DISCIPLINE SPECIFIC ELECTIVE COURSE – 11:
MICROBIAL BIOTECHNOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MICROB-DSE 11: **MICROBIAL BIOTECHNOLOGY**	**4**	**2**	**0**	**2**	**Class XII pass with Biology/ Biotechnology/ Biochemistry**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this course is to give students an overview of the beneficial role of microbial biotechnology in the welfare of humankind. They will learn about harnessing the power of microorganisms to manufacture medicinal, industrial, and agricultural products.
- Students will be acquainted with the large-scale culturing of microorganisms to produce various metabolites at a commercial scale. Students will gain hands-on experience in screening samples for enzyme and pigment producers and dye degrading microorganisms. They will learn to immobilise enzymes and cells and use enzyme-based biosensors for analytical purposes.
- The students will get conversant with applications of bioremediation and the protection of intellectual property rights.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to describe the emerging biotechnology industries at the national and international level, use of microbe-based technologies and innovations for the benefit of mankind.
- Student will be able to explain the potential use of high-yielding microorganisms to commercially produce human therapeutics and industrial products, biosensors and steroid biotransformation.

- Student will be able to describe how microorganisms are utilized for the industrial production of biofertilizers and biopesticides, their potential use in environmental pollution management.
- Student will be able to demonstrate immobilization of biocatalysts (whole cells/enzymes) and explain how this technology can find applications in large-scale enzymatic reactions, bioremediation and designing of biosensor-based kits.
- Student will be able to explain the screening of environmental samples to isolate organisms with desired properties (enzyme production, pigment production, dye degradation).
- Student will be able to describe the research work involving GMOs and approvals required thereof and will appreciate the importance of protecting Intellectual Property Rights.

Theory: **30 hours**

Unit 1: (4 hours)

Microbial Biotechnology as an emerging Industry: Global Biotechnology industries and their products. Biotechnology trends in India with particular reference to our country's premier biotechnology institutes and industries and their products : Biocon, Serum Institute of India, Bharat Biotech and Hindustan Antibiotics Ltd. Innovations and Startups based on Microbial Biotechnology. Biotechnology in mass production of valuable products using microorganisms and advantages of using microorganisms (Laboratory, pilot and industrial- scale bioreactors).

Unit 2: (14 hours)

Microbial Biotechnology in the development of human therapeutics and industrial products: Prokaryotes and eukaryotes as expression hosts for heterologous proteins. Microbial production of therapeutic recombinant products: hormones (insulin, human growth hormone), thrombolytic agents (streptokinase and tPA) and vaccines (Hepatitis B and Covid-19 vaccines). Industrial bulk products: Production of microbial polysaccharides (xanthan gum and agar-agar), bioplastics (PHB), food-grade pigments/colorants (phycocyanin and Beta-carotene/lycopene), high fructose corn syrup. Development and functioning of enzyme- based biosensors (GOD and cholesterol oxidase). Microbial transformation of steroids**.**

Unit 3: (12 hours)

Role of Microbial Biotechnology in agriculture and environment management: Biofertilizers: liquid and carrier-based biofertilizers. Mass production of *Rhizobium, Acetobacter diazotrophicus, Azotobacter sp*. Commercial production of Biocontrol agents (*Bacillus thuringiensis* & *Trichoderma harzianum*). Development of transgenic crops with particular emphasis on insect resistance, viral resistance and nutritional quality enhancement (Bt-brinjal, Roundup-ready crops and golden rice). RNAi and its application in crop improvement. Edible vaccines, synthetic meat and Single Cell Protein (*Spirulina* & *Fusarium graminearum*), biodiesel production (algal biofuel).

Microbial bioremediation of oil spills using genetically modified organisms (GMOs) and microbial consortia. Microorganisms in the removal of heavy metals from aqueous effluents and copper bioleaching.

Practicals: **60 hours**

Unit 1: (18 hours)

Immobilization of enzymes, cells and biosensors: Immobilization of yeast cells (*Saccharomyces cerevisiae*) by entrapment using calcium alginate beads/agarose/agar and determination of the invertase activity of the immobilized cells by carrying out an invertase assay. Immobilization of an enzyme (amylase/urease/invertase) using calcium alginate/ agarose/ agar and study of its long term storage stability using enzyme assays. Use of an enzyme-based biosensor (glucose oxidase/glucose-1-dehydrogenase based devices to monitor glucose uptake/consumption during a fermentation; cholesterol oxidase/beta- hydroxybutyrate dehydrogenase-based kits to monitor changes in levels of the substrate over a period of time).

Unit 2: (30 hours)

Screening for enzymes and pigment-producer / dye-degrading microorganisms, and expression of a cloned gene: Primary screening of soil samples to isolate microorganisms that produce hydrolytic enzymes (any one): amylase, protease, lipase, CM cellulase, xylanase. Isolation of pigment-producing microorganisms from the environment and laboratory-scale production of any pigment using the shake-flask technique OR Screening for dye-degrading (methylene blue/ methyl orange/ Rhodamine B, etc.) microorganisms from the environment using plate assays and study of the absorption spectra of any dye. Transformation and expression studies of a given plasmid (expressing Green Fluorescent Protein) in the BL21 strain of *E coli,* analysis of protein expression using SDS-PAGE.

Unit 3: (12 hours)

An orientation to the biosafety regulatory framework for Genetically Modified Organisms (GMOs) in India: An introduction to different methods of protecting Intellectual Property in India (Patents, Copyrights, Trademarks, Geographical Indications, Industrial Design and New Plant Varieties). Filing applications for approval of research proposals by the concerned regulatory bodies. Filing of a patent application to the regulator for the protection of a GMO. **Student group research project:** Case study of any microbial consortium available in India for environmental bioremediation.

Suggested Reading (Theory & Practical):

1. Industrial Microbiology by A.H. Patel. 2nd edition. Laxmi publication Pvt Ltd/Trinity Press. 2022.

2. Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition.

Pearson Education, USA. 2020.

3. Industrial Microbiology by L.E. Casida. 2nd edition. New Age International Publisher. 2019.

4. Intellectual Property Rights in India. Pidigam Saidaiah and K. Ravinder Reddy. International Books and Periodical Supply Service. 2020.

5. Prescott's Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition. McGrawHill Higher Education, USA. 2019.

6. Crueger's Biotechnology: A Textbook of Industrial Microbiology by W. Crueger, A. Crueger and K.R.Aneja. 3rd edition. Medtech Publisher, India. 2017.

7. Principles of Fermentation Technology by P.F. Stanbury, A.Whitaker and S.J. Hall. 3rd edition. Elsevier Science Ltd, Netherlands. 2016.

8. Benson's Microbiological Applications: Laboratory Manual in General Microbiology by A.E. Brown and H. Smith. 15th edition. Mc-Graw Hill Education, USA. 2022.

9. Manual of Industrial Microbiology and Biotechnology by R.H. Baltz, A.L.Domain, and J.E. Davies. 3rd edition. American Society for Microbiology. 2010.

10. Molecular Biotechnology by B.R. Glick, J.J. Pasternak and C.L. Patten. 4th edition, ASM Press, USA. 2009.

11. Microbial Biotechnology: Fundamentals of Applied Microbiology by A.N. Glazer and H. Nikaido. 2nd edition. W.H. Freeman and Company, UK. 2007.

12. Manual of Industrial Microbiology and Biotechnology by A.L. Demain, J.E. Davies and R.M. Atlas. 2nd edition. ASM Press, USA. 1999.

13. The DBT portal: https://dbtindia.gov.in/regulations-uidelines/regulations/biosafety- programme

14. Intellectual Property Rights: Chapter III on the INFLIBNET portal: http://shodhganga.inflibnet.ac.in/bitstream/10603/205165/7/chapter%20iii.pdf

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.