

1 Class presentation
2 Class and laboratory activities and experiments
3 Writing assignments that assess the ability to apply Good Laboratory Practices to reports and record keeping in lab notebooks (e.g. data collection and modifications to laboratory protocols, Standard Operating Procedures, lab report)
4 Laboratory practica that assess the ability to prepare and analyze graphs, follow a protocol, demonstrate basic lab skills and workplace competency, and explain deviations from the protocol
5 written examinations and quizzes

METHODS OF INSTRUCTION

- [x] Lecture
- [x] Laboratory
- [ ] Studio
- [x] Discussion
- [x] Multimedia
- [ ] Tutorial

- ☐ Independent Study
- ☑ Collaboratory Learning
- ☑ Demonstration
- ☑ Field Activities (Trips)
- ☑ Guest Speakers
- ☑ Presentations

TEXTBOOKS

Title	Type	Publisher	Edition	Medium	Author	IBSN	Date
Introduction to Biotechnology	Required	Pearson	4	Print	Thienman, Willian J.	978-0134650197	2018
Campbell Essential Biology	Supplemental	Pearsoon	7	Print	Simon, Eric J.	978-0134812946	2018
Laboratory Manual for Biotechnology and Laboratory Science: The Basics.	Required	Pearson	2	Print	Seidman, LisaA.	9780321644022	2011
Biotechnology: A Laboratory Skills Course	Required	Bio-Rad Laboratories, Inc.	2	Print	Brown, J. Kirk	9780983239635, 0983239630	2018
Biomanufacturing Laboratory Manual	Required	Northeast Biomanufacturing Center	1	on-line	Northeast Biomanufacturing Center and Collaborative		2012