BIOTECHNOLOGY

MODULE DESCRIPTION/OVERVIEW

How this module is related to immune modulation:

- **Biotechnology** is a multidisciplinary science that utilizes biological systems, living organisms or parts of these to develop or create different products.
- The module describes the applications of **genetic engineering including** applications of recombinant DNA technology, site directed mutagenesis and protein engineering in immunotherapy.
- This module will provide an introduction to the **concept of fermentation** including the main steps, types, fermentation modes, downstream processing and applications for the production of therapeutic or environmentally friendly products with immunomodulatory or anticancer activities and microbial products involved in biodegradation and bioremediation that eliminate harmful environmental impacts. Statistical optimization will be included to obtain the maximum yield of these products.
- This module is also designed to provide training for post-graduate students on **cell culture technology**, including basic cell-culture techniques, the cell types commonly used in culture and Applications of cell culture techniques in viral diagnosis and in evaluating the effect of new molecules in gene therapy in cancer and neurodegenerative diseases.

MODULE DESCRIPTION:

The module describes the applications of recombinant DNA technology in a variety of specialties, including crop agriculture, medical field applications like production of human growth hormone, interferon and human insulin; vaccine design and gene therapy. This module also describes the production and vast applications of monoclonal antibodies; as treatment of autoimmune diseases, cancer and viral infections. Also, the module outlines different applications of site directed mutagenesis in manipulation of the gene of interest, which can be a basis of development of new approaches for treatment of some genetic disorders, in addition to its application in protein engineering to improve the characteristics of certain proteins. The module also highlights the history and uses of several specific vaccines with an explanation of some new targets and technologies for vaccines based on immunologic principles

This module will provide an introduction to the concept of fermentation and how to use microorganisms to convert a substrate to beneficial products. The main steps involved in fermentation will also be studied including formulation of media, sterilization of equipment, production and growth of inoculum, extraction of product and disposal of effluents. Understanding the difference between different fermentation techniques including submerged and solid-state fermentation and Various fermentation modes will also be discussed including batch, fed batch, continuous and semi-continuous fermentation in addition to the different components of the fermenter. In this module, Students will learn how to apply different fermentation techniques for the production of antibiotics, amino acids enzymes bioinsecticides and biosurfactants. Students will learn Downstream processing steps that eventually provide the product at the desired level of purity, including filtration, centrifugation, solvent extraction and chromatography. Statistical optimization will be included which uses computer software to teach students to identify the most suitable medium components and

fermentation conditions to achieve maximum product concentration using minimal time and cost. Students will also learn to generate models and predict results of un-carried experiments.
This module is specifically designed for providing post-graduate students with information for learning the sources of different in vitro models of cell (tissue and organs), behaviors, different physiological characters, the advantages and disadvantages of using them, and their subsequent placement in an artificial environment (invitro culturing) under controlled conditions for different application.
The postgraduate student will recognize the cell types commonly used in culture after they are derived from original sources, and will understand maintenance requirements for establishing of cells in culture and the environment/equipment necessary to maintain favorable growth conditions
Students will acquire the skills for different methods and techniques used in cell culture and Apply cell culture techniques to develop and evaluate the effect of new molecules and gene therapy in cancer, neurodegenerative diseases.

MODULE LEARNING OBJECTIVES

Goal 1: Apply the concepts of genetic engineering in developing therapeutically bioactive products

Goal 2: Employ bioprocess engineering in diverse biotechnological applications in industry and the environment

Goal 3: Implement the principles and applications of cell culture techniques

MODULE INTENDED LEARNING OUTCOMES

Upon successful completion of this module, students will be able to:

A- KNOWLEDGE AND UNDERSTANDING: (REMEMBERING AND UNDERSTANDING)

A1. Understand genetic engineering, expression systems, protein engineering and site directed mutagenesis

A2.Discuss the therapeutic and diagnostic applications of monoclonal antibodies and different types of recombinant vaccines

A3.Recall the basic concepts and steps of fermentation and different types, modes and components of fermentation techniques

A4.Discuss different extraction and purification methods for biotechnological products (eg. chromatography)

A5. Differentiate between cell culture, tissue culture and organ culture and the different types of cell lines (primary, secondary) and different fixation and staining techniques.

A6.List the various components of cell culture media (e.g. Minerals, growth factors, hormones) and steps and conditions needed for sub-culturing and maintenance of cells in vitro

B- INTELLECTUAL SKILLS: (APPLICATION, ANALYSIS, SYNTHESIS, EVALUATION)

B1.Apply recombinant DNA technology to produce therapeutic products like monoclonal antibodies, vaccines and human proteins.

B2. Apply fermentation techniques for production of therapeutic products (eg. antibiotics, antifungals) or environmentally friendly products (eg biosensors, bioinsecticides, biosurfactants)

B3.Apply experimental design software for optimization and modelling of biotechnological products

B4.Apply cell culture in cancer immunotherapy, diagnosis of neurodegenerative disorders & viral infections production of vaccines or genetically engineered proteins

B5.Interpret and evaluate the results of experiments by statistical analysis

B6. Design well-structured reports and presentations to communicate scientific results to the general public and experts

C- PROFESSIONAL SKILLS: (PRACTICAL SKILLS)

C1.Carry out proper techniques for production of recombinant enzymes or proteins, monoclonal antibodies (ELISA, Immunohistochemistry)

C2.Implement bioprocess engineering for production and optimization of therapeutic or environmentally friendly products (eg antibiotics, biosensors, bioinsecticides, biosurfactants)

C3. Perform proper techniques for protein extraction, purification and analysis (eg. western blot, chromatography)

C4.Perform basic cell culture techniques for cancer immunotherapy, diagnosis of viral infections or production of vaccines

C5.Operate with various tools and instruments efficiently eg. laminar flow apparatus, inverted microscope, fermentors and other equipment

C6.Carry out different methods of disinfection and sterilization in the lab to maintain a safe laboratory environment and good working practice in the lab

D- GENERAL SKILLS: (ATTITUDES AND COMMUNICATION SKILLS)

D1.Show self confidence in manipulating the different biotechnology protocols

D2.Respect the ethical consideration in studying animal, and microbiological models

D3. Consider team members' communication styles, as well as their ability to operate independently or collaboratively with managing competitive scenarios.

D4.Appreciate time management skills.

D5. Support a motivational and productive work environment

D6. Motivate independent learning needed for continuous professional development

MODULE RESOURCES

Required Module Textbooks and Materials

- "Molecular Biotechnology: Principles and Applications of Recombinant DNA" by Bernard J Glick and Jack J Pasternak https://www.heavenlyfuel.com/jbframework/uploads/2017/06/Molecular-Biotechnology.pdf

- Principles of Fermentation Technology, 3rd edition, Peter Stanbury, Allan Whitaker, Stephen J. Hall, Butterworth-Heinemann (2016)

https://www.elsevier.com/books/principles-of-fermentation-technology/stanbury/978-0-08-099953-1

- Fermentation Microbiology And Biotechnology 3rd edition, E.M.T. El-Mansi • C.F.A. Bryce, CRC Press (2012) http://www.agrifs.ir/sites/default/files/27.Fermentation%20Microbiology%20and%20Biotechnology%20-2011.pdf

- Education, Gibco. "Cell culture basics handbook." Thermo Fisher Scientific 541 (2016). https://assets.thermofisher.com/TFS-Assets/BID/Handbooks/gibco-cell-culture-basics-handbook.pdf

- Freshney, R. Ian. Culture of animal cells: a manual of basic technique and specialized applications. John Wiley & Sons, 2015. https://books.google.com.eg/books/about/Culture_of_Animal_Cells.html?id=S99bCwAAQBAJ&redir_esc=y

Optional Module Textbooks and Materials

- Chisti, Y., Fermentation Technology, In: Industrial Biotechnology. Sustainable Growth and Economic Success. Edited by Wim Soetaert and Erick J. Vandamme Copyright © 2010 WILEY-VCH Verlag GmbH & Co. KgaA, Weinheim pg 149-171 https://www.researchgate.net/publication/325393615_Fermentation_technology

- Philippeos, Christina, et al. "Introduction to cell culture." Human Cell Culture Protocols. Humana Press, 2012. 1-13. https://pubmed.ncbi.nlm.nih.gov/22057441/

- Invitrogen, Gibco. "Cell culture basics." Life technologies (2014).

https://www.thermofisher.com/eg/en/home/references/gibco-cell-culture-basics.html

ASSIGNMENTS AND GRADING SCHEME

GRADING SYSTEM

Diagnostic: level assessment before the course

Formative: quizzes, Lecture activities during the course

Summative: at the end of the course

- **Written theoretical exams** including MCQ, essay questions, problem solving and True or False to assess student knowledge & understanding as well as intellectual abilities regarding the theory and practice of biotechnology
- **Practical exam** to assess student intellectual abilities as well as professional and practical skills gained from the course e.g **OSPE**

GRADING POLICY

Grades can be based on the following:

Practical presentations and assignments	30%
Exams	60%
Class attendance/participation	10%
Total Points	**100%**

MODULE POLICIES

LATE ASSIGNMENTS

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CLASSROOM PROTOCOL

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DISSABILITY