



Common Course Number: BSC-4420

Course Title: Biotechnology

Catalog Course Description:

This course will prepare students in the knowledge and proper use of laboratory techniques including but not limited to dissection, preservation, staining and mounting of biological specimens for microscopic examination; the use of quantitative and analytical techniques such as chromatography, spectrophotometry, and electrophoresis; the proper use of laboratory equipment such as centrifuges, balances, and microscopes. Preparing laboratory solutions, reagents, and field laboratory techniques. Special emphasis will be placed on appropriate laboratory safety techniques such as the proper use and disposal of laboratory reagents, materials and biological specimens

Credit Hours Breakdown: 3 lecture hours

Prerequisite: BSC-2010, BSC-2010-L; BSC-2011, BSC-2011-L, MCB-2013, MCB-2013-L, CHM-1045, CHM-1045-L, CHM-1046, CHM-1046-L, PCB - 3060, with a minimum grade of C, are required before taking this course.

Co requisite: BCH-3023, BSC-4420-L

Course Competencies:

Competency 1: The student will demonstrate knowledge of the science of biotechnology

Upon successful completion of this course, student will demonstrate knowledge of biotechnology as a science and its implementation in modern society by:

- A. Describing how bioscience and biotechnology bring together multidisciplinary capabilities for the study of life processes, living organisms, and human health.
- B. Discussing the specific technologies and capabilities that contribute to biotechnology such as:

- biomedical research and technology, including optics and imaging, sensors, stable isotopes, lasers, biomechanics, robotics, modeling/simulation, computation, and informatics;
-
- cellular analysis, including flow cytometry, digital fluorescence microscopy and other spectromicroscopies, cell growth and cell cycle control, DNA damage and repair, cell transformation and carcinogenesis, and transgenic mouse facilities;
-
- biomolecular structure, dynamics, and functional analysis, including scanning tunneling and transmission electron microscopy, x-ray and neutron scattering, high-field nuclear magnetic resonance, ultra-fast kinetic techniques, and optical infrared spectroscopies; and genome analysis including chromosome sorting, clone libraries, robotics, genome mapping and sequencing, positional cloning, protein/DNA interactions, modeling and simulation, computing tools, and databases

C. Relating the methods and technologies to the numerous social applications

- molecular medicine, a field to which the biotechnology contributes an understanding of diseases at the molecular level and a rational approach to the design of drugs and other therapies to cure these diseases, involves capabilities in genomics, structural biology, and theoretical and computational biology
-
- agricultural and food producing industries
-
- forensic science and practical usage

D. Analyzing social consequences of Biotechnological implementations to the life.

Competency 2: Experimental design and development

Upon successful completion of this course, the student will demonstrate knowledge of the elements of a well-designed and controlled experiments by:

- A. Reviewing concepts such as observation, hypothesis, predictions, experimental design, and conclusion. The students should be able to show the relationships among assumptions, hypotheses, conclusions, theories and laws. Differentiating among experimental, observational and modeling methods of research.

- B. Interpreting an experiment in which independent and dependent variables can be used to make a prediction.
- C. Identifying methods of using technology in data acquisition, manipulation, and analysis. Knowing the importance of establishing positive and negative controls in experimental design. Differentiate between qualitative and quantitative data. Critique, evaluate and interpret data from published journal articles.
- D. Recognizing that validity of scientific knowledge is based on repeatability of results, statistical significance of results, limitations of current technology, and freedom from bias.
- E. Recognizing that interpretations in science change over time to include novel observations.
- F. Differentiating between basic and applied research.

Competency 3: Laboratory safety procedures

Upon successful completion of this course, the student will demonstrate knowledge of the safety regulations that must be implemented at the biotechnology laboratory by:

- A. Explaining the organization of a Biotechnology Company and name and describe different biotechnology workplaces.
- B. Explaining the relevance of working in a safe laboratory environment, understanding the different physical hazards and risk assessments involved in working in the biotechnology laboratory.
- C. Outlining general personal protection regulations, identifying safety laboratory dressing, the locations and purpose of full body shower stations, eye wash stations, fire extinguishers, chemical storage rooms, flammable and corrosive chemical cabinets, glassware cabinets and other laboratory instruments used in the biotechnology laboratory.
- D. Explaining use of autoclaves, electrical equipment and gel electrophoresis devices
- E. Explaining proper procedure of broken glassware and sharp instruments disposal.
- F. Identifying the chemical hazards involved in working in the biotechnology laboratory.
- G. Working safely with different chemical by understanding the hazards and toxicity imposed by contacting with each chemical in the laboratory.

- H. Identifying the routes for toxicity exposure and implementing strategies for minimizing exposure.
- I. Integrating knowledge of safety procedures in radionuclides disposal.
- J. Manipulating biological molecules using non-radioisotopic techniques.
- K. Safely handling of microorganism's cultures and tissue cultures.
- L. Working effectively and properly with recombinant DNA products
- M. Recognizing proper storage and disposal of hazardous materials and biological specimens.
- N. Identifying federal, state, and International Science Engineering Fair guidelines for humane and ethical treatment and handling of biological specimens and experimental subjects.

Competency 4: Proper laboratory procedures and record keeping

Upon successful completion of this course, the student will demonstrate knowledge of how to document laboratory procedures appropriately by:

- A. Implementing rules of recording technique protocols and laboratory data in the biotechnology laboratory.
- B. Maintaining records in the laboratory notebook and taking responsibility for all entries included in this document
- C. Demonstrating thorough knowledge of all components and entries included in the laboratory notebook.

Competency 5: Protein isolation and characterization procedures

Upon successful completion of this course, the student will demonstrate knowledge of the proper techniques for protein isolation and purification by:

- A. Integrating the knowledge of proteins structure, function and properties to the practice.
- B. Implementing spectrophotometry as a quantitative method and explaining the chemical reaction mechanism responsible for the Bradford Assay.

- C. Implementing chromatography and electrophoresis for qualitative protein analysis.
- D. Explaining theoretical basics of protein purification by sodium dodecyl sulfate polyacrylamide-gel electrophoresis (SDS-PAGE) and Coomassie blue staining of proteins separated by this method.
- E. Explaining the theoretical basics of Immunomethods (ELISA) in qualitative protein analysis.
- F. Explaining the theoretical basics of *In situ* hybridization (Western Blotting)

Competency 6: Nucleic acids structure and function

Upon successful completion of this course, the student will demonstrate knowledge of nucleic acids structure, function and properties by:

- A. Explaining the actions of restriction endonucleases on DNA.
- B. Explaining the function of recognition sequences on DNA, and the appearance of products generated by restriction enzyme digestion of DNA (blunt-ended fragments, sticky-end fragments).
- C. Explaining how DNA fragments resulting from restriction enzyme digestion are resolved by separation techniques such as agarose gel electrophoresis and polyacrylamide gel electrophoresis.
- D. Distinguishing between agarose gel and polyacrylamide gel electrophoresis.
- E. Analyzing results from agarose gel electrophoretic mobility of restriction enzyme digestion products against a standard marker DNA.
- F. Constructing a standard curve that will relate the distance migrated by marker DNA fragments on agarose gel.
- G. Extrapolating the size of a given DNA fragment profiled by agarose gel electrophoresis from such standard curve.
- H. Constructing a restriction map for a given sample of DNA using restriction enzyme data manipulation.
- I. Quantifying isolated DNA by spectrophotometric methods or directly from agarose gel electrophoresis by comparing the isolated sample with standard DNA fragments of known concentrations.



- J. Discussing the process of bacterial transformation and its importance in recombinant DNA technology.
- K. Performing a bacterial transformation and manipulate culture media to select for transformants.
- L. Cloning a desired piece of DNA into a plasmid vector.
- M. Utilize DNA ligase to generate a phosphodiester bond between the cloned piece of DNA and the plasmid DNA vector.
- N. Transforming a suitable bacterial host with the recombinant DNA molecule just generated and selecting clones containing the desired piece of DNA.
- O. Explaining to clone an eukaryotic gene fragment coding for a protein on a plasmid DNA vector.
- P. Discussing the problems encountered by molecular biologists to express eukaryotic genes in prokaryotic cells.
- Q. Explaining a gene cloning, starting from the isolated protein product.
- R. Explaining what is known as gene library and how is it generated and stored.
- S. Distinguishing between a plasmid and a phage genomic library.
- T. Discussing techniques utilized to screen genomic libraries in searching for the gene of interest.
- U. Explaining non-isotopic techniques used in molecular cloning.
- V. Discussing applications of recombinant DNA technology such as vaccine production, hormone replacement therapy and pharmacy-therapeutics, gene therapy, and agricultural/environmental applications.
- W. Explaining PCR.
- X. Discussing the advantages and applications of PCR in diagnosis of inherited disorders, diagnosis of infectious diseases, forensic analysis, and analysis of evolutionary diversity among organisms.
- Y. Discussing the relevant sources of DNA used for PCR.
- Z. Performing a PCR reaction to amplify a desired DNA sample.

- AA. Discussing the applications of PCR in DNA cloning.
- BB. Comparing strategies for cloning fragments of DNA generated by PCR.
- CC. Implementing the purification of amplified PCR DNA product.
- DD. Discussing the Sanger's method for dideoxy DNA sequencing.
- EE. Explaining the preparation of template DNA used for sequencing using radiolabeled primers.
- FF. Describing the automation of DNA sequencing techniques using the Sanger's dideoxy method and non-radioisotope techniques.
- GG. Performing a non-radioisotope DNA sequencing protocol to obtain the sequence of a specific DNA fragment.
- HH. Discussing the goals, methodologies employed in mapping human genome and its implications in biotechnology and human welfare.
- II. Explaining the applications of DNA microarray technology for studying gene expression in specific tissues and during development.

Competency 7: Spontaneous and induced mutagenesis

Upon successful completion of this course, the student will be able to demonstrate knowledge of the principles of spontaneous and induced mutagenesis by:

- A. Implementing the knowledge of genome organization in viruses, prokaryotes and eukaryotes.
- B. Discussing the probability and frequency of spontaneous mutations on DNA, chromosome and genome levels.
- C. Discussing DNA, enzymatic, and immunological methods used to identify gene mutations.
- D. Discussing cytological methods used to identify chromosomal genomic mutations.
- E. Discussing methods of molecular cytogenetics used to diagnose mutations.
- F. Discussing methodologies for induced mutagenesis.

- G. Explaining procedures used to introduce mutated genes in bacteria and other more complex organisms.
- H. Discussing the molecular diagnostics of viral and bacterial infections.
- I. Discussing the impact of directed mutagenesis on industrial, medical and social outcome.

Competency 8: Cell and tissue culture

Upon successful completion of this course, the student will demonstrate knowledge of the scientific, practical and ethical importance of cell and tissue cultures, and cellular cloning by:

- A. Discussing the procedures used in cell and tissue cultivating.
- B. Explaining the contamination problems acquired during the culture maintaining including aseptic procedures.
- C. Discussing the impact of cultured cells and tissue on certain fields of pharmacological science and industries, agricultural science and industries, medicine.
- D. Explaining the concept of cell cloning.

Competency 9: Biotechnology and society: ethical, moral and legal issues

Upon successful completion of this course, the student will demonstrate knowledge of the general impact of biotechnology on society areas by:

- A. Discussing scientific research that may contribute to ethical, legal, and societal conflicts, (including but not limited to reproductive and life-sustaining technologies, genetic basis for behavior, population growth and control, modern genetic research, the human genome project, and government and business influences on biotechnology).
- B. Demonstrating knowledge pertinent to legislation regarding ethical issues in biotechnology.
- C. Identifying Florida Code of Ethics and possible consequences for its violation.