

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M. Sc. Biotechnology

[Academic Year of Implementation: 2018-2019]

Course Outline: Semester-VII

Theory:

BT: 1001	Bioprocess Technology-I
BT: 1002	Enzyme Technology
BT: 1003	Advances in Instrumentation and Techniques
BT: 1004	Cell and Tissue Culture Technology-I

Practical:

BTP: 1005	Enzyme and Bioprocess Technology
BTP: 1006	Cell Culture Technology-I

Course Outline: Semester-VIII

Theory:

BT: 2001	Bioprocess Technology-II
BT: 2002	Genomics and Proteomics
BT: 2003	Aquaculture Technology
BT: 2004	Agriculture Biotechnology

Practical:

BTP: 2005	Genomics and Bioprocess Technology
BTP: 2006	Agriculture Biotechnology & Aquaculture Technology

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M. Sc. Biotechnology Semester –VII

BT-1001: Bioprocess Technology-I

UNIT-1: Unit Operations in Bioprocess Technology:

- 1.1 Introduction to sterilization in bioprocess industry
- 1.2 Equipment sterilization
- 1.3 Monitoring & Validation of sterilization
- 1.4 Sterility audit and automation
- 1.5 Introduction to the development of inoculums for industrial process
- 1.6 Nutritional requirements in fermentation processes
- 1.7 Introduction to Response Surface Methodology (RSM)

UNIT-2: Mass Transfer and Instrument Control:

- 2.1 Gas-liquid mass transfer in cellular systems
- 2.2 Determination of Oxygen Transfer Rates (OTR)
- 2.3 Introduction to Heat Transfer
- 2.4 Fundamentals of Process Control
- 2.5 Control loops
- 2.6 Additional forms of Control
- 2.7 Measurement Elements

UNIT-3: Cell Separation Systems:

- 3.1 Introduction to Cell Separation Systems.
- 3.2 Criteria for Decision.
- 3.3 Pre-treatment's.
- 3.4 CGMP and Regulatory Considerations.
- 3.5 Conventional Filtration & Cross flow Microfiltration.
- 3.7 Centrifugation.
- 3.7 Cell Disruption: Physical and Chemical Methods.

UNIT-4: Product Recovery:

- 4.1 Product Isolation: Extraction and Sorption
- 4.2 Precipitation
- 4.3 Chromatography and fixed bed adsorption
- 4.4 Membrane Separation: RO and UF
- 4.5 Electrophoresis
- 4.6 Product Recovery Trains (General Concepts)
- 4.7 Recovery of: Polysaccharides, Proteins & Gluconic Acid

REFERENCES:

1. James, B. & Ollis David, F. (2010). *Biochemical Engineering Fundamentals*. Tata McGraw-Hill.
2. Lydersen, B. K., D'Elia, N. A. & Nelson, K. L. (2010). *Bioprocess Engineering: Systems, Equipment and Facilities*. Wiley India Pvt. Ltd.
3. Stanbury, P. F. & Whitaker, A. (1984). *Principles of Fermentation Technology*. Pergamon Press.
4. Vogel, H. C. & Todaro, C. M. (1996). *Fermentation and biochemical engineering handbook: principles, process design and equipment*. William Andrew.

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M. Sc. Biotechnology Semester –I/VII

BT-1002: Enzyme Technology

UNIT – 1: Enzyme Preparation:

- 1.1 Potential Sources of Enzymes
- 1.2 Screening for novel Enzymes
- 1.3 Media for enzyme production
- 1.4 Extraction and large scale purification of Enzymes
 - 1.4.1 Extraction of soluble and membrane-bound enzymes, Nature of the extraction medium
 - 1.4.2 Preliminary and Advanced purification procedures, Criteria of purity
 - 1.4.3 Determination of molecular weights of enzymes

UNIT – 2: Immobilized Enzymes and Biosensors:

- 2.1 Preparation and properties of immobilized enzymes
- 2.2 Application of Immobilized enzymes: General principles
- 2.3 Genetic immobilization of enzymes on yeast cell surface
- 2.4 Biosensors: Calorimetric, Potentiometric and Optical

UNIT – 3: Large Scale/ Industrial Uses of Enzymes:

- 3.1 Use of enzymes in detergents
- 3.2 Enzymes in the fruit juices, wine, brewing and distillation industries
- 3.3 Use of proteases in the leather and wool industry
- 3.4 Applications of glucose oxidase and catalase in the food industry
- 3.5 Use of enzymes in cellulose and starch hydrolysis
- 3.6 Use of lactases in the dairy industry
- 3.7 Medical applications of enzymes

UNIT – 4: Recent advances and future prospects in Enzyme Technology:

- 4.1 Enzymes and recombinant DNA technology.
- 4.2 Synthesis of artificial enzymes- Enzyme engineering.
- 4.3 Use of ‘unnatural’ substrates.
- 4.4 Coenzyme-regenerating systems.
- 4.5 Enzymes and Bioinformatics.

REFERENCES:

1. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry Trevor Palmer, Horwood Publishing Chichester, England.
2. Enzymes and Immobilized Cells in Biotechnology. Allen I. Laskin, The Benjamin/Cummings Publishing Company, INC., California.
3. Fermentation Microbiology and Biotechnology. Mansi El-Mansi & Charlie Bryce, Taylor & Francis Ltd, London.
4. Industrial Biotechnology. S. N. Jogdand, Himalaya Publishing House, Mumbai.
5. Fundamentals of Enzymology: Nicholes C. Price and Lewis Stevens, Oxford Univ. Press.

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M. Sc. Biotechnology Semester –VII

BT-1003: Advances in Instrumentation and Techniques

UNIT – 1: Advances in Spectroscopy:

- 1.1 Principle, Instrumentation, Interpretation of results in IR spectroscopy
- 1.2 FT-IR: Principle and application
- 1.3 Working principle of NMR
- 1.4 Mass spectrometry and their applications
- 1.5 Atomic spectroscopy
 - 1.5.1 Atomic absorption spectroscopy: Principle, atomizers, sources and applications
 - 1.5.2 X-ray diffraction/crystallography: Principle and application

UNIT – 2: Electrophoretic Techniques:

- 2.1 Electrophoresis of proteins
 - 2.1.1 SDS-PAGE
 - 2.1.2 Native gels and Gradient gels
 - 2.1.3 Isoelectric focusing
 - 2.1.4 Two dimensional electrophoresis
 - 2.1.5 Western blotting
- 2.2 Electrophoresis of nucleic acids
 - 2.2.1 Agarose gel of DNA and RNA
 - 2.2.2 DNA sequencing gels
 - 2.2.3 Southern Blotting
 - 2.2.4 PFGE, DGGE and TGGE

UNIT – 3: GC and HPTLC:

- 3.1 HPTLC: Methods of development and spot detection
- 3.2 GC: Principle, stationary and mobile phases
 - 3.2.1 Detectors: FID, TCD, ECD
 - 3.2.2 Quantitative analysis and qualitative analysis
 - 3.2.3 GC-MS combinations
 - 3.2.4 Limitations of GC

UNIT – 4: Advances in Liquid Chromatography:

- 4.1 HPLC
 - 4.1.1 Components of Instrumentation
 - 4.1.2 Isocratic, binary and quaternary system
 - 4.1.3 Types of columns
 - 4.1.4 Stationary and mobile phases
 - 4.1.5 Detectors: UV absorption, PDA, RI and fluorescence
- 4.2 Ion exchange chromatography: Types of resins, principles of separation, detection and applications
- 4.3 Gel filtration chromatography: Principles and applications

REFERENCE:

- 1. Skoog D. Skoog and West's Fundamentals of Analytical Chemistry. Andover: Cengage Learning EMEA; 2014.

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M. Sc. Biotechnology Semester –VII

BT-1004: Cell and Tissue Culture Technology-I

UNIT-1: Plant Genomes and Plant Tissue Culture:

- 1.1 Eukaryotic Gene structure and gene expression-regulation, Protein targeting
- 1.2 Types of plant promoters, enhancer and reporter system
- 1.3 Plant tissue culture: Culture environment and growth regulators
- 1.4 Types of culture

UNIT-2: Secondary Metabolites Isolation and Identification:

- 2.1 Classification, Biosynthetic pathway of secondary metabolites production, factors affecting production of secondary metabolites in plant tissue culture
- 2.2 Methods of extraction and isolation
- 2.3 Methods of separation
- 2.4 Methods of identification
- 2.5 Applications

UNIT-3: Immortalization and Cell Separation Techniques:

- 3.1 Control of senescence
- 3.2 Immortalization with viral genes
- 3.3 Telomerase-Induced immortalization
- 3.4 Tumorigenicity
- 3.5 Cell density and isopyknic sedimentation
- 3.6 Antibody based cell separation techniques
- 3.7 Fluorescence-Activated Cell Sorting (FACS)

UNIT-4: Cell culture, Cryopreservation and Cell Viability:

- 4.1 Primary culture
- 4.2 Criteria for subculture, subculture of cells growing in suspension and in monolayer
- 4.3 Cryopreservation, principles of cryopreservation
- 4.4 Cell viability

REFERENCES:

1. Plant Biotechnology: An Introduction to Genetic Engineering by Adrian Slater, Nigel W. Scott, Mark R. Fowler. Oxford University Press, 2008.
2. Phytochemical Methods A Guide to Modern Techniques of Plant Analysis by JB Harborne. Springer, 1998.
3. Introduction to Plant Biotechnology. 2nd edition. By H. S. Chawla. Oxford & IBH publishing Co. Pvt. Ltd. New Delhi.
4. Plant Tissue culture: Theory and Practice, a revised Edition, S. S. Bhojwani and M.K. Razdan, Elsevier.
5. Ian R. Freshney, Culture of animal cells: a manual of basic technique and specialized applications, 6th Ed., Willey Blackwell pub.

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M. Sc. Biotechnology Semester –VII

BTP-1005: Enzyme and Bioprocess Technology

1. To study time course of the reaction catalysed by alkaline phosphatase.
2. To determine temperature optima for alkaline phosphatase.
3. To investigate the thermal stability of horseradish peroxidase.
4. Preparation of double reciprocal curve.
5. Study of enzyme inhibition kinetics.
6. Estimation of oxygen transfer rate (OTR) by sulphite oxidation method.
7. Immobilization of whole cells (Yeast/Bacteria) by calcium alginate method.
8. Production, estimation and purification of amylase/lipase/protease.
9. Determination of thermal death point (TDP) and thermal death time (TDT) of microorganism for design of a sterilizer.
10. Demonstration of fermentation process in a bioreactor.

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BTP-1006: Cell Culture Technology-I

1. Preparation of commonly used Plant Tissue culture media (MS and Gamborg's B5 media) for plantlet regeneration.
2. Anther culture.
3. Embryo culture.
4. Qualitative analysis of important phytochemicals.
5. Isolation of protoplast.
6. To perform suspension culture (PBLCL) and prepare metaphase plate.
7. To perform GTG banding and learn Karyotyping of prepared metaphase plates.
8. Isolation of Peripheral Blood Mononuclear Cells (PBMC).
9. Assessment of cell viability by Trypan blue.
10. Cell Culture: Cell revival and Cell maintenance.

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M. Sc. Biotechnology Semester –VIII

BT-2001: Bioprocess Technology-II

UNIT-1: Fermentation of Food and Feed Products:

- 1.1 Fermentation of Wine
- 1.2 Fermentation of Beer
- 1.3 Fermentation of Vinegar
- 1.4 Production Single Cell Proteins
- 1.5 Fermentation of Gluconic acid

UNIT-2: Fermentation of Fine Chemicals:

- 2.1 Penicillin
- 2.2 Citric acid
- 2.3 Ethanol
- 2.4 L-lysine
- 2.5 Human Recombinant Insulin

UNIT-3: Industrial Production in Animal and Plant Cells:

- 3.1 Introduction to Large Scale Animal Cell Culture
- 3.2 Animal Cells and Bioreactor Technology
- 3.3 Stirred Tank Characteristics
- 3.4 Support Systems
- 3.5 Downstream Processing
- 3.6 Non-traditional cell culture processes & Regulatory issues
- 3.7 Cell culture production runs (example) & Plant cell cultivation

UNIT-4: Bioprocess Industry-Economics and Validation:

- 4.1 General Fermentation Process Economics
- 4.2 Economics of Fine Chemicals, Bulk Oxygenates and SCP Production
- 4.3 Bioproduct Regulation
- 4.4 Introduction to Biopharmaceutical Validation
- 4.5 Need for Validation and Occurrence of Validation
- 4.6 Validation Structure and Resources for Validation
- 4.7 Validation of Systems and Processes

REFERENCES:

1. Reed G. (2004). *Prescott and Dunn's Industrial microbiology*. CBS Publishers & Distributors
2. Pepler, H. J., & Perlman, D. (1979). *Microbial technology. Vol. 1 and 2*. Academic Press Inc.
3. Vogel, H. C., & Todaro, C. M. (1996). *Fermentation and Biochemical Engineering Handbook: Principles, Process Design and Equipment*. William Andrew.
4. James, B., & Ollis David, F. (2010). *Biochemical engineering fundamentals*. Tata McGraw-Hill.
5. Lydersen, B. K., D'Elia, N. A., & Nelson, K. L. (Eds.). (2010). *Bioprocess engineering: systems, equipment and facilities*. Wiley India Pvt. Ltd.

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BT-2002: Genomics and Proteomics

UNIT-1: Methods of Studying Genomes:

- 1.1 Genetic mapping: DNA Markers and Linkage mapping
- 1.2 Physical mapping: Restriction mapping, FISH, STS mapping
- 1.3 Chain termination sequencing: Traditional and Alternative methodology
- 1.4 NGS Techniques: Template preparation, Sequencing and Imaging, Emulsion PCR
- 1.5 NGS Platforms: Pyro-sequencing, SOLiD, Illumina, Ion Torrent, Helicose, PacBio, Nanopore
- 1.6 Assembly of a contiguous DNA sequence

UNIT-2: Annotation & Functional Genomics:

- 2.1 Locating genes in sequence
- 2.2 Determining function of individual genes
- 2.3 Global gene expression profiling: Microbial genes and Human diseases
- 2.4 Annotation case study of *Sachharomyces cerevisiae*
- 2.5 Comparative genomics: Bacteria, Organelles and Eukaryotes

UNIT-3: Proteomics-I:

- 3.1 2-D PAGE for proteome analysis
- 3.2 Detection of proteins in 2D gels
- 3.3 Mass Spectroscopy: Introduction, background and *de novo* sequencing using MS data
- 3.4 Use of protein microarrays
- 3.5 Structural proteomics: X-ray crystallography and NMR
- 3.6 International structural proteomics initiatives

UNIT-4: Proteomics-II & International Collaborative Projects:

- 4.1 Methods for studying protein interactions
- 4.2 Use of affinity purification
- 4.3 Bioinformatics support to study protein interaction
- 4.4 Metabolomics and global biochemical networks
- 4.5 Human Genome Project: Mapping phase, Sequencing phase and future
- 4.6 Other projects: ENCODE, HapMap, Human Microbiome Project

REFERENCES:

1. Brown T. Genomes 3. New York and London: Garland Science; 2007.
2. Primrose S, Twyman R. Principles of genome analysis and genomics. Malden, Mass.: Blackwell Pub.; 2003.
3. Pennington, S. and Dunn M. Proteomics from protein sequence to function. New Delhi: Viva Books Private Limited; 2002.

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M. Sc. Biotechnology Semester –VIII

BT-2003: Aquaculture Technology

UNIT-1: Introduction to Aquaculture:

- 1.1. Definition, scope & significance of aquaculture
- 1.2. General characteristics and economic importance of fishes
- 1.3. Sustainable aquaculture
- 1.4. Fish culture process
- 1.5. Components, design & types of Hatcheries
- 1.6. Different Aquaculture Systems

UNIT-2: Aqua-Food & Diseases:

- 1.1. Importance and types of feeds
- 1.2. Feed formulations & feed developmental process
- 1.3. Prebiotics & Probiotics in Aqua-feed
- 1.4. Bacterial, Viral, Fungal diseases of fishes and their diagnosis
- 1.5. Fish spoilage & marine toxins
- 1.6. Bio-fouling

UNIT-3: Aquaculture Biotechnology:

- 1.1. Transgenic fish production
- 1.2. Chromosomal manipulation – Triploidy, Polyploidy, Androgenesis & Gynogenesis
- 1.3. Applications of recombinant hormone & growth factors in aquaculture
- 1.4. Fish vaccines and its development
- 1.5. Cryopreservation

UNIT-4: Algal Biotechnology:

- 1.1. Economic importance of seaweeds & algae
- 1.2. Seaweed & microalgae culture methods
- 1.3. Bioactive compounds from marine organisms
- 1.4. Molecular farming of microalgae
- 1.5. Enhancement of protein production by microalgae

REFERENCES:

1. General & Applied Ichthyology (Fish & Fisheries) by S. K. Gupta & P. C. Gupta, S. Chand Publication, New Delhi.
2. Aquaculture Technology & environment by Ujwala Jadhav, Prentice Hall of India Pvt. Ltd., New Delhi.
3. Biotechnology & Genetics in Fisheries & Aquaculture by Andy Beaumont, Pierre Boudry, Kathrin Hoare.
4. Aquaculture - Farming aquatic animals & plants – Edited by John S. Lucas, Paul C. Southgate, Blackwell publishing Company.
5. Fisheries & Aquaculture Biotechnology by Varun Mehta, Book International Pub.
6. A Textbook of Fish Biology & Fisheries by S. S. Khanna & H. R. Singh.
7. Fish Health & Diseases by B. R. Selvamani & R. K. Mahadevan, Campus books Int., New Delhi.

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BT-2004: Agriculture Biotechnology

UNIT-1: Tissue Culture & Transgenic Technologies:

- 1.1 Role and molecular action of growth regulators in tissue culture
- 1.2 Direct transformation of protoplasts using PEG, electroporation, particle bombardment
- 1.3 *Agrobacterium* biology (Ti plasmids, Ri plasmids)
- 1.4 Ti plasmid based transformation

UNIT-2: Abiotic & Biotic Stress and Resistance of Crops:

- 2.1 Abiotic stress: Physiological and molecular responses of plants to water stress, salinity stress, temperature stress
- 2.2 Stress perception and stress signaling pathways
- 2.3 Plant interaction with bacterial, viral and fungal pathogens, biochemical and molecular basis of host plant resistance
- 2.4 Herbicide (glyphosate, phosphinothricin) and Pest (Bt toxin) resistance

UNIT-3: Molecular Breeding:

- 3.1 Restriction based and PCR based markers; RFLP: methodology and applications, RAPD and AFLP: Principles, methodology and advantages, disadvantages and applications
- 3.2 Development of SCAR and SSR, ISSR markers
- 3.3 Other markers: CAPS, SNP, Comparison of different marker systems
- 3.4 QTL and MAS

UNIT-4: Molecular Farming & Applications:

- 4.1 Definition and common perception of molecular farming
- 4.2 Transgenic plants as bioreactors
- 4.3 Relevance and advantages of plant based molecular farming
- 4.4 Edible vaccine; medicinally related proteins-antibodies (plantibodies), the oleosin system –Hirudin and Insulin production

REFERENCES:

1. Plant Biotechnology: An Introduction to Genetic Engineering by Adrian Slater, Nigel W. Scott, Mark R. Fowler. Oxford University Press, 2008.
2. Introduction to Plant Biotechnology. 2nd edition. By H. S. Chawla. Oxford & IBH publishing Co. Pvt. Ltd. New Delhi.
3. Plant Tissue culture: Theory and Practice, A revised Edition, S.S. Bhojwani and M.K. Razdan, Elsevier.
4. An Introduction to Plant Tissue Culture. 2nd Edition, by M. K. Razdan. Oxford & IBH Publishing Co. Pvt. Ltd.

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BTP-2005: Genomics and Bioprocess Technology

1. Preparation of standard curve for estimation of antibiotic Penicillin.
2. Preparation of standard curve for estimation of Citric acid
3. Preparation of standard curve for estimation of Ethanol.
4. Microbial fermentation of Penicillin
 - 4.1. Determination of optimum pH for production of Penicillin.
 - 4.2. Determination of optimum inoculum size for Penicillin production.
5. Microbial fermentation of Citric acid
 - 5.1. Determination of optimum pH for production of Citric acid.
 - 5.2. Determination of optimum inoculum size for Citric acid production.
6. Fermentative production of Ethanol using different substrates.
7. Recovery of Citric acid and Ethanol from fermented broth/medium.
8. Bioassay of antibiotic Penicillin.
9. Soil DNA extraction by spin column method
10. Total bacterial RNA extraction and separation by electrophoresis

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M. Sc. Biotechnology Semester –VIII

BTP-2006: Agriculture Biotechnology & Aquaculture Technology

Aquaculture Technology:

1. To study commercially important fishes of South Gujarat region (Any 10 specimen)
2. To study fresh water algae & sea weeds (Any 10 specimen)
3. Proximate analysis of fish feed (Crude Proteins, Crude Lipids, Carbohydrates, Fibers, Moisture & Ash)
4. Detection of White Spot Syndrome Virus in shrimps by PCR technique (Demonstration).
5. Review Article on any recent/emerging areas of aquaculture (**OR**) Field Visit to any one place – Processing Unit (Fish/Prawn), Culture Farm (Fish/Prawn), Fish Feed development industry, Fisheries/Aquaculture Educational/Research Institute, Seaweed/Algal Culture facility, Fish/Algal Product development industry

Agriculture Biotechnology:

1. Standardization and preparation of commonly used Plant Tissue culture media (MS and Gamborg's B5) for *in vitro* regeneration of agriculturally important plants media.
2. Quantitative analysis of important phytochemicals.
3. Estimation of antioxidants and antioxidant enzymes - Ascorbate peroxidase, Superoxide dismutase, Catalase and Peroxidase.
4. Rapid *in vitro* screening tests for abiotic stress tolerance (drought and salinity).
5. Isolation of DNA from suitable plant source.

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