VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M. Sc. Biotechnology
(Five Years Integrated Course)

Course Outline: Semester-VII

Theory:

BT: 1001	Bioprocess Technology-I
BT: 1002	Enzyme Technology
BT: 1003	Biotechnology of Extremophiles
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	Biofuel Technology
BT: 2003	Aquaculture Technology
BT: 2004	Agriculture Biotechnology

Practical:

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M. Sc. Integrated Biotechnology

Syllabus: Semester - VII

BT-1001: Bioprocess Technology-I

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UNIT-1: Unit Operations in Bioprocess Technology

1.1 Introduction to Sterilization in bioprocess industry.
1.2 Equipment sterilization.
1.3 Monitoring of sterilization.
1.4 Validation of sterilization.
1.5 Sterility audit and automation.
1.6 Introduction to the development of inoculums for industrial process.
1.7 Nutritional requirements in fermentation processes.
1.8 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.
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.
3.6 Cross flow Microfiltration.
3.7 Centrifugation.
3.8 Cell Disruption: Physical Mechanical 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 (Individual Product Based examples of Recovery Processes).

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. (Eds.). (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. Integrated Biotechnology

Syllabus: Semester - VII

BT-1002: Enzyme Technology

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UNIT – 1: Enzyme Preparation

- Potential Sources of Enzymes.
- Screening for novel Enzymes.
- Media for enzyme production.
- Extraction and large scale purification of Enzymes.
  - (a) Extraction of soluble and membrane-bound enzymes, Nature of the extraction medium.
  - (b) Preliminary and Advanced purification procedures, Criteria of purity.
  - (c) Determination of molecular weights of enzymes.

UNIT – 2: Immobilized Enzymes and Biosensors

- Preparation and properties of immobilized enzymes.
- Application of Immobilized enzymes: general principles.
- Genetic immobilization of enzymes on yeast cell surface.
- Biosensors: Calorimetric, Potentiometric and Optical biosensors.

UNIT – 3: Large Scale/ Industrial Uses of Enzymes

- Use of enzymes in detergents.
- Enzymes in the fruit juices, wine, brewing and distillating industries.
- Use of proteases in the leather and wool industry.
- Applications of glucose oxidase and catalase in the food industry.
- Use of enzymes in cellulose and starch hydrolysis.
- Use of lactases in the dairy industry.
- Medical applications of enzymes.

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

- Enzymes and recombinant DNA technology.
- Synthesis of artificial enzymes- Enzyme engineering.
- Use of ‘unnatural’ substrates.
- Coenzyme-regenerating systems.
- 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. Biotechnology. Keshav Trehan, New Age International Publishers, New Delhi.

6. Fundamentals of Enzymology: Nicholes C. Price and Lewis Stevens, Oxford Univ. Press.

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M. Sc. Integrated Biotechnology

Syllabus: Semester - VII

BT-1003: Biotechnology of Extremophiles

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UNIT-1: Hyper Thermophiles and Psychrophiles

1.1 Extremophiles and Chemical evolution.
1.2 Hyperthermophiles: Isolation, classification, habitats and ecological aspects.
1.3 Psychrophiles: Distribution and isolation, physiology, molecular biology and biotechnology.
1.4 Biochemical basis of adaptation of Hyperthermophiles and Psychrophiles.

UNIT –2: Alkaliphiles and Acidophiles

2.1 Alkalophiles- Classification, physiology and cell wall.
2.2 Alkaline enzymes and application.
2.3 Acidophiles: Nutritional Classification, Microbial Interactions in Acidic Environments.
2.4 Identification and Enumeration of Acidophiles.
2.5 Acidophiles: Metal tolerance, Acid toxicity and Wider perspective.

UNIT – 3: Halophiles and Barophiles

3.1 Halophiles: Taxonomy and Ecology, Adaptation.
3.2 Applications of halophiles enzymes and other biotechnological potential.
3.3 Barophiles: Classification,The variety of Deep Sea habitats.
3.4 Biochemistry and Physiology of Barophiles**.**
3.5 Adaptation to Extreme pressure.

UNIT-4: Methanogens and Anaerobic non Methanogenic Extremophiles

4.1 Methanogens: Extreme habitats of Methanogens.
4.2 Adaptation to extreme Environments by methanogens.
4.3 Anaerobic non methanogens:Mechanism of Tolerance.
4.4 Biotechnological applications of non-methanogenic extremophiles.

REFERENCES:

1. Koki Horikoshi, William D. Grant "Extremophiles: Microbial Life in Extreme Environments.Wiley-Liss, New York. 1998.
2. Charles Gerday and Nicolas Glansdorff "Physiology and Biochemistry of Extremophiles, American Society for Microbiology, 2007
3. H.J. Rehm and G. Reed "Biotechnology: Special processes Second edition. Volume 10 – Wiley, John & Sons, 2001
4. Joshua Lederberg " Encyclopedia of Microbiology" Second edition. Volume-2 DK, Academic Press, 2000.

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M. Sc. Integrated Biotechnology

Syllabus: Semester - VII

BT-1004: Cell and Tissue Culture Technology-I

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UNIT-1: PLANT GENOMES AND PLANT TISSUE CULTURE

Introduction - gene structure and gene expression-regulation, implication for plant transformation,-Protein targeting, heterologous promoters, genome size and organization, Arabidopsis and new technologies. Plant tissue culture - plasticity and totipotency, culture environment, growth regulators, media regulators, culture types, plant regeneration.

UNIT-2: SOMACLONAL VARIATIONS

Nomenclature, Schemes for obtaining somaclonal variation, Application of somaclonal variations, Basis of somaclonal variations, Disadvantages, Gametoclonal variation

UNIT-3: TRANSFORMATION AND IMMORTALIZATION

Role in cell line characterization, Transformation, Genetic instability, Immortalization, Control of senescence, Immortalization with viral genes, Telomerase induced immortalization, Aberrant Growth Control, Tumorigenicity.

UNIT-4: CELL CLONING AND CELL SEPARATION

Cell cloning, Stimulation of plating efficiency, Suspension cloning and isolation of clones, Cell density and isopyknic sedimentation, Cell size and sedimentation velocity, Antibody based techniques and Fluorescent – activated cell sorting.

REFERENCES:

1. Plant Tissue culture: Theory and Practice, a revised Edition, S.S. Bhojwani and M.K. Razdan, Elsevier.
2. Plant Cell, tissue & Organ Culture. Fundamental Methods by O.L.Gamborg andG.C.Philips. Narosa Publishing House, New Delhi.
3. Introduction to Plant Biotechnology. 2nd edition. By H.S.Chawla. Oxford & IBH publishing Co. Pvt. Ltd. New Delhi.
4. Medicinal Plant Biotechnology by Ciddi Veerasham. CBS Publishers.
5. Ian Freshney, Culture of Animal Cells (Fifth Edition), Wiley-Leiss.
6. Jannie P. Mather and Peneolpe E. Roberts, Introduction to Cell and Tissue Culture, Plenum Press.
7. A. Doyle and B. Griffith, Cell and Tissue Culture: Laboratory Procedures in Biotechnology, Wiley publications.
8. D. C. Darling and S. J. Morgan (1994) Animal cell culture and media, Bios Scientific Publishers Limited.
9. C. D. Helgason and C. L. Miller, Basic Cell Culture Protocols, Humana press.
10. Basant Kumar Sinha and Rinesh Kumar, Principles of Animal Cell Culture, International Book Distribution Co.
11. B.D. Singh, Expanding Horizons of Biotechnology, Kalyani Publishers.

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M. Sc. Integrated Biotechnology

Practical Syllabus: Semester - VII

BTP-1005: Enzyme and Bioprocess Technology

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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 peroxidise.
4. Determination of molecular weight of a given protein (enzyme) by gel filtration.
5. Separation of proteins (enzymes) by isoelectric focussing.
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.
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.

REFERENCES:

1. Sawhney, S. K. & Singh, R. (2008) Introductory Practical Biochemistry [ISBN: 978-81-7319-302-6] Narosa Publishing House Pvt. Ltd. New Delhi.
2. Sadasivam, S. & Manickam, A. (2006) Biochemical Methods [81-224-0976-8] New Age International (P) Limited, New Delhi.
3. Patel, R. J. (2008) Experimental Microbiology Vol.1/2, Aditya, Ahmedabad.
4. Aneja, K. R. (2008) Experiments in Microbiology, Plant Pathology and Biotechnology [ISBN: 81-224-1494-X] New Age International (P) Limited, New Delhi.

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M. Sc. Integrated Biotechnology

Practical Syllabus: Semester - VII

BTP-1006: Cell Culture Technology-I

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1. Plant Tissue Culture Laboratory organization.
2. Stocks and Media preparation (MS, B5).
3. Explant selection, treatment and inoculation.
4. Callus Induction.
5. Shoot and root regeneration form callus.
6. Isolation of Peripheral Blood Mononuclear Cells (PBMC).
7. Cell Culture: Cell revival, Subculture, Viability and Cell maintenance.
8. Genotoxic assay: Micronucleus assay.
9. Cytotoxic assay: MTT assay.
10. Estimation of GST activity in serum/cell lysates.

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VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M. Sc. Integrated Biotechnology

Syllabus: Semester - VIII

BT-2001: Bioprocess Technology-II

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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 Single Cell Proteins.

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.
3.7 Regulatory issues.
3.8 Example of cell culture production runs.
3.9 Plant Cell Cultivation.

UNIT-4: Bioprocess Industry: Economics and Validation

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

REFERENCES:

1. Reed G. (2004). *Prescott and Dunn's Industrial microbiology*. CBS Publishers & Distributors

2. Peppler, 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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VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M. Sc. Integrated Biotechnology

Syllabus: Semester - VIII

BT-2002: Biofuel Technology

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UNIT-1: Introduction

1.1. Brief history an introduction: types of energy sources, status in India.
1.2. Biorenewable energy resources.
1.3 Types of biofuels.
1.4. Potential yield from biomass: C3 plants, C4 plants and CAM plants, microalgae.
1.5. Environmental aspects of biofuels.

UNIT-2: Biomass Feedstocks

2.1 Definition.
2.2 Biomass components.
2.3 Categories of biomass and biomass characterization.
2.4 Biomass fuel analyses.
2.5 Biomass processing for biofuel production.

UNIT-3: Types of Biofuels and their Production

3.1 Bioethanol.
3.2 Biodiesel.
3.3 Biooils.
3.4 Biohydrogen.
3.5 Biomethane.

UNIT-4: Future Prospects

4.1 Designer cells: metabolically engineered cells for ethanol production.
4.2 Biofuel from supercritical fluid.
4.3 Future of syngas fermentation.
4.4 Integrated refining concepts.
4.5 Biodiesel from Algae.

REFERENCES:

1. Biofuels: Securing the Planet's future Energy Needs-Ayhan Demirbas Publication: Springer ISBN 978-1-84882-010-4
2. Biofuels: Alternative Feedstocks and Conversion Processes- A.Pandey, C.Larroche, S.C. Ricke Publication: Academic Press Elsevier ISBN 978-0-12-385099-7
3. Biofuel Technology Handbook-Dominik Rutz, Rainer Janssen WIP Renewable Energies
4. Biogas from Waste an Renewable Resources: An Introduction-Dieter Deublein, Angelika Steinhauser Publication: Wiley VCH ISBN 978-3-527-31841-4
5. Handbook of Environmental Biotechnology-S.C.Bhatia Vol. 2 Publication: Atlantic ISBN 978-81-269-0946-9.

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M. Sc. Integrated Biotechnology

Syllabus: Semester - VIII

BT-2003: Aquaculture Technology

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UNIT-1: Introduction to Aquaculture

(I) History, definition, scope and significance of aquaculture. Different aquaculture systems, Aquaculture - Global and Indian Scenario, Sustainable aquaculture.

(II) Fisheries - General characters of fishes, and shell fishes. Economic importance of fishes, Fish spoilage, Common fish species for culture.

(III) Hatcheries management – Components & general design of hatcheries, fish culture process in brief, types of hatcheries.

UNIT-2: Food & Health

(I) Feed Technology: Importance of feed, Types of aquatic feeds (Micro encapsulated feeds, micro coated feeds, micro-particulate feeds, bio-encapsulated feeds, Live feeds), mycotoxins and their effects on feeds), Feed development process (Aquatic feed formulation and preparation, digestibility and nutrient balances, production and utilization of aquatic feeds shrimp, prawn and finfish)

(II) Diseases & Health Management

(a) Immunology and defense mechanism in fin and shell fishes, Methods of pathological examination of fish and Diagnostic tools – microscopy, PCR, molecular & immune detection DNA/RNA techniques, Good pond management practices, Nutritional deficiency diseases, genetically and environmentally induced diseases

(b) Protozoa, Bacterial, Fungal, Viral diseases (any 3 diseases of fin & shell fishes each)

UNIT-3: Aquaculture Biotechnology

Biotechnological tools for aquaculture, gene manipulation in fish, transgenic fish production. Chromosome manipulation in fish and shell fishes - triploidy, polyploidy, gynogenesis, androgenesis. Monosex production, super male and super female fish production techniques. Application of recombinant hormone and growth factors in fish culture. Tissue culture in sea weed and pearl production. Use of probiotics and antibiotics in aquaculture operations. Fish Vaccines & its development, Cryopreservation, Biofouling.

UNIT-4: Algal Biotechnology

Economic importance of Algae & Sea Weeds, Microalgae - indoor and mass culture methods, biotechnological approaches for production of important microalgae, Single cell protein from algae, Sea weeds culture, Vitamins, minerals and omega3 fatty acids from micro algae, Enrichment of micro algae with micronutrients, Bioactive compounds from marine organisms.

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 Diseases & Health Management by Ravi Kant Verma, Tejpal Dahiya, Pawan kumar Yadav, V. P. Saini, Agrotech Pub. Academy, Udaipur.
(8) Fish Genetics by Sangeeta Malvee
(9) Fish Health & Diseases by B. R. Selvamani & R. K. Mahadevan, Campus books Int., New Delhi
(10) Fishes – Introduction to Ichthyology by Moyle Cech.

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Syllabus: Semester - VIII

BT-2004: Agriculture Biotechnology

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UNIT-1: Tissue culture and transgenic technologies

- Cell suspension and secondary metabolites
- Somatic hybridization,
- Selection of hybrids
- Cybrids
- Direct transformation of protoplasts using PEG, electroporation, particle bombardment,
- *Agrobacterium* biology (Ti and Ri plasmids)
- Ti plasmid based transformation,
- Crown gall and Hairy root disease

UNIT-2: Abiotic-Biotic Stress and Resistance of crops

- Abiotic Stress: Physiological and molecular responses of plants to water, temperature and salinity stress,
- Stress perception and stress signaling pathway
- Biotic stress: Plant interaction with bacterial, viral and fungal pathogens, Biochemical and molecular basis of host plant resistance,
- Pathogen derived resistance.
- Commercial status of transgenic plants,
- Herbicide resistance (glyphosate, sulfonyl urea, phosphinothricin)
- Pest resistance (Bt toxin, Protease inhibitors; GNA and other lectins, α-amylase inhibitors)
- Delay of fruit ripening, polygalacturanase, Golden rice for β-carotene accumulation

UNIT-3: Molecular Breeding and Molecular Farming

- Molecular markers- DNA profiling using different assays- RFLP,RAPD, AFLP, ISSR, SNP, Development of SSR and SCAR markers,
- Development of Mapping population,
- MAS
- Screening and Validation
- QTL mapping
- Gene pyramiding
- Molecular farming of Proteins
- Medicinally related proteins
- Biopharmaceuticals

UNIT-4: Secondary Metabolites Isolation and Identification

- Methods of extraction and isolation, separation and identification
- Secondary metabolite studies (Phenols, Flavonoids, Anthocyanins, Flavaonols Tannins, Essential oils, Alkaloids)

REFERENCES:

1. M. J. Chrispeels and D.F. Sadava (eds), Plants, Genes and Crop Biotechnology, 2nd Edition, Jones and Barlett Press, 2003
2. Introduction to Plant Biotechnology, H.S Chawla . Oxford & IBH publishing Co. Pvt. Ltd. New Delhi.
3. H.K. Das (ed)., Text Book of Biotechnology, Wiley India Pvt Ltd. New Delhi,2004
4. Anolles, G. C. and Gresshoff, P.M., DNA markers – protocols, applications and overviews. Wiley – Liss, New York, 1997
5. Purohit, S. S., Biotechnology – Fundamentals and Applications, 8 Th Edition, Agrobios, India, 2007.
6. U. Chakraborty, Bishwanath Chakraborty, 2005. Stress biology, Vidhyasekaran, P. 2007. Narosa Publishing House
7. Gatehouse, A. M .R., Hilder, V. A. and Boulter, D., Plant Genetic manipulation for crop protection In: Biotechnology in Agriculture Series (Eds.) Vol. 7 CAB International, Wallingford, UK. 266p. 1992
8. Panda N. and G.S.Khush, Host plant resistance to insects. CAB International, Walling Ford. 431p, 1995
9. Slater, A., Scott, N. and Fowler, M., Plant biotechnology -The genetic manipulations of plants. Oxford University press. 346p. 2003.

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VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M. Sc. Integrated Biotechnology

Practical Syllabus: Semester - VIII

BTP-2005: Biofuel and Bioprocess Technology

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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. Esterification of Oleic acid for Biodiesel production.

10. Demonstration of Biomethane potential (BMP) of solid organic wastes.

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VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M. Sc. Integrated Biotechnology

Practical Syllabus: Semester - VIII

BTP-2006: Agriculture Biotechnology & Aquaculture Technology

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Aquaculture Technology

Part - A

(1) To study commercially important fin fishes (Catla, Mrigal, Labeo, Catfish, Indian Shark, Mudskipper, Mullet, Bombay duck, Pomphret, Mackerel, Hilsa)
(2) To study commercially important shell fishes (Feshwater Prawn, Salt water prawn, Edible Pearl Oyster, Pearl Oyster for pearl, Mussel, scallop, lobsters, and calms)
(3) To study fresh water algae & Sea Weeds (6 specimens in each)
(4) Proximate analysis of fish feed (Protein, Lipids, Carbohydrates, Fibres, Moisture & Ash)
(5) To study demonstration of detection of White Spot Syndrome Virus (WSSV) & Yellow Head Virus (YHV) viral diseases of prawns & shrimps by PCR technique.
Note: For practical 1, 2 & 3 classification, general characters, economic importance, salient features if any, should be included.

Part – B

(1) Review Article or Project (on recent emerging areas, research, challenges in aquaculture)
(2) Field Visit (any one)
(a) Fish/ Prawn culture farm, (b) Fish/ Prawn Processing Unit, (c) Fish feed development industry (d) Any Fisheries/Aquaculture Educational - Research Institute (e) Fish product/ algal product development industry (f) Sea weed/ algal culture

Agriculture Biotechnology

1. Standardization and preparation of commonly used Plant Tissue culture media (MS and Gamborg's B5 media)
2. Direct plant regeneration (in vitro clonal propagation) from suitable horticultural or agricultural plant
3. Anther culture
4. Embryo culture
5. Qualitative and quantitative analysis of 5 important phytochemicals
6. Rapid screening tests for abiotic stress tolerance (drought, salinity - PEG, Mannitol &
7. NaCl)
8. Estimation of antioxidants and antioxidant enzymes - Ascorbate, Superoxide dismutase, Catalase, and Peroxidase
9. Leaf disc transformation using *Agrobacterium*, establishment of transgenic plants, and GUS staining
10. DNA finger printing methods, RAPD, SSR.

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