

**FOUR YEARS UNDER GRADUATE (FYUG) PROGRAMME
UNDER NEW EDUCATION POLICY, 2020**

**Proposed Syllabus
for
B.Sc. Biotechnology
(Semesters 7th and 8th)**

Date of approved by the Academic Council: 21/05/2025



**North-Eastern Hill University,
Shillong-793022**

7th Semester

Course Code	Course Title	Credits			Total Contact hours
		Theory	Practical	Total Credits	
BIT - 400	Research Methodology & proposal writing (Major)	4	-	4	60
BIT - 401	Microbial Technology (Major)	3	1	4	75
BIT - 402	Immunotechnology (Major)	3	1	4	75
BIT - 403	Nanobiotechnology (Major)	3	1	4	75
BIT - 404	Conservation Biotechnology (Minor)	4	-	4	60
	Total	17	3	20	345

8th Semester

Course Code	Course Title	Credits			Total Contact hours
		Theory	Practical	Total Credits	
BIT - 450	Advances in Bioinformatics (Major)	3	1	4	75
BIT - 451	Fermentation Biotechnology (Minor)	4	-	4	60
BIT - 452	Dissertation/Project (Major)	-	12	12	360
BIT - 453 [#]	Industrial Biotechnology (Major)	-	4	4	120
BIT - 454 [#]	Molecular Diagnostic (Major)	-	4	4	120
BIT - 455 [#]	Fundamentals of Medical Microbiology (Major)	4	-	4	60
	Total	Honours		20	435
		Honours with research		20	495

BIT-453 / BIT-454 / BIT-455 are in lieu of Paper BIT 452.

SEMESTER VII
BIT – 400

RESEARCH METHODOLOGY & PROPOSAL WRITING
(Major)

Credits: 4
Contact Hours: 60
Total Marks: 100

Learning Objective:

This syllabus provides a comprehensive overview of research methodology, including both quantitative and qualitative approaches, and emphasizes hands-on experience through the group project

Course Outcome (CO):

At the end of the course, the students will be able to:

- CO1** Understand basic elements of scientific research, including research methods, planning, writing the research proposal, data collection and analysis, and writing scientific communications.
- CO2** Demonstrate the ability to choose methods appropriate to research aims and objectives.
- CO3** To prepare students to adapt to the research environment and understand how projects are executed in research laboratory.
- CO4** Develop skills in qualitative and quantitative data analysis and presentation
- CO5** To prepare the students to present their topic of research and explain its importance.

(Theory)

Credits: 4
Contact Hours: 60

UNIT I

Historical development of science and scientific research; Nature and types of scientific knowledge: empirical, theoretical, and applied; The scientific method: hypothesis formulation, experimentation, observation, and conclusion; Experimental design: manipulative experiments, use of controls, Reasoning approaches: deductive vs inductive reasoning; Descriptive science and its significance; Paradigms in biology: reductionist vs holistic perspectives.

UNIT II

Systematic approach to designing and conducting research; Identifying a suitable research environment: choosing a lab and defining research question; Essential qualities of a good mentor and mentee; Importance of maintaining a comprehensive and organized lab notebook, Introduction to data collection, analysis, and interpretation; Ethical practices in scientific research: plagiarism, data falsification, authorship, and integrity.

UNIT III

Selecting a research topic of interest; Conducting an effective literature review and gap analysis; Formulating research objectives and hypothesis; Writing a research proposal: structure, content, and formatting; Developing a work plan for both quantitative and qualitative investigations; Understanding timelines, resource planning, and budgeting.

UNIT IV

Presentation of research proposals: structure, clarity, and delivery techniques; Mid-term evaluation of project progress, Final project presentation: summarizing research findings and analysis, Communicating future perspectives and potential impacts of the research; Effective use of visual aids (graphs, charts, diagrams) in scientific communication.

SUGGESTED READINGS:

1. Research methodology: Methods and techniques (2004) C.R. Kothari, 2^d revised. Ds., New Age International Publishers.
2. Research methodology is a step-by-step guide to beginners (201 1) Ranjit Kumar 6* ed., Sage Publications.
3. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (2017)
4. J. David Creswell and John W. Creswell, 6* eds. Sage Publications.
5. Research Methods: A Practical Guide for Students and Researchers (2017) Willie Chee Keong Tanby World scientific publ.
6. Chalmers, A. F. (2013). *What Is This Thing Called Science?* Indianapolis: Hackett Publishing.
7. Kuhn, T. S. (2012). *The Structure of Scientific Revolutions* (4th ed.). Chicago: University of Chicago Press.
8. Popper, K. R. (2002). *The Logic of Scientific Discovery*. New York: Routledge.

SEMESTER VII
BIT – 401

MICROBIAL TECHNOLOGY
(Major)

Credits: 4
Contact Hours: 75
Total Marks: 100

Learning Objective:

These outcomes aim to provide students with a comprehensive understanding of the development of suitable technology for downstream bioproducts from microorganisms

Course Outcome (CO):

At the end of the course, the students will be able to:

- CO1** Explore the use of microorganisms in industrial processes, such as food and beverage production, pharmaceuticals, and biofuels.
- CO2** Adhere to safety protocols and practices in the handling and manipulation of microorganisms.
- CO3** Identify and classify various types of microorganisms, including bacteria, viruses, fungi, and protozoa.
- CO4** Analyze genetic variations and mechanisms of gene regulation in microorganisms.
- CO5** Effectively communicate scientific ideas and findings, both in written and oral formats.

(Theory)

Credits: 3
Contact Hours: 45

UNIT I

Microbial genetics: replication and regulation of bacterial gene expression; DNA amplification using PCR; Manipulation of gene expression in prokaryotes; Increasing protein production and its expression in *E. coli*, Genetic study of HIV, coronavirus, and λ phage; Introduction to strain improvement, culture preservation, and inoculum development.

UNIT II

Microbial production of amino acids, antibiotics, enzymes, and organic acids; Screening for microbial products; Immobilization of microbial cells and microalgae for pollutant removal, Bioprocess technology: fermentation processes, procedures, and equipment; Applications: beer brewing, wine, vinegar, cheese manufacture; Mold-modified foods; Fermented foods and probiotics.

UNIT III

Bio-insecticides, biofertilizers, and microbial inoculants; Microbial culture selection for industrial use; Microbes in alternative energy production; Microbial endophytes and their novel metabolites; Introduction to patenting in microbial technology.

(Practical)

Credits: 1
Contact Hours: 30

UNIT IV

1. Production of Yogurt.
2. Production of Cheese.
3. To isolate and identify microbes from any probiotic food and test for its characteristics.
4. Determination of alcohol content from wine.
5. To immobilize microalgae or bacteria using calcium alginate beads and test pollutant degradation in simulated wastewater.
6. Study of a patent and developing a hypothetical patent application.

SUGGESTED READINGS:

1. Stanier, R. Y., Ingraham, J. L., Wheelis, M. L., & Painter, P. R. (2000). *General Microbiology*. London: The Macmillan Press Ltd.
2. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (2017). *Microbiology: An Application-Based Approach* (5th ed.). New Delhi: McGraw Hill Education.
3. Waites, M. J., Morgan, N. L., Rockey, J. S., & Highton, G. (2016). *Industrial Microbiology: An Introduction* (2nd ed.). Oxford: Wiley-Blackwell.
4. Glazer, A. N., & Nikaido, H. (2017). *Microbial Biotechnology: Fundamentals of Applied Microbiology* (2nd ed.). Cambridge: Cambridge University Press.
5. Crueger, W., & Crueger, A. (2019). *Biotechnology: A Textbook of Industrial Microbiology* (3rd ed.). New Delhi: Medtech Science Press.
6. Patel, A. H. (2019). *Industrial Microbiology* (2nd ed.). New Delhi: Macmillan India.
7. Cappuccino, J. G., & Welsh, C. (2020). *Microbiology: A Laboratory Manual* (12th ed.). New York: Pearson Education.
8. Dubey, R. C., & Maheshwari, D. K. (2022). *Practical Microbiology* (Revised ed.). New Delhi: S. Chand & Company Ltd.
9. Aneja, K. R. (2023). *Experiments in Microbiology, Plant Pathology and Biotechnology* (8th ed.). New Delhi: New Age International Publishers.
10. Kavitha, T., & Prakasham, R. S. (2021). *Practical Manual on Industrial Microbiology and Biotechnology*. Hyderabad: BS Publications.
11. Benson, H. J. (2019). *Microbiological Applications: Laboratory Manual in General Microbiology* (13th ed.). New York: McGraw-Hill Education.

SEMESTER VII
BIT – 402

IMMUNOTECHNOLOGY
(Major)

Credits: 4
Contact Hours: 75
Total Marks: 100

Learning Objective:

Upon successful completion of the Immunotechnology course, students will be able to understand the fundamental principles of immune system components, responses, and their applications in biotechnology

Course Outcome (CO):

At the end of the course, the students will be able to:

- CO1** To provide a fundamental understanding of the immune system and immunological techniques.
- CO2** To familiarize students with antigen-antibody interactions, immune response mechanisms, and immunodiagnostic tools.
- CO3** Analyse and interpret data from immunological experiments for use in diagnostics, vaccine development, and therapeutic strategies.
- CO4** Demonstrate ethical and safe laboratory practices while handling immunological materials and conducting research involving animals or human samples.
- CO5** Evaluate current trends and applications in Immunotechnology, including monoclonal antibodies, immunotherapy, and recombinant vaccine technologies.

(Theory)

Credits: 3
Contact Hours: 45

UNIT I

Purification of mononuclear cells from peripheral blood, isolation and characterization of T cells subsets; Mitogen and antigen-induced lymphocyte proliferation assay, mixed lymphocyte reaction (MLR), Assay of macrophage activation, Macrophage and Dendritic cell cultivation.

UNIT II

Production of antibodies and its biotechnological application such as ELISPOT, immunohistochemistry, Vaccination, landscape of vaccine development, types of production, modern methods, epitopes mediated vaccines, CTL vaccines – cloned vaccines, vaccine genomics, Immunofluorescence and FACS.

UNIT III

Immunotechnology in disease diagnosis and management, Immunogenetics and transplantation immunology, Cancer immunotherapy and immuno-oncology, Ethical, biosafety, and regulatory aspects of Immunotechnology.

(Practical)

Credits: 1
Contact Hours: 30

UNIT IV

1. Bleeding techniques and serum separation.

2. SRID.
3. Rocket immuno electrophoresis.
4. Fraction of T & B sub-populations from peripheral blood.
5. Western blotting for protein detection.

SUGGESTED READINGS:

1. Kuby, J., Kindt, T. J., Osborne, B. A., & Goldsby, R. A. (2018). *Kuby Immunology* (8th ed.). New York: W. H. Freeman and Company.
2. Parslow, T. G., Stites, D. P., Terr, A. I., & Imboden, J. B. (2019). *Medical Immunology* (12th ed.). New York: McGraw-Hill Education.
3. Male, D., Brostoff, J., Roth, D. B., & Roitt, I. (2020). *Immunology* (9th ed.). Amsterdam: Elsevier.
4. Goldsby, R. A., Kindt, T. J., & Osborne, B. A. (2021). *Immunology* (7th ed.). New Delhi: Oxford University Press.
5. Chakravarty, A. K. (2018). *Immunology and Immunotechnology*. New Delhi: Oxford University Press.
6. Shetty, N. (2020). *Immunology: Introductory Textbook* (3rd ed.). New Delhi: New Age International Publishers.
7. Talwar, G. P., & Gupta, S. K. (2019). *A Handbook of Practical and Clinical Immunology* (2nd ed.). New Delhi: CBS Publishers & Distributors.
8. Arora, D. R. (2022). *Practical Microbiology and Immunology* (3rd ed.). New Delhi: CBS Publishers & Distributors.
9. Rajasekaran, A., & Thangam, T. S. (2020). *Laboratory Manual in Immunology and Immunotechnology*. Chennai: MJP Publishers.
10. Rao, C. V. (2018). *Immunology: A Lab Manual*. New Delhi: Narosa Publishing House.
11. Purohit, S. S., & Mathur, S. K. (2019). *Immunology and Immunotechnology: Theory and Practical Manual*. Jodhpur: Agrobios (India).

**SEMESTER VII
BIT – 403**

**NANOBIOTECHNOLOGY
(Major)**

**Credits: 4
Contact Hours: 75
Total Marks: 100**

Learning Objective:

To provide knowledge of standard practices, methodologies and applications of nanotechnology in biotechnology tools and applications.

Course Outcome (CO):

At the end of the course, the students will be able to:

- CO1** Identify and explain key concepts and terminologies in nanobiotechnology.
- CO2** Describe methods for synthesizing and characterizing nanomaterials used in biological applications.
- CO3** Assess the environmental, ethical, and safety issues related to the use of nanomaterials in biotechnology.
- CO4** Understand nanobiotechnology techniques in real-world applications such as drug delivery and biosensing.

(Theory)

**Credits: 3
Contact Hours: 45**

UNIT I

Fundamentals of Nanoscience and Nanotechnology, Scope and applications of Nanobiotechnology; Nanomaterials: Definition, classification, and properties; Green synthesis of nanomaterials using microbes, plants, and biomolecules; Nanomembranes in bioreactors, Nanospheres for metabolite detection; Ethical, safety, and regulatory aspects of Nanobiotechnology.

UNIT II

Interaction of nanomaterials with biological systems; Protein and DNA-based nanostructures; Nanoparticles in drug delivery, bioimaging, and biosensing; Nanomaterials in diagnostics and therapeutics (Cancer therapy, gene delivery); Role of nanotechnology in regenerative medicine and tissue engineering.

UNIT III

Nanobioremediation: Role of nanoparticles in pollutant removal/degradation, Wastewater treatment using nanomaterials; Nano-biofertilizers and nanomaterials in agriculture; Biosensors for environmental monitoring, Risks and benefits of nanomaterials.

(Practical)

**Credits: 1
Contact Hours: 30**

UNIT IV

1. UV-Vis spectroscopy of metal nanoparticles.
2. Dynamic Light Scattering (DLS) for particle size distribution.
3. SEM/TEM demo (video or institutional access if available).
4. Microbial synthesis of silver/gold nanoparticles using bacterial/fungal cultures.

5. Biomolecule-assisted synthesis using proteins, polysaccharides, or enzymes.

SUGGESTED READINGS:

1. Poole Jr., C. P., & Owens, F. J. (2003). *Introduction to Nanotechnology*. John Wiley & Sons.
2. Kulkarni, S. K. (2019). *Nanotechnology: Principles and Practices*. CRC Press.
3. Niemeyer, C. M., & Mirkin, C. A. (2004). *Nanobiotechnology: Concepts, Applications and Perspectives*. Wiley-VCH.
4. Hunt, G., & Mehta, M. (2018). *Nanotechnology: Risk, Ethics and Law*. Earthscan.
5. Feynman, R. P. (2012). *There's Plenty of Room at the Bottom: An Invitation to Enter a New Field of Physics*. Basic Books.
6. Kumar, C. S. S. R. (2017). *Nanomaterials for Medical Diagnosis and Therapy*. Wiley.
7. Rao, C. N. R., & Müller, A. (Eds.). (2007). *Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience*. Wiley-VCH.
8. Andrews, D. L., & Scholes, G. D. (Eds.). (2014). *Excitons in Nanoscale Systems*. Springer.
9. Bharat, B. (2015). *Nanotechnology Applications for Clean Water*. William Andrew.
10. Sozer, N., & Kokini, J. L. (2009). *Nanotechnology and Functional Foods: Effective Delivery of Bioactive Ingredients*. Wiley-Blackwell.
11. Srikandan, C. S., Rajendran, V., & Sreekumar, T. (2012). *Laboratory Manual for Nanoscience and Nanotechnology*. MJP Publishers.
12. Hornyak, G. L., Dutta, J., Tibbals, H. F., & Rao, A. K. (2009). *Introduction to Nanoscience and Nanotechnology*. CRC Press.
13. Ahmed, S. (Ed.). (2020). *Green Nanomaterials: Synthesis, Characterization and Applications*. Wiley-VCH.
14. Cooper, J. M., & Cass, A. E. G. (2004). *Biosensors: A Practical Approach*. Oxford University Press.
15. Panpatte, D. G., Jhala, Y. K., Shelat, H. N., & Vyas, R. V. (Eds.). (2019). *Nanotechnology for Sustainable Agriculture, Food and Environment*. Springer.

SEMESTER VII
BIT – 404

CONSERVATION BIOTECHNOLOGY
(Minor)

Credits: 4
Contact Hours: 60
Total Marks: 100

Learning Objective:

Upon completion of this course, students will be able to apply biotechnological tools for the conservation of biodiversity. They will also understand strategies for genetic resource preservation and ecosystem rehabilitation

Course Outcome (CO):

At the end of the course, the students will be able to:

- CO1** Understand the principles and significance of biotechnology in biodiversity conservation and ecosystem sustainability.
- CO2** Apply biotechnological methods such as cryopreservation, tissue culture, and DNA barcoding in conservation efforts.
- CO3** Evaluate the role of genomics and bioinformatics in species identification, monitoring, and management.
- CO4** Develop strategies for the conservation of bioresources using *in situ* and *ex situ* approaches and understand the ethical, legal, and social implications of using biotechnology in conservation practices.

(Theory)

Credits: 4
Contact Hours: 60

UNIT I

Concept and importance of biodiversity: levels and values, Biodiversity hotspots in India: Western Ghats, Eastern Himalayas, Indo-Burma. Marine bio-resources: seaweeds, mangroves, marine invertebrates and vertebrates, Inland aquatic resources: freshwater and estuarine ecosystems, Microbial bioresources: relevance and status.

UNIT II

Molecular tools in conservation: DNA barcoding, genotyping, and genome sequencing, Cryopreservation and gene banks (seed, sperm, ova, DNA banks), Micropropagation and tissue culture in conservation, Role of biotechnology in ex situ conservation (e.g., botanical gardens, aquaria, zoos), Marker-assisted selection and molecular breeding for conservation.

UNIT III

In situ and *ex situ* conservation strategies, Captive breeding, reintroduction, and translocation, Conservation genetics and population viability analysis, Genetic rescue and managing genetic bottlenecks, Case studies: conservation of endangered flora and fauna using biotechnological interventions

UNIT IV

Conservation significance of traditional knowledge and ethno-botany, measures of conservation, National and international policies on biodiversity conservation (CBD, Nagoya Protocol, CITES, Wildlife Protection Act), community participation and role of NGOs, Ethical,

legal, biopiracy and social implications of conservation biotechnology, Sustainable use of genetic resources and benefit-sharing

SUGGESTED READINGS:

1. Gulia K. S. (2007). Natural resources of Himalaya. Isha Books
2. RA Singh (2014). Geology, Biodiversity & Natural Resources of Himalaya and Their Intellectual Property Law. Pratyush Publications.
3. Matthias Hartmann and Jörg Weipert (2015). Biodiversity and Natural Heritage of the Himalaya, Volume 5. Naturkundemuseum Erfurt.
4. Pavel Kindleman (2012). Himalayan biodiversity in the changing world. Springer.
5. T. Pullaiah (2024). Biodiversity hotspots of Himalaya. Apple Academic Press.
6. Suresh Kumar (2024). Biodiversity of the Himalayas, Volume 1: Utilization, Conservation and Management of Plant Resource., Volume 2: Utilization, Conservation and Management of Animal Resources. Apple Academic Press.
7. Preeti Dhar and Durga Nath Dhar (2019). Medicinal Plants of India. World Scientific publishing.
8. Hota Dharamvir (2007). Bioactive Medicinal Plants. Meripustak
9. S.K. Tripathi (2019). Medicinal Plants of India: Conservation and sustainable use. Today's & Tomorrow's Printers and Publications.
10. Benson, E. E. (1999). *Plant Conservation Biotechnology*. CRC Press.
11. Van Dyke, F., & Lamb, R. L. (2020). *Conservation Biology: Foundations, Concepts, Applications* (3rd ed.). Springer.
12. Sodhi, N. S., & Ehrlich, P. R. (Eds.). (2010). *Conservation Biology for All*. Oxford University Press.
13. Pullaiah, T., & Krishnamurthy, K. V. (Eds.). (2023). *Medicinal Plants: Biodiversity, Biotechnology and Conservation*. Springer.

SEMESTER VIII
BIT – 450

ADVANCES IN BIOINFORMATICS
(Major)

Credits: 4
Contact Hours: 75
Total Marks: 100

Learning Objective:

Upon completion of this course, students will be able to analyse complex biological data using advanced bioinformatics tools and algorithms. They will also gain proficiency in interpreting genomic, transcriptomic, and proteomic datasets for research and practical applications

Course Outcome (CO):

At the end of the course, the students will be able to:

- CO1** Gain a comprehensive understanding of the basic principles and concepts underlying bioinformatics, including molecular biology, genetics, and computational techniques.
- CO2** Develop hands-on skills in using bioinformatics tools and software for analyzing biological data, such as sequence alignment, structural bioinformatics, and functional annotation
- CO3** Understand the challenges and opportunities associated with integrating data from different omics disciplines, such as genomics, transcriptomics, proteomics, and metabolomics.
- CO4** Enhance problem-solving skills by applying bioinformatics techniques to address specific research questions, fostering critical thinking in the context of biological data analysis.
- CO5** Acquire the ability to apply computational methods to solve real-world biological problems, enabling the interpretation of complex biological data sets

(Theory)

Credits: 3
Contact Hours: 45

UNIT I

Molecular biology concept- Molecular markers (SNPs, VNTRs, 23SrRNA), Sequence alignment-Pairwise, Multiple, local and global alignments, substitution, Insertions and deletions in a sequence, statistical significance of alignments; Phylogenetic tree, Gene structure prediction- GenScan, Repeat Masker; detection of functional sites in DNA sequences-Promoter Scan.

UNIT II

Substitution Scoring Matrices (PAM and BLOSUM) for protein sequences; Pattern and domain databases-PROSITE, BLOCKS, PRINTS; motifs and profiles; Biomolecular interaction-DNA - protein and protein- ligand interactions.

UNIT III

Protein structure-X-ray crystallography, The protein databank and the PDBSum-SCOP, CATH, DALI and HSSP; Visualisation of molecular structures-RasMol and Pymol; Protein secondary structure prediction, Fold Recognition; Transmembrane topology prediction.

(Practical)

Credits: 1
Contact Hours: 30

UNIT IV

1. Retrieval of protein and nucleotide sequences from suitable databanks.
2. Similarity searches using BLAST tools.
3. Online tools for PCR primer generation and restriction analysis.
4. Visualization of genome maps-usage of Map viewer from NCBI resource.

SUGGESTED READINGS:

1. Bioinformatics: A practical guide to the analysis of genes and proteins. Baxevanis A.D and Ovellette B.F.F., Wiley-Interscience, (2002).
2. Molecular and Biotechnology. A comprehensive desk reference, R.A. Meyes (Ed.) VCH Publishers Inc. (1995)
3. Textbook of Biotechnology Das H.K., Wiley Dreamtech India Pvt Ltd, (2004).
4. Principles of Genome analysis and genomics, Primrose SB, Twyman RM, Blackwell Science (2002).
5. Human Molecular Genetics, Strachan T and Read AP, Garland Science, (2004).
6. Bioinformatics: A practical guide to the analysis of genes and proteins. Baxevanis A.D and Ovellette B.F.F., Wiley-Interscience, (2002).
7. Molecular and Biotechnology. A comprehensive desk reference, R.A. Meyes (Ed.) VCH Publishers Inc. (1995)
8. Principles of Genome analysis and genomics, Primrose SB, Twyman RM, Blackwell Science (2002).
9. Mukhopadhyay, C. S. (2022). *Concepts in Bioinformatics: From Basics to Advanced*. Springer.
10. Baxevanis, A. D., Bader, G. D., & Wishart, D. S. (2020). *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins* (4th ed.). Wiley.

SEMESTER VIII
BIT – 451

FERMENTATION BIOTECHNOLOGY
(Minor)

Credits: 4
Contact Hours: 60
Total Marks: 100

Learning Objective:

These outcomes are designed to provide students with a strong foundation in both the theoretical principles and practical applications of fermentation biotechnology, preparing them for careers in industry, academia, or research.

Course Outcome (CO):

At the end of the course, the students will be able to:

- CO1** Students should develop the ability to identify and troubleshoot problems that may arise during fermentation processes, applying knowledge of microbiology, biochemistry, and engineering principles.
- CO2** Students should understand methods for the recovery and purification of fermentation products, including filtration, centrifugation, chromatography, and other separation techniques.
- CO3** Students should be able to design and operate bioreactor systems for fermentation processes, considering factors such as agitation, aeration, temperature control, and monitoring of key process
- CO4** Students should gain a comprehensive understanding of the principles underlying fermentation processes, including microbial physiology, metabolism, and growth kinetics.
- CO5** Students should be familiar with various microorganisms used in fermentation processes, including bacteria, yeasts, and molds, and understand their roles in different fermentation applications.

(Theory)

Credits: 4
Contact Hours: 60

UNIT I

Scope of fermentation technology, Major types of organisms used in fermentation; Microbial growth kinetics, Batch culture, Continuous culture, Fed-batch: Types and applications; Isolation, preservation, and improvement of industrially important microorganisms, Media for industrial fermentations – media formulation.

UNIT II

Strain improvement and crippled strains; Fermenter design: Principal features of bioreactors – Stirred tanks, Bubble column, Airlift, Online control of fermenters; Use of sensors and solutions to common problems in fermentation; Common contaminants in fermentation processes; Introduction to photobioreactors and solid-state fermentation (SSF), Anaerobic fermentation, Basics of reaction engineering.

UNIT III

Modern fermentation processes versus traditional fermentation; Fermented products from milk, vegetables, cereals, meat, and fish, Biochemical changes during the fermentation process; Traditional fermented foods of North East India: Fermented vegetables (Gundruk, Sinki),

Bamboo shoot-based foods (Soibum, Lungsiej), Fermented cereals and pulses (Kinema, Tungrymbai, Hawaijar), Fermented fish product.

UNIT IV

Genetic manipulation of microbes for enhanced production, use of immobilized cells and enzymes, advances in metabolic engineering and synthetic biology, environmental and regulatory aspects of fermentation technology, GEOs and biosafety in relation to fermentation technology.

SUGGESTED READINGS:

1. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2017). Principles of Fermentation Technology (3rd ed.). Amsterdam: Elsevier.
2. Crueger, W., & Crueger, A. (2019). Biotechnology: A Textbook of Industrial Microbiology (3rd ed.). New Delhi: Medtech Science Press.
3. Waites, M. J., Morgan, N. L., Rockey, J. S., & Higton, G. (2016). Industrial Microbiology: An Introduction (2nd ed.). Oxford: Wiley-Blackwell.
4. Singh, B. D. (2021). Biotechnology: Expanding Horizons (4th ed.). New Delhi: Kalyani Publishers.
5. Satyanarayana, U., & Chakrapani, U. (2021). Biotechnology and Bioprocessing (2nd ed.). Hyderabad: Books and Allied (P) Ltd
6. Mansi, E. M. T. E. F., & Bryce, C. F. A. (2018). Fermentation Microbiology and Biotechnology (4th ed.). Boca Raton: CRC Press.

SEMESTER VIII
BIT – 452

DISSERTATION/PROJECT
(Major)

Credits: 12
Contact Hours: 360
Total Marks: 300

1. Identification of the research problem, writing of synopsis proposal, presentation of the synopsis. **Credit: 3**
2. Dissertation: materials and methods, experiments, collection, tabulation and analysis of data, interpretation of results, discussions. **Credit: 5**
3. Presentation on dissertation and *Viva voce*. **Credit: 4**

SUGGESTED READINGS:

1. Information now: a graphic guide to student research and web literacy by Upson, Matt; Luetkenhaus, Holly; Hall, C. Michael; 2021, Second edition.
2. How to do a research project: a guide for undergraduate students by Robson, Colin, 2007

SEMESTER VIII
BIT – 453

INDUSTRIAL BIOTECHNOLOGY
(Major)

Credits:4
Contact Hours:120
Total Marks: 100

Learning Objective:

The course aims to equip students with hands-on skills in microbial biotechnology, enzyme technology, fermentation, and downstream processing techniques relevant to industrial applications

Course Outcome (CO):

At the end of the course, the students will be able to:

- CO1** Demonstrate proficiency in microbial isolation, screening, and cultivation techniques for industrially relevant microorganisms.
- CO2** Apply enzyme assay methods and analyze factors affecting enzyme activity and stability under varying industrial conditions.
- CO3** Operate and monitor small-scale fermentation systems and evaluate bioproduct yields using basic downstream processing techniques.
- CO4** Interpret data related to microbial growth, product formation, and bioprocess parameters using analytical tools and technique.
- CO5** Design and conduct basic biotechnological experiments aligned with industrial applications, including biofuel production, waste treatment, and biofertilizer formulation.

(Practical)

Credits: 4
Contact Hours: 120

1. Isolation and screening of industrially important microorganisms (eg. *Bacillus* sp, *Aspergillus* sp., *Saccharomyces* sp.).
2. Calculation of biomass yield coefficient ($Y_{x/s}$) and product yield ($Y_{p/x}$).
3. Enzyme extraction and partial purification from microbial or plant sources.
4. Enzyme immobilization techniques (e.g., alginate bead entrapment, covalent binding).
5. Study and demonstration of bioreactor components (lab/digital model).
6. Production of bioethanol or biobutanol from biomass (molasses, fruit waste).
7. Microbial production of any one antibiotic of industrial significance.
8. Extraction of bioplastics (PHA/PHB).
9. Biosurfactant production and surface tension analysis.
10. Quantitative screening of industrial microbes – zone diameter measurement for enzyme-producing microbes (e.g., amylase, lipase).
11. Batch fermentation using *Saccharomyces cerevisiae* for ethanol production.
12. Thin Layer Chromatography (TLC) for detection of antibiotics.

SUGGESTED READINGS:

1. Thakur, I. S. (2020). Laboratory Manual of Microbial Biotechnology. New Delhi: I. K. International Publishing House Pvt. Ltd.
2. Patel, A. H. (2008). Industrial Microbiology. New Delhi: Macmillan India Ltd.

3. Narayanan, P., & Ramamurthy, K. (2007). *Laboratory Manual in Industrial Biotechnology*. New Delhi: New Age International Publishers.
4. Mansi, E. M. T. E. F., & Bryce, C. F. A. (2007). *Fermentation Microbiology and Biotechnology* (2nd ed.). Boca Raton: CRC Press.
5. Jayaraman, J. (2011). *Laboratory Manual in Biochemistry*. New Delhi: New Age International Publishers.
6. Dubey, R. C., & Maheshwari, D. K. (2015). *Practical Microbiology*. New Delhi: S. Chand Publishing.
7. Kumar, H. D. (2012). *A Laboratory Manual of Plant Biotechnology*. New Delhi: Daya Publishing House.
8. Bajpai, P. (2016). *Biotechnology: Practical Manual Series* (Vol. 1 & 2). New Delhi: Springer India.
9. Wilson, K., & Walker, J. (2010). *Principles and Techniques of Biochemistry and Molecular Biology* (7th ed.). Cambridge: Cambridge University Press.

SEMESTER VIII
BIT – 454

MOLECULAR DIAGNOSTICS
(Major)

Credits: 4
Contact Hours: 120
Total Marks: 100

Learning Objective:

To provide undergraduate students with hands-on experience in the fundamental and advanced techniques of molecular diagnostics, enabling them to understand, apply and analyze nucleic acid and protein-based diagnostic methods used in research, clinical and environmental settings.

Course Outcome (CO):

At the end of the course, the students will be able to:

- CO1** Extract, quantify, and analyze DNA and RNA from biological samples using standard molecular biology protocols.
- CO2** Perform and interpret polymerase chain reaction (PCR) and gel electrophoresis techniques for gene amplification and detection.
- CO3** Apply molecular diagnostic methods in simulated clinical and research-based scenarios.
- CO4** Design primers and analyze genetic data using bioinformatics tools like NCBI BLAST and Primer3.
- CO5** Demonstrate understanding of molecular diagnostic workflows through problem-solving and case-based simulations for genetic and infectious diseases.

(Practical)

Credits: 4
Contact Hours: 120

1. Extraction of DNA from Chicken Liver & Quantification of DNA using Spectrophotometry (A260/A280).
2. Restriction Digestion of DNA & RFLP Analysis.
3. Creation of pedigrees and study on patterns of inheritance.
4. BLAST Analysis of PCR Amplicons.
5. Primer Design Using NCBI Primer-BLAST / Primer3.
6. Sex determination using Amelogenin gene PCR.
7. Microsatellite/STR Analysis (Demo or Simulation).
8. RNA extraction.
9. Serum protein electrophoresis.
10. ELISA – Antibody Detection (e.g., HIV Simulation).
11. Western Blotting – Demonstration of Antigen Detection.
12. Lateral Flow Assay (Rapid diagnostic test – e.g., COVID-19 demo).

SUGGESTED READINGS:

1. Sambrook, J., & Russell, D. W. (2001). *Molecular Cloning: A Laboratory Manual* (3rd ed.). Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
2. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: A Laboratory Manual* (4th ed.). Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

3. Wilson, K., & Walker, J. (2010). *Principles and Techniques of Biochemistry and Molecular Biology* (7th ed.). Cambridge: Cambridge University Press.
4. Maheswari, P., & Ramya, B. (2019). *Laboratory Manual of Molecular Biology* (1st ed.). New Delhi: I.K. International Publishing House.
5. Garland, P. B., & Knight, I. G. (2002). *Biochemical Techniques: Theory and Practice* (2nd ed.). Oxford: Blackwell Science.
6. Dey, P. (2015). *Basic and Advanced Laboratory Techniques in Histopathology and Cytology* (1st ed.). New Delhi: Springer.
7. Rapley, R., & Manning, D. L. (1998). *Molecular Biology and Biotechnology* (3rd ed.). Cambridge: Royal Society of Chemistry.
8. Patabhi, V., & Gautham, N. (2002). *Biophysics* (1st ed.). Boston: Springer.
9. Freifelder, D. (1982). *Physical Biochemistry: Applications to Biochemistry and Molecular Biology* (2nd ed.). New York: W.H. Freeman.

SEMESTER VIII
BIT – 455

FUNDAMENTALS OF MEDICAL MICROBIOLOGY
(Major)

Credits: 4
Contact Hours: 60
Total Marks: 100

Learning Objective:

These outcomes aim to equip students with the knowledge, skills, and attitudes necessary to understand and address the role of microorganisms in human health and disease, both in clinical practice and public health settings.

Course Outcome (CO):

At the end of the course, the students will be able to:

- CO1** Apply and compare critical thinking skills to solve clinical cases involving infectious diseases, including differential diagnosis and treatment options.
- CO2** Evaluate and generalize the role of medical microbiology in public health, including outbreak investigation, surveillance, and prevention strategies.
- CO3** Collect and classify the epidemiological data to understand the spread and control of infectious diseases.
- CO4** Summarize and measure the professionalism and ethical behavior in the practice of medical microbiology, including adherence to safety protocols.
- CO5** Describe and understand the fundamental principles of microbiology, including microbial structure, function and diversity.

(Theory)

Credits: 4
Contact Hours: 60

UNIT I

Introduction: Normal microflora of the human body; Disease reservoirs and epidemics, nosocomial infections, carriers, septic shock, septicaemia, pathogenicity, virulence factors, toxins, antimicrobial resistance and biosafety levels; Pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of gram-positive bacteria (*Mycobacterium tuberculosis*).

UNIT II

Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of disease caused by gram-negative bacteria (*Salmonella typhi*); Disease transmission and host immunity.

UNIT III

Viruses- Structure, Classification and growth; Diseases caused by Viruses – DNA virus (Hepatitis B), RNA virus (Influenza); Host immune response to viral infections, Multiplication of virus, Culture and maintenance of viruses.

UNIT IV

Fungal and Protozoan infections: Dermatophytoses (Trichophyton), subcutaneous infection (Sporothrix), systemic infection (Histoplasma) and opportunistic fungal infections (Candidiasis), gastrointestinal infections (Amoebiasis), blood-borne infections (Malaria).

SUGGESTED READINGS:

1. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.
2. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier. .
3. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education
4. Edward K Wagner and Martinez J Hewlette (2005) Basic Virology, Blackwell Publishing.
5. Michael T. Madigan and John M. Martinko ((2006) Brock Biology of Microorganisms, Pearson-Prentice Hall
6. Ford, M. (2019). *Medical Microbiology* (3rd ed.). Oxford University Press.
7. Yotis, W. W. (2009). *Fundamentals of Medical Microbiology & Immunology*. Outskirts Press.
8. Murray, P. R., Rosenthal, K. S., & Pfaller, M. A. (2015). *Medical Microbiology* (8th ed.). Elsevier