Chowgule Education Society's
Parvatibai Chowgule College of Arts and Science
Autonomous
Accredited by NAAC with Grade 'A+'
Best Affiliated College-Goa University Silver Jubilee Year Award

MINUTES OF MEETING OF THE BOARD OF STUDIES IN BIOTECHNOLOGY

HELD ON 17th FEBRUARY, 2024 at Parvatibai Chowgule College of Arts & Science (Autonomous) Margao – Goa

Vide Chowgule College notice F.133(C)/1397 (dated 6th February 2024) a meeting of this BOS was convened on 17th February, 2024 at 02:00 pm through online Google meet, Parvatibai Chowgule College of Arts & Science, Margao – Goa. Since the number of members present represented the Quorum, the BoS began its proceedings.

Members present:

1. Dr. Starlaine Mascarenhas – Chairperson
2. Dr. Shaiesh Morajkar – Member Secretary
3. Prof. Meenal Kowshik – AC Nominee
4. Dr. Flory Pereira – AC Nominee
5. Dr. Tamal Raha – Industrial Representative
6. Dr. Aman Dongre – Member
7. Ms. Ravina Pai – Member
8. Ms. Reshma Zakane – Member
9. Ms. Samradni Paigankar- Alumni student representative

Members Absent with intimation:

1. Prof. Srikanth Mutnuri – VC Nominee

Proceedings:

The Chairperson welcomed the members of the Board of Studies (BOS). The Chairperson introduced and explained the agenda for the meeting and read out the minutes of the previous B.O.S meet. The meet continued taking up the following agenda.

Agenda Items:

a) Revision of CLO & alignment of CLO to PLO/ PO in accordance with OBE. Applicable only to the NEP implemented syllabus.
b) To approve minor revision of syllabi of the following courses under the existing structure:
    i. Semester 5: Plant Biotechnology (BIO-V.E-11)
    ii. Semester 6: Industrial Biotechnology (BIO-VI.C-8)
c) Any Other Business (A.O.B.)

PART B: Important Points/ recommendations of BOS that require consideration / approval of Academic Council:

1. Revised Course Learning outcomes (CLO's) of three year undergraduate degree programme in Biotechnology (under the NEP course structure) (Annexure A).
2. Minor revision in syllabi of the following semester V and VI courses under the existing course structure (Annexure A):
   a. Major elective course in semester V: Plant Biotechnology (BIO-V.E-11)
   b. Major core course in semester VI: Industrial Biotechnology (BIO-VI.C-8)
3. Revised Programme Learning Outcomes (PLO's) of three year undergraduate degree programme in Biotechnology (under the NEP course structure) (Annexure B).

Dr. Shaiesh Morajkar
Member Secretary
Board of Studies

Dr. Starlaine Mascarenhas
Chairperson
Board of Studies

Dated: 24th February 2024

Annexure A
Summary of the changes incorporated in CLOs

Semester	Course	Existing CLOs	Revised CLOs	Reason for revising
I	UG-BIO-101: Biomolecules	CLO1: Discuss the structure of atoms, biomolecules and chemical bonds. CLO2: Understand concepts of enzyme kinetics, bio-polymers and metabolic reactions in a living system. CLO3: Understand and apply general laboratory safety measures as well as calculate for preparation of various chemicals for experiments. CLO4: Prepare different solutions such as buffers, reagents and stock solutions for experiments independently. CLO5: Operate various lab instruments such as weighing balance, water bath and spectrophotometer.	CLO1: Appreciate the landmarks of biochemistry and comprehend the structure cum functional significance of major biomolecules- carbohydrates and proteins. CLO2: Elucidate the structure and functional importance of lipids and nucleic acids CLO3: Understand concepts of modified biomolecules such as vitamins, hormones, enzyme kinetics, and biomolecular interactions in a living system. CLO4: Obtain practical knowledge of general laboratory safety measures, preparation of different solutions such as buffers, reagents, stock solutions and working of instruments such as weighing balance, water bath and spectrophotometer	Aligning and mapping with the framework of OBE
	UG-BIO-102: Cell biology	CLO1: Understand the structure and functional aspects of the Cell wall and plasma membrane. CLO2: Correlate the function of each cell organelle with proper coordination. CLO3: Demonstrate an understanding of cell communication. CLO4: Prepare various plant and	CLO1: Understand the structure and functional aspects of the Cell wall and plasma membrane. CLO2: Comprehend the structure and functional importance of each cell organelle. CLO3: Gain an understanding of cell cycle and cell-cell communication. CLO4: Obtain practical knowledge in	

		animal specimens for observation of cell structures CLO5: Identify and analyse different biological cells using a compound microscope.	identification and analysis of cell organelle & ultrastructure via microscopy, cell cycle stages and perform cell viability studies.	
	UG-BIO-SEC1: Mushroom cultivation	CLO1: Understand the importance of mushroom cultivation. CLO2: Understand the mushroom cultivation technology and types of storage methods.	CLO1: Appreciate the types of mushrooms-edible and non-edible. CLO2: Understand the process of mushroom cultivation (spawn cultivation, setting up of farm, growing and harvesting mushroom) CLO3: Learn about different value products and preservation techniques.	
	UG-BIO-MDC1: Food and Fermentation technology	CLO1: Introduced the basics of food fermentation technology. CLO2: Understand the principle and benefits of fermented foods. CLO3: Learn about fermentation of cereal based foods CLO4: Learn about fermentation of non-cereal based foods CLO5: Prepare simple home based fermented foods.	CLO1: Appreciate the principle and importance of fermentation technology along with the types of cereal based fermented foods. CLO2: Understand the process of production of fermented beverages CLO3: Comprehend the process of production of non-cereal based fermented food such as dairy and non-dairy products	
II	UG-BIO-103: Basic Microbiology	CLO1: Understand the scope and importance of Microbiology, classification schemes, cultivation, preservation and maintenance of microbial cultures. CLO2: Discriminate between various groups of microorganisms and also comprehend the beneficial and harmful	CLO1:Understand the scope of Microbiology, basics of microscopy and bacterial Taxonomy. CLO2: Learn various techniques of culturing, preservation and maintenance of microorganisms CLO3: Understand the structure and organisation of microorganisms, growth	

		effects of each group of microorganisms. CLO3: Compare, analyse, apply the concepts of principle, working of microscopes types. CLO4: Adhere to strict laboratory safety measures to be followed in a microbiology laboratory. CLO5: Master skills in aseptic techniques as well comprehend the importance of cleaning and decontamination.	characteristics and reproduction patterns. CLO4:Obtain skills in microscopic observation, aseptic techniques and microbiological culture methods.	
	UG-BIO-104: Fundamental Genetics	CLO1: Outline the basic principles of Mendelian genetics and compare and analyse different inheritance patterns as well as solve problems based on genetic principles. CLO2: Compare and contrast different mutations, their effects on cells and the application of the same to research. CLO3: Differentiate between the structure and working of a compound and dissection microscope. CLO4: Construct and interpret a karyotype prepared from a spread of metaphase chromosomes. CLO5: Understand and identify Barr bodies and Giant chromosomes.	CLO1: Outline the basic principles of Mendelian genetics and inheritance patterns CLO2:Appreciate the importance of cell division, inbreeding , linkage, crossing over and its significance in population genetics CLO3: Understand the sex determination patterns, pedigree analysis and disorders associated with structural and numerical chromosomal aberrations. CLO4: Understand the working of dissection and compound microscope, and identify Barr bodies, Giant chromosomes, construct and interpret karyotypes	
	UG-BIO-SEC2: Elementary	CLO1: Understand basics of Bioinformatics and its	CLO1: Introduced to application of computers in biology	

	tools for visualisation of biological data	application in biological sciences. CLO2: Get acquainted with biological databases and its types, data retrieval systems, tools, and algorithms for analysis of biological data.	and basic concepts of bioinformatics such as nucleotide and protein databases. CLO2: Learn about basic sequence alignment tools CLO3: Comprehend the visualisation of protein structure by various *in silico* modelling tools.	
	UG-BIO-MDC2: Basics of Biodiversity	CLO1: Gain awareness on basic knowledge of local biodiversity. CLO2: Understand basic concepts of biodiversity identification and generate a sense of belonging and ownership to the biodiversity and its conservation.	CLO1: Understand the types of biodiversity, hotspots and threats. CLO2: Acquire knowledge on the identification of species of commonly known species flora and fauna. CLO3: Emphasise on threats to biodiversity and the need for conservation by various strategies through case studies analysis.	
III	UG-BIO-201: Molecular Biology	CLO1: Understand basic concepts in molecular biology CLO2: Explain the structure of DNA and its properties CLO3: Distinguish between DNA, RNA and Proteins CLO4: Compare differences between replication, transcription and translation processes in prokaryotes and eukaryotes. CLO5: Describe the mechanism of gene transfer and regulation	CLO1: Learn the discovery of genetic material, its transfer and DNA Replication CLO2: Understanding DNA damage, its repair and process of transcription CLO3: Comprehend the concept of genetic code, its translation and gene expression. CLO4: Perform basic techniques in molecular biology research such as isolation of genetic material, its quantification, and observation.	
	UG-BIO-202: Enzymology	CLO1: Understand the structure of an enzyme and kinetics of enzyme catalysed reactions CLO2: Comprehend factors that affect enzymatic activity	CLO1: Elucidate the structure of an enzyme and features of enzyme catalysis. CLO2: Comprehend enzyme kinetics and	

		CLO3: Analyse and compare different types of enzyme inhibitions CLO4: Value the wide applications of enzymes and future potential CLO5: Isolate and purify crude forms of enzyme extract and apply appropriate method for determination of activity of enzyme	different types of enzyme inhibitions. CLO3: Understand various enzyme purification techniques and appreciate wide application of enzymes in food, detergent, leather and diagnostic industries CLO4: Learn methods of isolation, and purification of crude forms of enzyme, determination of enzyme activity & specific activity and analyse the effect of various factors on the same.	
	UG-BIO-203: Metabolism of Biomolecules	CLO1: Understand and explain the metabolic processes of the human body CLO2: Elucidate the interconnections of metabolic pathway. CLO3: Analyse the effect of diet on metabolism and defects caused due to improper metabolism. CLO4: Evaluate the causes and treatment of various metabolic disorders through case studies. CLO5: Estimate and isolate various biomolecules using spectrophotometry, Thin layer chromatography & centrifugation techniques.	CLO1: Understand the basic concepts of human metabolic with emphasis on carbohydrate and amino acid metabolism. CLO2: Appreciate the mechanism of fatty acid and nucleic acid metabolism and analyse the interconnections of various metabolic pathway. CLO3: Analyse the effect of diet on metabolism and evaluate the causes and treatment of various metabolic disorders through case studies. CLO4: Estimate and isolate various biomolecules using spectrophotometry, Thin layer chromatography & centrifugation techniques.	
	UG-BIO-SEC3: Biostatistics	CLO1: Appreciate the application of statistics in biology. CLO2: Understand the	CLO1: Gain an introduction to Biostatistics & different	

		concepts of sampling, representation and interpretation of the data using graphical methods and MS Excel. CLO3: Solve problems on measures of central tendency, dispersion and hypothesis testing and apply appropriate statistical tools in their final year project work.	measures of data analysis. CLO2: Understand the methods of Regression analysis, Hypothesis testing and application of basic statistical software. CLO3: Carry out Graphical/ Diagrammatic representation of data based on an experimental study.	
	UG-BIO-MDC3: Composting technology	CLO1: Understand the importance and application of compost production for sustainable environment management. CLO2:Undestand the various methods of composting	CLO1:Understand the importance of composting and selection of right organism for the same. CLO2:Appreciate various techniques of composting technology CLO3: Understand the design of composting technology unit and various composting derived value added products.	
IV	UG-BIO-204: Immunology	CLO1: Trace the history of immunology and gain knowledge of the structure and function of the cells and organs of immune systems CLO2: Understand the mechanisms of Ag-Ab reaction, hypersensitivity reactions and importance of Complement system CLO3: Compare and contrast primary and secondary immune response. CLO4: Evaluate the importance of Monoclonal Ab and their role in various	CLO1: Explore the historical development of immunology, differences between the primary and secondary immune response. CLO2: Gain knowledge of the immune system's building blocks, structure and function of the immune system's cells and organs. CLO3: Understand mechanisms of antigen-antibody reactions, hypersensitivity reactions, and the complement system. CLO4: Appreciate the importance of monoclonal antibodies, various	

		immunodeficiency diseases CLO5: Get acquainted with various techniques involved in immunology	immunodeficiency diseases, and the techniques used in immunological research.	
	UG-BIO-205: Molecular Genetics	CLO1: Understand the various molecular aspects of human genetics including DNA variation and mutations. CLO2: Differentiate between the various methods of chromosome analysis and cell division CLO3: Compare and contrast the various techniques associated with forensics genetics CLO4: Investigate the risk factors in genetic counselling for individuals with a family history of genetic disorders CLO5: Apply their knowledge of various molecular techniques in order to diagnose specific genetic disorders.	CLO1: Understand the methods of chromosome analysis, cell division, molecular aspects of human genetics including DNA variation and mutations. CO2: Understand the importance of molecular techniques in diagnosis of genetic disorders, calculation of risk factors and application of various genetic counselling strategies CLO3: Appreciate the significance of gene therapy and concepts in forensic genetics CLO4: Obtain practical knowledge of various molecular techniques like electrophoresis and karyotyping to diagnose specific genetic disorders and problem solving for calculation of disorder risk factors.	
	UG-BIO-206: Basics of Plant and Animal Sciences	CLO1: Understand classification of plant and animal kingdom CLO2: Compare and contrast the differences in morphology and anatomy in angiosperms CLO3: Examine features of the non-chordates and chordates CLO4: Critique various phyla of the plant and animal	CLO1: Comprehend plant classification system along with morphological and anatomical aspects of Angiosperms CLO2: Elaborate general characteristics and habitats of non-chordates and chordates CLO3: Acquire knowledge of distinctive salient features of each phyla in animal kingdom CLO4: Proficiency in light microscopy aiding	

		kingdoms based on characteristics CLO5: Sketch the morphology and anatomy of selected plant and animal specimens.	to analyse distinct characteristics in plant and animal kingdom	
	UG-BIO-207: Tools and Techniques in Biotechnology	CLO1: Comprehend the principle and application of various centrifugation techniques in biological sciences CLO2: Understand the principle and apply various spectroscopic and chromatographic techniques for industrial analysis CLO3: Compare and contrast various electrophoretic techniques used in molecular biology research CLO4: Evaluate the various radioactivity techniques used in biomedical research CLO5: Perform purification and separation of proteins.	CLO1: Understand the concepts of units of measurements, and importance and usage of buffer systems in biological systems CLO2: Learn the principle, types, instrumentation, and applications of various tools and techniques used in biotechnology such as Spectrophotometer, Centrifuge, chromatography, electrophoresis. CLO3: Introduced to the probes used in molecular biology and concepts and techniques using radioactivity. CLO4:Apply various analytical techniques such as spectrophotometery, centrifugation, chromatography and electrophoresis for isolation of major biomolecules.	
	UG-BIO-VOC1: Evolution and Anthropology	CLO1: Understand basic concepts of evolution and anthropology and importance in biotechnology CLO2: Explain the evolutionary history and describe the historical development of anthropology CLO3: Compare and contrast past and present cultures	CLO1: Understand basic concepts of evolution and anthropology and importance in biotechnology CLO2: Explain past and present cultures including ecological adaptations with scientific approach CLO3: Describe quantitative and qualitative methods in	

		including ecological adaptations with scientific approach CLO4: Examine the quantitative and qualitative methods in the analysis of anthropological data CLO5: Critically evaluate the logic of anthropological research and apply anthropological research to contemporary environmental, social, or health issues worldwide.	the analysis of anthropological data CLO4: Critically evaluate the logic of anthropological research and apply anthropological research to contemporary environmental, social, or health issues worldwide.	
V	UG-BIO-301: Concepts in Genetic Engineering	CLO1: Understand the functions of several enzymes and vectors used in cloning. CLO2: Acquaint to the versatile tools and techniques employed in recombinant DNA technology. CLO3: Explain the construction of DNA & cDNA library CLO4: Procure skills for selection of recombinants CLO5: Acquire skills on techniques of plasmid isolation	CLO1: Understand the functions of various enzymes and vectors utilized in the cloning process. CLO2: Appreciate diverse tools and techniques applied in the field of recombinant DNA technology. CLO3: Explain the step-by-step process involved in constructing DNA and cDNA libraries. CLO4: Develop skills in plasmid isolation techniques and selection of recombinants	
	UG-BIO-302: Environmental Biotechnology	CLO1: Explain the scope of Environmental Biotechnology. CLO2: Understand the basic ecological concepts, various pollution, its measurements & remediation. CLO3: Describe the various eco-friendly bio-products. CLO4: Assess the quality of the water	CLO1: Understand the scope and opportunities in Environmental Biotechnology CLO2: Learn the importance of biotechnology in environmental monitoring CLO3: Learn the applications of biotechnology in pollution abatement and about the eco-friendly bio-products.	

		sample through various parameters like MPN test, dissolved oxygen concentration, biological oxygen demand, chemical oxygen demand and nitrates of water sample. CLO5: Understand the working of sewage treatment plant.	CLO4: Assess the quality of the water sample through various parameters like MPN test, dissolved oxygen concentration, biological oxygen demand, chemical oxygen demand and nitrates of water sample.	
	UG-BIO-303: Plant Biotechnology	CLO1: This paper aims at introducing the concept of in vitro culture of plants including set up of a plant tissue culture laboratory, instruments and sterilization techniques. CLO2: This paper will help the students to understand that various parts of the plant may be cultured, with each type of culture having specific applications. CLO3: Plant tissue culture also lends itself for production of transgenic plants which have various applications. CLO4: On completion of this module, the student will be able to understand all about plant biotechnology in terms of set up of a laboratory, culture of explants CLO5: In addition, the students will be able to understand genetic engineering methods for production of transgenic plants.	CLO1: Comprehend Plant tissue culture lab techniques encompassing sterilization methods, media preparation and organogenesis CLO 2: Explore different culture techniques involving various plant organs CLO3: Understand the application of plant tissue culture in production of transgenic plants and synthetic biology. CLO4: Develop practical expertise in setting up plant tissue culture lab and techniques for regeneration of explant	

	UG-BIO-VOC2: Bioethics and Biosafety	CLO1: Understand the importance of general safety measures in laboratories and biosafety guidelines CLO2: Justify the design of confinement facilities at different Biosafety levels, CLO3: Demonstrate good laboratory practices CLO4: Discuss the relevance of intellectual property rights to biotechnological innovations, CLO5: Describe the standard operating procedures for disposal of various types of wastes from the Biotechnology laboratory	CLO1: Understand the importance of general laboratory safety measures, biosafety levels and guidelines. CLO2: Gain knowledge on the practical aseptic techniques, standard operating procedures and waste disposal techniques to ensure safety of personnel in a laboratory setting, environment, and community. CLO3: Understands the significance of intellectual property (IP) rights in biotechnology, different types of IP protection, and their role in supporting research and development. CLO4: Understand the significance of biosafety and bioethics through real life case- studies and application in protection of GMO's and GEM's	
VI	UG-BIO-304: Industrial Biotechnology	CLO1: Understand and explain various features of a fermenter. CLO2: Comprehend various concepts of Upstream and Downstream processes. CLO3: Describe the production processes of fermentation products like wine or vinegar at the industrial level. CLO4: Design small scale experiments to produce common enzymes like amylase. CLO5: Prepare basic fermentation products like wine, vinegar, etc.	CLO1: Understand features and types of bioreactors along with gaining insight in microbial screening, selection and preservation techniques. CLO2: Learn about fermentation processes, fermentation media, product (detection and assay) and scale-up. CLO3: Comprehend downstream processing methods CLO4: Gain practical skills in screening of antibiotic producing microbes and fermentation processes.	

	UG-BIO-305: Bioinformatics	CLO1: Explain the scope of Bioinformatics CLO2: Understand the basic concept of biological databases, various types and applications of biological databases. CLO3: Describe the various applications of BLAST and FASTA in understanding differences in evolutionary patterns CLO4: Assess the mutations, genetic disorders and understand importance of drug design *In silico* CLO5: Will be able to construct evolution tree, cladogram, retrieve and biological information accessed through various information resources.	CLO1: Gain basic knowledge of the concepts of Bioinformatics and its resources. CLO2: Understand the basic concept of biological databases, various types and applications of biological databases. CLO3: Describe the various applications of BLAST and FASTA in understanding differences in sequence alignment and Phylogeny CLO4: Will be able to construct an evolution tree, cladogram, retrieve and biological information accessed through various information resources.	
	UG-BIO-306: Animal Cell culture	CLO1: Understand the basic concepts of animal cell culture. CLO2: Comprehend the various requirements and techniques for animal cell culture and importance of the same. CLO3: Understand the importance of primary and established cell lines for biotechnological applications. CLO4: Appreciate the various methods of characterization and growth assessment techniques in culturing animal cells. CLO5: Understand the applications of animal cells in the	CLO1: Comprehend the basic concepts of animal cell culture and the importance of various requirements (equipment and media) for the same. CLO2: Understand the importance of various cell culture techniques, growth cycle, cell synchronization, primary and established cell lines for biotechnological applications. CLO3: Appreciate the various methods of cell characterization, cell separation, growth assessment techniques and applications of animal cells in diagnostics and therapeutics.	

		development of disease diagnostics and therapeutics.	CLO4: Develop practical skills in animal cell culture media preparation, basic cell culture and subculture techniques and growth assessment methodology.	
	UG-BIO-VOC3: Advanced Cell Biology	CLO1: Understand the theory behind the working of various techniques in cell biology. CLO2: Explain the processes of membrane transport and signal transduction. CLO3: Describe the regulation of the cell cycle events. CLO4: Isolate and visualize the subcellular organelles. CLO5: Prepare slides and identify various stages of Mitosis and Meiosis.	CLO1: Understand the theory behind the working of various techniques in cell biology. CLO2: Explain the processes of membrane transport and regulation of the cell cycle events. CLO3: Understand the importance of various signal transduction pathways and scope of cancer biology CLO4: Isolate and visualize the subcellular organelles, various stages of Mitosis and Meiosis.	

Annexure A

Summary of the changes incorporated in syllabus

Semester	Course	Existing	Changes suggested	Reason
V	Plant Biotechnology (BIO-V.E-11) – (Under the existing course structure)	Module 3: Gene transfer techniques were repetitive and already explained in the semester 5 course viz. 'Concepts in Genetic engineering'. Hence content restricted to methods of gene transfer in plants only with applications of transgenic plants. Additionally, a section on 'Plant Metabolic Engineering with Synthetic Biology' is introduced under module 3	**New section under Module 3 as follows:** **Genetic transformation techniques and applications of transgenic plants** Agrobacterium-mediated transformation, biolistics, Insect resistance (BT toxin); drought and salt tolerance; herbicide resistance; increasing shelf life of fruits; Biofortification- golden rice and edible vaccines **Plant Metabolic Engineering with Synthetic Biology:** Techniques for metabolic engineering of plants to enhance the production of pharmaceuticals and nutraceuticals; a case study of successful metabolic engineering projects, synthetic biology approaches for pathway optimisation and enzyme engineering	Refining course by substituting repetitive sections with plant synthetic biology.
VI	Industrial Biotechnology (BIO-VI.C-8) – (Under the existing course structure)	Module 1: Did not have Rotary Drum type of Bioreactors Module 2: Did not have Methods of immobilization. Module 3: mentioned about organisms in general.	Module 1: Added rotary drum type of bioreactors Module 2: Added methods of immobilization and restructured types of fermentation processes along with sterilization methods into physical and mechanical. Module 3: Added a component on industrially important organisms	Restructuring of the syllabus for better understanding of the concepts with relevance to the concerned module.

Revised Syllabus (under the existing course structure)
(To be implemented w.e.f. Acad. Year 2024-2025)

BIO-V.E-11: PLANT BIOTECHNOLOGY

Course Title : Plant Biotechnology
Course Code : BIO-V.E-11
Credits : 4
Marks : 100

Course Objectives: This course aims at introducing the concept of in vitro culture of plants including set-up of a plant tissue culture laboratory, instruments and sterilization techniques. This course will help the students to understand that various parts of the plant may be cultured, with each type of culture having specific applications. Plant tissue culture also lends itself to the production of transgenic plants which have various applications.

Course Learning Outcomes

Upon completion of the course, the student will be able to:
CLO1: This paper aims at introducing the concept of in vitro culture of plants including set up of a plant tissue culture laboratory, instruments and sterilization techniques.
CLO2: This paper will help the students to understand that various parts of the plant may be cultured, with each type of culture having specific applications.
CLO3: Plant tissue culture also lends itself for production of transgenic plants which have various applications.
CLO4: On completion of this module, the student will be able to understand all about plant biotechnology in terms of set up of a laboratory, culture of explants
CLO5: In addition, the students will be able to understand genetic engineering methods for production of transgenic plants.

BIO-V.E-11: PLANT BIOTECHNOLOGY (THEORY)

Module I **(15 Hours)**

History and development of plant tissue culture 2 hrs
Overview of plant tissue culture, Milestones in plant biotechnology
Laboratory organization 4 hrs
Washing and drying facility; general laboratory and media preparation area; transfer area; culture room; growth chambers and greenhouse (ideal conditions for incubation and maintenance of cultures/plants).
Sterilization techniques 2 hrs
Sterilization techniques used for plant material and culture media– steam, dry, filter, ultraviolet, alcohol, flame and chemical
Plant tissue culture media 4 hrs
Major and minor inorganic nutrients; vitamins; carbon source; hormones; complex organic additives and their functions; composition of some commonly used plant tissue culture media – MS, White's, Nitsch, Gamborg's B5
Totipotency 2 hrs
Totipotency and its Importance; Various parts of the plant serving as Explants
Organogenesis 1 hr
Root and shoot regeneration and applications

Module II **(15 Hours)**

Organ culture and its applications 5 hrs
Root; shoot tip/meristem; anther and pollen; ovary and ovule embryo
Callus and cell suspension cultures 4 hrs

Callus culture – principle; characteristics of callus tissue; applications; cell suspension culture – principle; isolation; growth patterns; concept of batch and continuous culture; viability testing

Somaclonal variation 2 hrs

Concept; isolation of variants; mechanisms of soma clonal variation and applications

Somatic embryogenesis and artificial seeds 2 hrs

Somatic embryogenesis – principle; procedure and applications; artificial seeds – methods of production and applications

Applications of Tissue Culture in Plant Sciences 2 hrs

Micropropagation; gene conservation banks; forestry

Module III **(15 Hours)**

Protoplast culture and somatic hybridization 4 hrs

Protoplast culture – principle; isolation of protoplasts (mechanical and enzymatic); methods of culture; checking viability; somatic hybridization - protoplast fusion (spontaneous and induced); selection of hybrid protoplasts; applications of somatic hybridization

Production of secondary metabolites 2 hrs

Classification of secondary metabolites with examples; production using culture methods - callus culture; cell suspension culture; hairy root culture (*A. rhizogenes*); immobilized cell systems

Genetic transformation techniques and applications of transgenic plants 6 hrs

Agrobacterium-mediated transformation, biolistics, Insect resistance (BT toxin); drought and salt tolerance; herbicide resistance; increasing shelf life of fruits; Biofortification- golden rice and edible vaccines

Plant Metabolic Engineering with Synthetic Biology 3 hrs

Techniques for metabolic engineering of plants to enhance the production of pharmaceuticals and nutraceuticals; a case study of successful metabolic engineering projects, synthetic biology approaches for pathway optimisation and enzyme engineering

PRACTICALS

1. Washing, Packing and Sterilization of Glassware
2. Preparation of Stock solutions for Murashige and Skoog (MS) medium
3. Preparation, sterilization and pouring of MS medium
4. Aseptic germination of seedlings
5. Callus induction from hypocotyl and carrot cambial explants and subculturing
6. Shoot tip culture
7. Regeneration of shoot/root from callus
8. Setting up of cell suspension culture and checking viability by Evan's blue method
9. Setting up an in vitro culture from a seed embryo (embryo culture)
10. Encapsulation of somatic/true embryo (synthetic seeds) and Regeneration of Plants from Synthetic Seeds

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Mandatory:

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2. Slater, A., Scott, N., & Fowler, M. (2008). Plant biotechnology: the genetic manipulation of plants. OUP Oxford.
3. Jha, T.B. & Ghosh,B. (2005) Plant Tissue Culture, University Press (India) Pvt. Ltd.
4. Singh, B.D. (2005) Plant Biotechnology, Kalyani Publishers.
5. Chawla, H.S. (2002) Introduction to Plant Biotechnology, Science Publishers Inc. USA.

Supplementary:

1. Gahlawat, S. K., Salar, R. K., Siwach, P., Duhan, J. S., Kumar, S., & Kaur, P. (Eds.). (2017). Plant biotechnology: recent advancements and developments (pp. 1-390). Singapore: Springer.
2. Smith, R. H. (2012). Plant tissue culture: techniques and experiments. academic press.
3. Hammond, J., McGarvey, P., & Yusibov, V. (Eds.). (2012). Plant biotechnology: new products and applications (Vol. 240). Springer Science & Business Media.
4. Purohit, S. D. (2012). Introduction to plant cell tissue and organ culture. PHI Learning Pvt. Ltd.
5. Altman, A., & Hasegawa, P. M. (Eds.). (2011). Plant biotechnology and agriculture: prospects for the 21st century. Academic press.

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1. Organogenesis: https://www.plantcelltechnology.com/blog/organogenesis-in-plants/
2.Tissue culture technology:
https://www.sciencedirect.com/science/article/abs/pii/S0140196301908845
3. Application of Plant Biotechnology:
https://www.sciencedirect.com/science/article/pii/B9780128022214000054
4. Plant Synthetic Biology:
https://www.sciencedirect.com/science/article/pii/S221466282030044X
5. Cell Suspension Culture:
https://www.sciencedirect.com/science/article/abs/pii/S0926669020306671

BIO-VI.C-8: INDUSTRIAL BIOTECHNOLOGY
Course Title: Industrial Biotechnology
Course Code: BIO-VI.C-8
Credits: 4
Marks: 100
Pre-requisites: Completion of BIO-II.C-4-Basic Microbiology

Course Objectives: This course is designed to introduce the students to the basic concepts in Industrial Biotechnology. The paper covers concepts in Industrial Biotechnology, mainly introducing the basics of upstream processes in fermentation technology on an industrial scale.

Course Outcomes
Upon completion of the course, the student will be able to:
CLO1: Understand and explain various features of a fermenter.
CLO2: Comprehend various concepts of Upstream and Downstream processes.
CLO3: Describe the production processes of fermentation products like wine or vinegar at the industrial level.
CLO4: Design small scale experiments to produce common enzymes like amylase.
CLO5: Prepare basic fermentation products like wine, vinegar, etc.

BIO-VI.C-8: INDUSTRIAL BIOTECHNOLOGY (THEORY)
Module I **(15 Hours)**
Fermentation equipment and its use - 10 hrs
Definition of fermenter/bioreactors; structure of ideal fermenter; definition and uses of impellers and their types; sparger s and their types; baffles; headspace; controls and sensors (temperature, pH, antifoam, dissolved oxygen and carbon dioxide sensor); Types of reactors (definition, description, diagram and uses)- stirred tank reactors; bubble columns; airlift bioreactors (internal and external loop); fluidized bed; packed bed column, photobioreactors; tray bioreactors, Rotary drum bioreactor.
Screening and selection of microorganisms - 3 hrs
Primary screening-definition; techniques; crowded Plate; auxanography; enrichment; indicator dye; secondary screening- definition and features; giant colony technique
Stock cultures - 2 hrs
Cryogenic preservation; aims of preservation of cultures; definition of working and primary stock cultures; techniques of preservation- serial subculture, sterile soil, water, silica gel; sterile mineral oil; lyophilisation

Module II **(15 Hours)**
Types of fermentation processes - 3 hrs
Surface/solid state (SSF) & Submerged Fermentation (SmF); Batch, fed-batch and Continuous systems; Immobilization methods in brief.
Fermentation media - 5 hrs
Characteristics of an ideal fermentation media; production media; media composition crude, synthetic; media; sterilization methods – Physical (Heat & radiation), chemical and Mechanical (filtration); batch and continuous sterilization, inoculum preparation.
Detection and assay of fermentation products - 5 hrs
Physical or chemical assay- titration and gravimetric assay; turbidity analysis, cell determination; spectrophotometric assay; chromatographic partition assay; biological assay- concept benefits and drawbacks; diffusion assay; turbidimetric and growth assay; end point assay; metabolic response assay; enzymatic assay
Scale up of fermentations and increasing product yields - 2 hrs

Significance of scale up; pilot fermenters; increasing product yields by mutagens-physical and chemical mutagens/strain improvement

Module III **(15 Hours)**

Downstream processing - 10 hrs

Biomass: separation of cells flocculation; floatation; filter aids and filtration (surface, depth); centrifugation- batch centrifuge Ex: tubular bowl centrifuge; continuous centrifuge Ex: Basket centrifuge; disintegration in brief: mechanical Ex: ultrasonication; homogenisers and use of ballotine; non mechanical Ex: thermal lysis; chemical detergent solubilisation, organic solvents; enzymatic methods Ex: Lysozyme

Broth: Enrichment: evaporation, membrane filtration, liquid-liquid extraction, precipitation, adsorption Purification: chromatography

Formulation - crystallization and drying (convection drying Ex: spray dryers, freeze drying)

Industrial production - 5 hrs

Industrially important organisms; fermentation media and conditions; downstream processing and uses -alcohol /Wine; penicillin; vinegar;

PRACTICALS

1. A study on the phases of growth of microorganisms during batch fermentation (equipment: Erlenmeyer flask, medium: nutrient broth, inoculum: E. coli).
2. Parts of a fermenter
3. Preparation and sterilization of medium for batch fermentation process
4. Batch fermentation using fermenter
5. Preparation and sterilization of medium for fed-batch fermentation process
6. Fed-batch fermentation
7. Decontamination and sterilization of the fermenter
8. Primary screening of antibiotic producing bacteria by crowded plate technique
9. Secondary screening for antibiotic producers by Giant Colony Technique
10. Production of wine (from pineapple or any other fruit/vegetable) using yeast
11. Production of vinegar from toddy
12. Estimation of total reducing sugars and acidity (total and volatile) in wine and vinegar (before and after fermentation)

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Mandatory:

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3. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology, Science Publishers Enfield, NH, USA.
4. Stanbury P. F, Whitaker A. & Hall S. J. (1997). Principles of fermentation technology, 2nd Edition, Aditya Books Pvt. Ltd, New Delhi, India.
5. Prescott & Dunn. (1982). Industrial Microbiology, 4th edition, AVI Publishing Co, New Delhi, India.

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2. Ratlege C. (2006). Basic Biotechnology. Cambridge University Press.Cambridge, UK
3. Sivasankar B., (2005) Bioseparations: Principles and techniques. 2005. Prentice hall of India Ltd. Delhi, India.

4. Prave P., Faust U., Sitting W., & Sukatsch D.A., (2004). Fundamentals of Biotechnology. 2004. Wiley- VCH publishers, Weinheim, Germany.
5. Rutledge C. & Kristiansen B. (2001). Basic Biotechnology, 2nd edition. Cambridge press, UK.

WEB REFERENCES

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2. Downstream processing: https://www.ncbi.nlm.nih.gov/books/NBK236005/
3. Isolation and Screening: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4027325/
4. Fractional Distillation: https://www.youtube.com/watch?v=3pL2X-8-eVk
5. Photobioreactors: https://www.sciencedirect.com/science/article/pii/S2095809917304241

Annexure B

PROGRAMME LEARNING OUTCOMES (PLO)

After successful completion of a three years Bachelor's degree in **Biotechnology**, the student will be able to:

PLO-1: SKILL DEVELOPMENT IN CELL CULTURE, MOLECULAR BIOLOGY AND BIOPROCESS TECHNOLOGY	Gain mastery in core lab techniques like cell culture, molecular biology, and bioprocessing, enabling them to conduct experiments, and contribute meaningfully to diverse projects.
PLO-2: DIAGNOSTIC AND INDUSTRIAL READINESS	Apply genetic engineering techniques to ace industrial processes to produce valuable products like enzymes, biofuels, biopolymers and biopharmaceuticals, equipping them for roles in fields like diagnostics, agriculture, environmental science, and food technology.
PLO-3: COMPUTATIONAL AND BIOINFORMATICS LITERACY	Understand the use of computational tools to analyze biological data and it's applications in genetic diseases and evolutionary relationships.
PLO-4: INCULCATING ENTREPRENURIAL APTITUDE	Trained to approach problems scientifically, analyse data critically, and propose innovative solutions, making them valuable assets in research and development. Additionally, would be able to comprehend interdisciplinary approaches applying integrated knowledge from various aspects of life science combined with entrepreneurial aptitude to address complex challenges in biotechnology.