TECHNO INDIA UNIVERSITY

WEST BENGAL

DEPARTMENT OF MICROBIOLOGY

SYLLABUS STRUCTURE AND COURSE DETAILS

w.e.f 2024-25

SEMESTER 6

IMMUNOLOGY (Theory)

Program: B. Sc. in Microbiology	**Year, Semester:** 3rd Yr., 6th Sem
Course Title: IMMUNOLOGY (Theory)	**Subject Code:** TIU-UMB-MJ-T32301
Contact Hours/Week: 2–1–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

1. Describe the fundamental principles of innate and adaptive immunity and the historical contributions of key scientists to the field of immunology.
2. Explain the structure, function, and interactions of the cells and organs of the immune system, including T cells, B cells, antigen-presenting cells, and lymphoid tissues.
3. Compare and contrast the characteristics, functions, and mechanisms of action of antigens, antibodies, the complement system, and the major histocompatibility complex (MHC).
4. Describe the processes involved in the generation of humoral and cell-mediated immune responses, including antigen processing and presentation, T cell and B cell activation, and effector mechanisms.
5. Explain the mechanisms and consequences of immunological disorders, including autoimmunity, hypersensitivity, immunodeficiencies, and tumor immunity.
6. Outline the principles and applications of major immunological techniques, such as ELISA, Western blotting, flow cytometry, and immunofluorescence

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Understand the key concept of Innate and Adaptive immunity	K1
CO-2:	Remember the different Immune Cells and Organs	K2
CO-3:	Explain the structure and function of Antigens and Antibodies	K4
CO-4:	Evaluate Major Histocompatibility Complex and disease management	K4
CO-5:	Understand the Complement System and generation of Immune response	K5
CO-6:	Analyze Immunological Disorders, Tumor Immunity and Immunological techniques	K3

COURSE CONTENT :

MODULE 1:	**INTRODUCTION**	**5 Hours**
Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of the field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa		
MODULE 2:	**IMMUNE CELLS AND ORGANS**	**5 Hours**
Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT		
MODULE 3:	**ANTIGENS**	**5 Hours**
Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants		
MODULE 4:	**ANTIBODIES**	**5 Hours**
Structure, Types, Functions and Properties of antibodies; Antigenic Determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies		
MODULE 5:	**MAJOR HISTOCOMPATIBILITY COMPLEX**	**5 Hours**
Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways)		
MODULE 6:	**COMPLEMENT SYSTEM**	
Components of the Complement system; Activation pathways (Classical, Alternative, and Lectin pathways); Biological consequences of complement Activation		
MODULE 7:	**GENERATION OF IMMUNE RESPONSE**	**7 Hours**
Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction to tolerance		
MODULE 8:	**IMMUNOLOGICAL DISORDERS AND TUMOR IMMUNITY**	**7 Hours**
Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome, Leukocyte adhesion deficiency, CGD; Types of tumors, tumor Antigens, causes and therapy for cancers.		

MODULE 9:	**IMMUNOLOGICAL TECHNIQUES**	**5 Hours**
Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluorescence, Flow cytometry, Immunoelectron microscopy.		
TOTAL LECTURES		**45 Hours****

Books:

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 5th edition W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway'sImmunobiology. 7th edition Garland Science Publishers, New York.
5. PeakmanM, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication

IMMUNOLOGY (Practical)

Program: B. Sc. in Microbiology	**Year, Semester:** 3rd Yr., 6th Sem
Course Title: IMMUNOLOGY (Practical)	**Subject Code:** TIU-UMB-MJ-L32301
Contact Hours/Week: 0–0–1 (L–T–P)	**Credit: 1**

COURSE OBJECTIVE :

Enable the student to:

1. Perform and interpret common immunological assays, including blood grouping, Total Leukocyte Count (TLC), Ouchterlony immunodiffusion, Dot ELISA, and immunoelectrophoresis.
2. Apply appropriate laboratory techniques and aseptic procedures to conduct immunological experiments accurately and safely.
3. Analyze the results of immunological assays to determine antigen-antibody interactions and cellular components of blood.
4. Explain the principles behind each immunological technique and their applications in immunological studies

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Demonstration on the identification of human blood groups.	K3
CO-2:	Perform Total Leukocyte Count of the given blood sample.	K3
CO-3:	Perform Differential Leukocyte Count of the given blood sample	K3
CO-4:	Understand to separate serum from the blood sample (demonstration).	K2
CO-5:	Perform immunodiffusion by Ouchterlony method.	K4
CO-6:	Perform DOT ELISA and Immunoelectrophoresis.	K4

COURSE CONTENT :

MODULE 1:	**STUDY THE IMMUNOLOGICAL PARAMETERS IN THE HUMAN BODY**	**15 Hours**
1. Identification of human blood groups. 2. Perform Total Leukocyte Count of the given blood sample. 3. Perform immunodiffusion by Ouchterlony method. 4. Perform DOT ELISA. 5. Perform immunoelectrophoresis.		
TOTAL LECTURES		**15 Hours****

Environmental Microbiology (Theory)

Program: B. Sc. in Microbiology	**Year, Semester:** 3rd Yr., 6th Sem
Course Title: Environmental Microbiology (Theory)	**Subject Code:** TIU-UMB-MJ-T32302
Contact Hours/Week: 2–1–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

1. Describe the structure and function of ecosystems and analyze the diverse microbial communities inhabiting terrestrial, aquatic, atmospheric, animal, and extreme environments
2. Explain the various types of microbe-microbe, microbe-plant, and microbe-animal interactions, including their ecological significance.
3. Outline the key steps and microbial processes involved in the major biogeochemical cycles, including carbon, nitrogen, phosphorus, and sulfur cycling.
4. Describe the sources, types, and methods of solid and liquid waste management, including the principles of composting, sanitary landfill, and wastewater treatment.

5. Explain the principles of microbial bioremediation and analyze the microbial degradation of common pollutants, including pesticides, organic matter, and inorganic matter.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Explain the structure and function of ecosystems and classify different microbial habitats, including terrestrial, aquatic, atmospheric, and extreme environments	K2
CO-2:	Analyze various microbial interactions, including microbe-microbe, microbe-plant, and microbe-animal relationships, and evaluate their ecological significance	K4
CO-3:	Demonstrate an understanding of microbial involvement in biogeochemical cycles, including carbon, nitrogen, phosphorus, sulfur, iron, and manganese cycles, and interpret their roles in ecosystem sustainability	K4
CO-4:	Assess different methods of solid and liquid waste management and compare the effectiveness of various waste treatment processes, including composting, sanitary landfills, and sewage treatment techniques	K4
CO-5:	Investigate the principles of microbial bioremediation and examine the microbial degradation of pesticides, hydrocarbons, oil spills, and heavy metals.	K4
CO-6:	Apply knowledge of environmental microbiology to real-world challenges such as pollution control, waste treatment, and microbial ecosystem management.	K3

COURSE CONTENT :

MODULE 1:	**MICROORGANISMS AND THEIR HABITATS**	**10 Hours**
Structure and function of ecosystems, Terrestrial Environment: Soil profile and soil microflora, Aquatic Environment: Microflora of fresh water and marine habitats Atmosphere: Aero microflora and dispersal of microbes Animal Environment: Microbes in/on human body (Microbiome) & animal (ruminants) body, Extreme Habitats: Extremophiles-microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels. Microbial succession in decomposition of plant organic matter		
MODULE 2:	**MICROBIAL INTERACTIONS**	**5 Hours**
Microbe-microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation Microbe-Plant interaction: Symbiotic and non-symbiotic interactions Microbe-animal interaction: Microbes in ruminants, nematophagus		

fungi and symbiotic luminescent bacteria		
MODULE 3:	**BIOGEOCHEMICAL CYCLING**	**15 Hours**
Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction Phosphorus cycle: Phosphate immobilization and solubilization Sulphur cycle: Microbes involved in Sulphur cycle Other elemental cycles: Iron and manganese		
MODULE 4:	**WASTE MANAGEMENT**	**10 Hours**
Solid Waste management: Sources and types of solid waste, methods of solid waste disposal (composting and sanitary landfill) Liquid waste management: Composition and strength of sewage (BOD and COD), primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment		
	MICROBIAL BIOREMEDIATION	**5 Hours**
Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inorganic (metals) matter, biosurfactants		
TOTAL LECTURES		**45 Hours****

Books:

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition,
Benjamin/Cummings Science Publishing, USA
2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition, Pearson/ Benjamin Cummings
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology, 2nd edition, Academic Press
4. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York
5. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg
6. Barton LL & Northup DE (2011). Microbial Ecology, 1st edition, Wiley Blackwell, USA
7. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
8. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
9. Lynch JM &Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.

ENVIRONMENTAL MICROBIOLOGY (Practical)

Program: B. Sc. in Microbiology	**Year, Semester:** 3rd Yr., 6th Sem
Course Title: ENVIRONMENTAL MICROBIOLOGY (Practical)	**Subject Code:** TIU-UMB-MJ-L32302
Contact Hours/Week: 0–0–1 (L–T–P)	**Credit: 1**

COURSE OBJECTIVE :

Enable the student to:

1. Analyze the physicochemical properties of soil, including pH, moisture content, water holding capacity, percolation, and capillary action.
2. Employ appropriate microbiological techniques to isolate and characterize bacteria and fungi from soil and rhizosphere environments at different temperatures.
3. Investigate microbial activity in soil through the qualitative detection of enzymatic activity, specifically amylase and urease.
4. Document and analyze the processes and operations involved in solid waste management or wastewater treatment through a field trip report.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Recall fundamental soil properties such as pH, moisture content, water holding capacity, percolation, and capillary action.	K2
CO-2:	Describe the techniques used for isolating bacteria and fungi from soil and rhizosphere at different temperatures.	K2
CO-3:	Demonstrate the process of microbial isolation from soil and rhizosphere using appropriate laboratory methods.	K4
CO-4:	Analyze the presence of microbial activity in soil by detecting enzyme activity (amylase, urease) through qualitative tests.	K3
CO-5:	Design experimental approach for isolating and identifying soil microbes based on environmental conditions.	K4
CO-6:	Assess the environmental impact of solid waste landfill sites or wastewater treatment plants based on field trip observations.	K3

COURSE CONTENT :

MODULE 1:	**DEMONSTRATION OF SOIL MICROBES AND THEIR APPLICATION**	**15 Hours**
1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action. 2. Isolation of microbes (bacteria & fungi) from soil (28oC & 45oC). 3. Isolation of microbes (bacteria & fungi) from rhizosphere.		

4. Study the presence of microbial activity by detecting (qualitatively) enzymes (amylase, urease) in soil. 5. Report on Field Trip of any non hazardous, solid waste landfill site (garbage dump, rubbish dump or municipal landfills receiving household waste)/ wastewater treatment plant	
TOTAL LECTURES	**15 Hours****

BACTERIAL PATHOGENESIS (Theory)

Program: B. Sc. in Microbiology	**Year, Semester:** 3rd Yr., 6th Sem
Course Title: BACTERIAL PATHOGENESIS(Theory)	**Subject Code:** TIU-UMB-MJ-T32303
Contact Hours/Week: 2–1–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

1. Describe the fundamental concepts of bacterial pathogenesis, including host-pathogen interactions, virulence factors, and mechanisms of bacterial attachment, invasion, and colonization.
2. Explain the etiology, pathogenesis, symptoms, transmission, treatment, and control of major bacterial diseases affecting different body systems, including respiratory, gastrointestinal, sexually transmitted, urinary tract, and skin infections.
3. Outline the principles and applications of key laboratory techniques used for the culture, identification, and diagnosis of bacterial pathogens, including culture methods and various immunological and molecular diagnostic tests.
4. To explore the history of phycology with an emphasis on contributions from Indian scientists.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Explain the fundamental concepts of bacterial pathogenesis, including infection processes, host-pathogen interactions, and the role of virulence factors and toxins in disease development.	K2
CO-2:	Explain the fundamental concepts of bacterial pathogenesis, including infection processes, host-pathogen interactions, and the role of virulence factors and toxins in disease development.	K4
CO-3:	Evaluate the pathogenesis, symptoms, transmission, treatment, and control of major bacterial diseases affecting different organ systems,	K5

	including respiratory, gastrointestinal, and sexually transmitted infections.	
CO-4:	Demonstrate proficiency in laboratory techniques for the culture, identification, and diagnosis of bacterial pathogens using conventional and molecular methods	K4
CO-5:	Classify antibiotics based on their mechanisms of action and assess their therapeutic applications, potential side effects, and drug interactions	K5
CO-6:	Investigate antibiotic resistance mechanisms, identify factors contributing to resistance spread, and propose strategies to mitigate resistance through antibiotic stewardship and novel therapeutic approaches	K6

COURSE CONTENT :

MODULE 1:	**INTRODUCTION TO BACTERIAL PATHOGENESIS**	**5 Hours**
Basic concepts of infection and host-pathogen interactions, bacterial virulence factors, and toxins (types, mechanisms of action, and their effects on the host).		
MODULE 2:	**MECHANISMS OF BACTERIAL PATHOGENESIS**	**7 Hours**
Adhesion factors involved in bacterial attachment, invasion strategies, host colonization, inflammatory response of host, tissue damage and disease progression, biofilm formation and quorum sensing		
MODULE 3:	**BACTERIAL DISEASES**	**15 Hours**
Following diseases to be studied with reference to the causative agents, symptoms, mode of transmission, pathogenesis, treatment and control Respiratory disease: tuberculosis (Mycobacterium tuberculosis), pneumonia (Streptococcus pneumoniae) Gastrointestinal disease: Salmonellosis (Salmonella typhi), cholera (Vibrio cholerae) Sexually transmitted infections: Gonorrhea (Neisseria gonorrhoeae), syphilis (Treponema pallidum) Others: Urinary tract infections (Escherichia coli), Skin and soft tissue infections (Staphylococcus aureus), tetanus (Clostridium tetani)		
MODULE 4:	**LABORATORY TECHNIQUES FOR CULTURE AND IDENTIFICATION OF BACTERIAL PATHOGENS**	**8 Hours**
Sample collection, transport, and culturing of clinical samples. Principles of different diagnostic tests (ELISA, immunofluorescence, agglutination-based tests, complement fixation, PCR, DNA probes).		

MODULE 5:	ANTIBIOTICS	10 Hours
Definition, classification of antibiotics based on their mechanism of action, side effects, drug interaction and allergic reactions. Mechanisms of action of antibiotics: Cell wall inhibitors (beta-lactams), Protein synthesis inhibitors (tetracyclines, macrolides), DNA synthesis inhibitors (quinolones), RNA synthesis inhibitors (rifamycins) Antibiotic Resistance: Overview of antibiotic resistance mechanisms, factors contributing to the emergence and spread of antibiotic resistance, strategies to combat antibiotic resistance (e.g., stewardship, combination therapy)		
TOTAL LECTURES		**45 Hours****

Books:

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition, McGraw Hill Publication
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology, 4 th edition. Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition, Pearson International Edition.
6. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
7. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.
8. SubbaRao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
9. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

BACTERIAL PATHOGENESIS (Practical)

Program: B. Sc. in Microbiology	**Year, Semester:** 3rd Yr., 6th Sem
Course Title: BACTERIAL PATHOGENESIS (Practical)	**Subject Code:** TIU-UMB-MJ-L32303
Contact Hours/Week: 0–0–1 (L–T–P)	**Credit: 1**

COURSE OBJECTIVE :

Enable the student to:

1. Understand the principles of bacterial identification through cultural, morphological, and biochemical tests, including IMViC, TSI, nitrate reduction, urease, and catalase assays.
2. Learn the composition, selective properties, and applications of differential media such as EMB agar, MacConkey agar, Mannitol salt agar, Deoxycholate citrate agar, and TCBS for bacterial differentiation
3. Develop hands-on skills in microbiological techniques, including skin swab sampling for bacterial flora analysis and antibacterial susceptibility testing using the Kirby-Bauer method
4. Gain proficiency in determining the Minimum Inhibitory Concentration (MIC) of antibiotics, interpreting results for bacterial resistance profiling, and understanding antimicrobial stewardship.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Identify laboratory strains of *E. coli*, *Salmonella*, *Pseudomonas*, *Staphylococcus*, and *Bacillus* based on cultural, morphological, and biochemical characteristics using tests such as IMViC, TSI, nitrate reduction, urease, and catalase assays.	K3
CO-2:	Explain the composition and applications of differential media such as EMB agar, MacConkey agar, Mannitol salt agar, Deoxycholate citrate agar, and TCBS for bacterial identification	K2
CO-3:	Analyze the bacterial flora of the skin using the swab method and interpret the presence and significance of commensal and potentially pathogenic bacteria	K4
CO-4:	Perform antibacterial susceptibility testing using the Kirby-Bauer disk diffusion method and interpret the results to determine bacterial resistance or susceptibility to antibiotics	K4
CO-5:	Determine the Minimum Inhibitory Concentration (MIC) of antibiotics against bacterial pathogens and evaluate their effectiveness in inhibiting bacterial growth	K5

CO-6:	Demonstrate proficiency in microbiological techniques for bacterial identification, differential media selection, and antimicrobial susceptibility testing, ensuring good laboratory practices and biosafety compliance	K5

COURSE CONTENT :

MODULE 1:	**DEVELOPMENT OF BACTERIAL CULTURE AND STUDY THE ANTIMICROBIAL ASSAYS**	**15 Hours**
1. Identify laboratory strains of *E. coli, Salmonella, Pseudomonas, Staphylococcus, Bacillus* (any three) on the basis of cultural, morphological and biochemical characteristics through IMViC test, growth on TSI and nitrate reduction, urease production and catalase tests (any two). 2. Study of composition and use of important differential media for identification of bacteria: EMB agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS 3. Study of bacterial flora of skin by swab method 4. Perform antibacterial sensitivity by Kirby-Bauer method 5. Determination of minimal inhibitory concentration (MIC) of an antibiotic.		
TOTAL LECTURES		**15 Hours****

PLANT BIOTECHNOLOGY (Theory)

Program: B. Sc. in Microbiology	**Year, Semester:** 3rd Yr., 6th Sem
Course Title: PLANT BIOTECHNOLOGY (Theory)	**Subject Code:** TIU-UBT-MI-T32202
Contact Hours/Week: 2–1–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

1. Understand the fundamentals of plant tissue culture and its applications in plant propagation.
2. Analyze the techniques and principles involved in plant genetic transformation.
3. Evaluate the role of biotechnology in developing genetically modified crops with improved traits.
4. Assess the ethical, legal, and social implications of plant biotechnology.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Understand the fundamentals of plant tissue culture and its applications	K1
CO-2:	Analyze techniques and principles of plant genetic transformation	K2
CO-3:	Evaluate the role of biotechnology in developing genetically modified crops	K5

CO-4:	Apply tissue culture techniques for plant propagation	K3
CO-5:	Assess the ethical, legal, and social implications of plant biotechnology	K5
CO-6:	Design experiments to investigate plant responses to biotechnological interventions	K6

COURSE CONTENT :

MODULE 1:	Introduction to Plant Biotechnology	**8 Hours**
Definition and scope of plant biotechnology History and development of plant biotechnology Applications in agriculture, horticulture, and forestry		
MODULE 2:	Plant Tissue Culture	**7 Hours**
Media preparation and sterilization techniques Callus induction and organogenesis Protoplast isolation and fusion Somatic embryogenesis		
MODULE 3:	Plant Genetic Transformation	**8 Hours**
Agrobacterium-mediated gene transfer Biolistic methods (gene gun) Selectable markers and reporter genes Regeneration of transgenic plants		
MODULE 4:	Genetically Modified Crops	**7 Hours**
Bt cotton and herbicide-resistant crops Golden rice and biofortified crops Transgenic crops for stress tolerance Regulatory aspects and biosafety concerns		
MODULE 5:	Applications of Plant Biotechnology	**8 Hours**
Production of secondary metabolites Somaclonal variation and its applications Cryopreservation of germplasm Molecular breeding techniques		
MODULE 6:	Ethical, Legal, and Social Implications	**7 Hours**
Intellectual Property Rights (IPR) in biotechnology Biosafety regulations and guidelines		

Public perception and acceptance of GMOs Ethical considerations in genetic modification	
TOTAL LECTURES	**45 Hours****

Books:

1. Plant Biotechnology and Genetics: Principles, Techniques, and Applications by C. Neal Stewart Jr.
2. Plant Tissue Culture: Techniques and Experiments by Roberta H. Smith
3. Plant Biotechnology: The Genetic Manipulation of Plants by Adrian Slater, Nigel W. Scott, and Mark R. Fowler
4. Principles of Plant Biotechnology by R. C. Dubey

PLANT BIOTECHNOLOGY (Practical)

Program: B. Sc. in Microbiology	**Year, Semester:** 3rd Yr., 6th Sem
Course Title: PLANT BIOTECHNOLOGY (Practical)	**Subject Code:** TIU-UBT-MI-L32202
Contact Hours/Week: 0–0–1 (L–T–P)	**Credit: 1**

COURSE OBJECTIVE :

Enable the student to:

1. To prepare Murashige and Skoog (MS) medium and perform surface sterilization of plant explants for tissue culture.
2. To establish and maintain in vitro cultures of various plant tissues, including shoot tips, nodal segments, and callus cultures.
3. To isolate plasmid DNA from bacterial cultures and perform restriction digestion and ligation for recombinant DNA experiments.
4. To prepare competent cells, transform them with recombinant plasmids, and confirm successful genetic modification through screening.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Demonstrate proficiency in preparing and sterilizing plant tissue	K3

	culture media	
CO-2:	Cultivate various plant tissues and organs using in vitro techniques	K3
CO-3:	Apply genetic transformation methods to produce genetically modified plants	K3
CO-4:	Analyze the production of secondary metabolites and their applications	K4
CO-5:	Implement conservation strategies for endangered plant species through tissue culture	K3
CO-6:	Evaluate the ethical, legal, and social issues related to plant biotechnology	K5

COURSE CONTENT :

MODULE 1:	**INVESTIGATING GENETIC TRANSFORMATION IN PLANTS: FROM TISSUE CULTURE TO MOLECULAR CONFIRMATION**	**15 Hours**

1. Preparation of MS Medium
Learn the composition and preparation of Murashige and Skoog (MS) medium for plant tissue culture.
2. Surface Sterilization and Inoculation
Demonstrate surface sterilization techniques and inoculate explants such as leaf and nodal segments from plants
3. Micropropagation Techniques
Cultivate shoot tip cultures
4. Callus Culture
Induce and maintain callus cultures from various plant tissues.
5. Isolation of Bacterial Plasmid DNA
Isolate plasmid DNA from bacterial cultures for genetic studies
6. Restriction Digestion and Ligation
Perform restriction digestion of DNA and ligate fragments for recombinant DNA experiments.
7. Competent Cell Preparation and Bacterial Transformation
Prepare competent cells and transform them with recombinant plasmids.
8. Confirmation of Transformation
Screen transformed colonies to confirm successful genetic modification
9. Genomic DNA Extraction from Plants
Extract genomic DNA from plant tissues for analysis.
10. Quantification of DNA
Quantify DNA using spectrophotometric methods and assess quality through agarose gel electrophoresis.

TOTAL LECTURES	**15 Hours****

Books:

1. Plant Biotechnology and Genetics: Principles, Techniques, and Applications by C. Neal Stewart Jr.

2. Plant Tissue Culture: Techniques and Experiments by Roberta H. Smith

3. Plant Biotechnology: The Genetic Manipulation of Plants by Adrian Slater, Nigel W. Scott, and Mark R. Fowler

4. Principles of Plant Biotechnology by R. C. Dubey

NANOTECHNOLOGY IN BIOLOGY (Theory)

Program: B. Sc. in Microbiology	**Year, Semester:** 3rd Yr., 6th Sem
Course Title: NANOTECHNOLOGY IN BIOLOGY (Theory)	**Subject Code:** TIU-UBT-MI-T32201
Contact Hours/Week: 2–1–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

1. Introduce foundational concepts in nanotechnology
2. Understand the synthesis, classification, and biointerface of nanomaterials
3. Familiarize students with tools, techniques, and characterization methods
4. Explore microbial contributions to nanotechnology and their applications
5. Evaluate current and emerging applications of nanotechnology in biology

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Define and explain fundamental concepts of nanotechnology and its interdisciplinary role in microbiology and biological sciences.	K2
CO-2:	Classify various nanomaterials and describe their synthesis methods, surface functionalization, and interactions with biomolecules.	K3
CO-3:	Analyze nanoparticle characterization data obtained from techniques like SEM, TEM, FTIR, DLS, and XRD.	K4
CO-4:	Evaluate the biosynthesis of nanoparticles by microbes and assess	K5

	their utility in antimicrobial activity, diagnostics, and bioremediation.	
CO-5:	Apply knowledge of nanotechnology for designing targeted drug delivery systems and smart nanocarriers with stimuli-responsive features.	K3
CO-6:	Discuss current and future applications of nanotechnology in diagnostics, therapeutics, and vaccine development, and critically examine ethical and safety issues.	K5

COURSE CONTENT :

MODULE 1:	**INTRODUCTION TO NANOTECHNOLOGY IN LIFE SCIENCES**	**5 Hours**
Definition, history, and scope of nanotechnology, Nanoscience and microbiology: Interdisciplinary linkages, Unique properties of nanomaterials: size, surface area, reactivity, Applications in biological systems and environmental microbiology		
MODULE 2:	**NANOMATERIALS AND THEIR BIOLOGICAL INTERFACES**	**7 Hours**
Classification: metal, metal oxide, carbon-based, polymeric, and lipid nanoparticles, Synthesis of nanoparticles: top-down and bottom-up approaches, Surface functionalization and bioconjugation, Nanoparticle interaction with biomolecules: proteins, DNA, membranes, Biosafety and nanotoxicity: cellular uptake and immune response		
MODULE 3:	**BIONANOTECHNOLOGY TOOLS AND TECHNIQUES**	**15 Hours**
Nanofabrication techniques: soft lithography, self-assembly, Characterization of nanomaterials: SEM, TEM, DLS, FTIR, XRD, AFM, Targeted drug delivery using nanoparticles, Smart nanocarriers: stimuli-responsive and controlled release systems		
MODULE 4:	**MICROBIAL NANOTECHNOLOGY**	**8 Hours**
Microbial synthesis of nanoparticles: role of bacteria, fungi, and algae, Applications of microbial nanomaterials in bioremediation and diagnostics, Antimicrobial nanomaterials and resistance modulation, Microbe-nanoparticle interactions in soil and aquatic environments.		
MODULE 5:	**APPLICATIONS AND EMERGING TRENDS**	**10 Hours**
Nano-enabled diagnostics: lateral flow assays, lab-on-chip devices, Cancer nanotherapeutics and nanoimaging, Nanovaccines and immune modulation, Ethical, regulatory, and safety issues in nanobiotechnology.		
TOTAL LECTURES		**45 Hours****

Books:

1. "Bionanotechnology: Concepts, Applications and Perspectives" by C.M. Niemeyer and C.A. Mirkin (Wiley-VCH)
2. "Bionanotechnology: Principles and Applications" by David S. Goodsell (Wiley-Blackwell)
3. "Nanobiotechnology: Bioinspired Devices and Materials of the Future" by Oded Shoseyov and Ilan Levy (Wiley-Blackwell)
4. "Nanotechnology in Biology and Medicine: Methods, Devices, and Applications" by Tuan Vo-Dinh (CRC Press)

NANOTECHNOLOGY IN BIOLOGY (Practical)

Program: B. Sc. in Microbiology	**Year, Semester:** 3rd Yr., 6th Sem
Course Title: NANOTECHNOLOGY IN BIOLOGY (Practical)	**Subject Code:** TIU-UBT-MI-L32201
Contact Hours/Week: 0–0–1 (L–T–P)	**Credit: 1**

COURSE OBJECTIVE :

Enable the student to:

1. To develop a fundamental understanding of nanoparticle synthesis techniques using both green and chemical methods for biological applications.
2. To equip students with hands-on skills in the characterization of nanoparticles, particularly through UV-Vis spectroscopy and interpretation of absorption spectra.
3. To train students in evaluating the antimicrobial efficacy of nanoparticles using standardized microbiological assays such as agar diffusion and MIC determination.

4. To foster laboratory proficiency in linking nanotechnology to microbiological outcomes, emphasizing safe, accurate, and reproducible experimental procedures.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Demonstrate the green synthesis of silver nanoparticles using plant extracts and explain the underlying principles.	K3
CO-2:	Perform chemical synthesis of gold nanoparticles and interpret the reaction process.	K3
CO-3:	Operate UV-Vis spectroscopy equipment to characterize nanoparticles and analyze the resulting spectra.	K4
CO-4:	Conduct antimicrobial activity assays using the agar diffusion method and interpret zones of inhibition.	K4
CO-5:	Determine the Minimum Inhibitory Concentration (MIC) for nanoparticles and evaluate their antimicrobial efficacy.	K5
CO-6:	Compare the effectiveness of green and chemically synthesized nanoparticles in microbial inhibition experiments.	K5

COURSE CONTENT :

MODULE 1:	**COMPARATIVE SYNTHESIS AND ANTIMICROBIAL EFFICACY OF NANOPARTICLES**	**15 Hours**
Green synthesis of silver nanoparticles using plant extracts, Chemical synthesis of gold nanoparticles, UV-Vis spectroscopy for nanoparticle characterization, Antimicrobial activity assay using agar diffusion method, Minimum Inhibitory Concentration (MIC) determination for nanoparticles.		
TOTAL LECTURES		**15 Hours****