TECHNO INDIA UNIVERSITY

WEST BENGAL

DEPARTMENT OF MICROBIOLOGY

SYLLABUS STRUCTURE AND COURSE DETAILS

w.e.f 2024-25

SEMESTER 7

FOR B.SC (HONS IN MICROBIOLOGY WITH RESEARCH)

INSTRUMENTATION AND BIOTECHNIQUES (Theory)

Program: B. Sc. in Microbiology	**Year, Semester:** 4th Yr., 7th Sem
Course Title: INSTRUMENTATION AND BIOTECHNIQUES (Theory)	**Subject Code:** TIU-UMB-MJ-T41401
Contact Hours/Week: 2–1–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

1. Understand the principles, methodologies, and applications of various chromatographic techniques, including paper chromatography, TLC, column chromatography, HPLC, and GLC, for biomolecular separation and analysis.
2. Gain knowledge of electrophoretic techniques such as SDS-PAGE, 2D gel electrophoresis, isoelectric focusing, and blotting methods, along with their applications in protein and nucleic acid analysis
3. Learn and apply the principles of spectrophotometry, including UV-Vis spectroscopy, fluorescence, and phosphorescence, for the characterization and quantification of biomolecules.
4. Develop proficiency in sedimentation and mass spectrometry techniques, including centrifugation methods, ultracentrifugation, MALDI-TOF, and ESI-MS, for molecular weight determination and proteomics applications.

COURSE OUTCOME :

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

CO-1:	To understand the importance, principle and types of microscopy techniques.	K2
CO-2:	To understand the importance, principle and types of chromatography, spectrophotometric, centrifugation & electrophoretic techniques and their role in the study of biological system.	K2
CO-3:	Basic understanding of Moments, Skewness, central tendency kurtosis by moments.	K1
CO-4:	Well versed in the concepts Probability and Probability Distribution along with its application	K3

CO-5:	Understand the Statistical Quality Control, Correlation and regression analysis.	K1
CO-6:	Good understanding and analytical knowledge in applying & testing of Hypothesis and Analysis of variance. and basic understanding of Moments, Skewness, central tendency kurtosis by moments.	K3

COURSE CONTENT :

MODULE 1:	**CHROMATOGRAPHY**	**7 Hours**
Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography, Column packing and fraction collection. Gel filtration chromatography, ion-exchange chromatography and affinity chromatography, GLC, HPLC		
MODULE 2:	**ELECTROPHORESIS**	**8 Hours**
Theory of electrophoresis: Moving boundary and zone electrophoresis, Principle and applications of native polyacrylamide gel electrophoresis, SDS- polyacrylamide gel electrophoresis, 2D gel electrophoresis, Isoelectric focusing, Zymogram preparation and Agarose gel electrophotresis, Gradient Electrophoresis, Immunooelectrophoresis, Instrumentation for Southern and Western Blot.		
MODULE 3:	**SPECTROPHOTOMETRY**	**10 Hours**
Interaction of Electromagnetic radiation with matter: scattering and absorption, Principles and applications of absorption spectra, Instrumentation of UV-Vis absorption spectrophotometer, Analysis of biomolecules using UV-Vis spectroscopy, Colorimetry and turbidometry, Introduction to emission spectroscopy: Fluorescence and Phosphorescence and their applications in biology.		
MODULE 4:	**SEDIMENTATION**	**10 Hours**
Principles of sedimentation: Boundary and Zone sedimentation; Factors affecting sedimentation velocity and sedimentation co-efficient Preparative and analytical centrifugation, RCF and sedimentation coefficient, determination of molecular weight from sedimentation, differential centrifugation, density gradient centrifugation and ultracentrifugation and their applications, eukaryotic cell fractionation.		
MODULE 5:	**MASS SPECTROMETRY**	**10 Hours**
Principles of mass spectrometry, m/z ratio, time of Flight analysis, MALDI and ESI Mass spectrometry, Mass spectrometry as an indispensible tool for Proteomics		
TOTAL LECTURES		**45 Hours****

Books:

1. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology, 7 th Edition, Cambridge University Press, 2010.
2. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5th Ed., W.H. Freeman and Company.
3. Willey MJ, Sherwood LM &Woolverton C J. (2013). Prescott, Harley and Klein's Microbiology. 9th Ed., McGraw Hill.
4. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
5. Cooper G.M. and Hausman R.E. (2009). The Cell: A Molecular Approach. 5th Edition, ASM Press & Sunderland, Washington D.C., Sinauer Associates, MA.
6. Nigam A and Ayyagari A. 2007. Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill.

INSTRUMENTATION AND BIOTECHNIQUES (Practical)

Program: B. Sc. in Microbiology	**Year, Semester:** 4th Yr., 7th Sem
Course Title: INSTRUMENTATION AND BIOTECHNIQUES (Practical)	**Subject Code:** TIU-UMB-MJ-L41401
Contact Hours/Week: 0–0–1 (L–T–P)	**Credit: 1**

COURSE OBJECTIVE :

Enable the student to:

1. Understand and apply chromatographic techniques such as paper and thin-layer chromatography for the separation and identification of amino acids.
2. Develop proficiency in gel filtration chromatography for the separation and analysis of proteins based on their size and molecular weight.
3. Gain hands-on experience in SDS-PAGE for determining the molecular weight of proteins and analyzing their electrophoretic mobility
4. Learn and perform spectrophotometric analysis by determining the λmax of an unknown sample and calculating its extinction coefficient for quantitative assessment.

COURSE OUTCOME :

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

CO-1:	Understand the basic on Mean, Median, Mode from Grouped and Ungrouped Data Sets	K2
CO-2:	Make a concept on Standard Deviation and Coefficient of Variation	K2
CO-3:	Understand the Curve Fitting, Correlation and Regression	K2
CO-4:	Make an idea on Testing of Hypothesis - t-test, Chi-Square Test	K1

CO-5:	Brief understanding on Fluorescent Microscopy, Electron Microscopy, Phase Contrast Microscopy, λmax and Extinction Coefficient	K2
CO-6:	Remember the Separation of Components Using Centrifugation and chromatographic techniques	K1

COURSE CONTENT :

MODULE 1:	**STUDY OF DIFFERENT SEPARATION TECHNIQUES AND QUANTIFICATION**	**15 Hours**
1. Separation of amino acids by paper / thin layer chromatography. 2. Separation of proteins by gel filtration chromatography 3. Determination of molecular weight of a protein by SDS-Polyacrylamide Gel Electrophoresis (PAGE). 4. Determination of λmax for an unknown sample and calculation of extinction coefficient		
TOTAL LECTURES		**15 Hours****

ESSENTIAL TOOLS IN BIOLOGICAL RESEARCH (Theory)

Program: B. Sc. in Microbiology	**Year, Semester:** 4th Yr., 7th Sem
Course Title: ESSENTIAL TOOLS IN BIOLOGICAL RESEARCH (Theory)	**Subject Code:** TIU-UMB-MJ-T41402
Contact Hours/Week: 2–1–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

1. Apply statistical methods in biological research, including hypothesis testing, probability distributions, and regression analysis, to analyze and interpret biological data effectively.
2. Utilize bioinformatics tools and databases for sequence alignment, phylogenetic tree construction, and retrieval of genomic and proteomic data to support biological research.
3. Understand biosafety principles and regulations, including risk assessment and management of GMOs, and comply with national and international biosafety guidelines.
4. Develop scientific documentation and presentation skills, including research writing, poster/oral presentation, and ethical considerations in scientific communication to prevent academic misconduct and plagiarism.

COURSE OUTCOME :

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

CO-1:	Apply statistical methods to analyze biological data, including measures	K4

	of central tendency, dispersion, hypothesis testing, correlation, regression, and ANOVA, using appropriate statistical software	
CO-2:	Utilize bioinformatics databases and tools to retrieve, analyze, and interpret biological sequence data,	K3
CO-3:	Evaluate biosafety guidelines and regulations, assess the risks associated with genetically modified organisms (GMOs) and living modified organisms (LMOs)	K3
CO-4:	Explain the principles of intellectual property rights (IPR), including patents, trademarks, copyrights, and geographical indications	K2
CO-5:	Develop effective oral and poster presentations to communicate biological research findings, and apply the principles of scientific writing to produce clear and concise research articles and reviews	K4
CO-6:	Demonstrate an understanding of ethical practices in scientific research, including the prevention of plagiarism and academic misconduct, and apply these principles in the documentation and presentation of biological data	K2

COURSE CONTENT :

MODULE 1:	**USE OF STATISTICS IN BIOLOGICAL RESEARCH**	**10 Hours**
Principles of statistical analysis of biological data. Scope of statistics: utility in biological research. Sampling parameters: Difference between sample and population, difference between parametric and non-parametric statistics; Sampling Distributions, Standard Error, Testing of Hypothesis, Level of Significance and Degree of Freedom; Measures of central tendency, Measures of dispersion; skewness, kurtosis; Elementary Probability and basic laws; Dependent and independent variables, Curve Fitting, Correlation and Regression. Mean and Variance of Discrete and Continuous Distributions: Binomial, Poisson, and Normal distribution. Large Sample Test based on Normal Distribution, Small sample test based on t-test, Z- test and F test; Confidence Interval; Distribution-free test - Chi-square test; ANOVA and its applications.		
MODULE 2:	**FUNDAMENTALS OF BIOINFORMATICS**	**10 Hours**
Sequence Alignments, Phylogeny and Phylogenetic trees Local and Global Sequence alignment, pairwise and multiple sequence alignment. Scoring an alignment, scoring matrices, PAM & BLOSUM series of matrices Types of phylogenetic trees, Different approaches of phylogenetic tree construction - UPGMA, Neighbour joining, Maximum Parsomony, Maximum likelihood. Types of biological databases: - Genome databases, Protein sequence and structure databases, gene expression databases, Database of metabolic pathways, Indexing databases and Citation databases, retrieval and handling of data from Biological databases.		

MODULE 3:	PRINCIPLES OF BIOSAFETY	10 Hours
Biosafety guidelines and regulations (National and International); GMOs LMOs- Concens and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC ete. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of International Agreements - Cartagena Protocol.		
MODULE 4:	**INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS**	**7 Hours**
Patents, Types, Trademarks, Copyright & Related Rights, Industrial Design and Rights, Traditional Knowledge, Geographical Indications- importance of IPR - patentable and non patentables - patenting life - legal protection of biotechnological inventions World Intellectual Property Rights Organization (WIPO)		
MODULE 5:	**DOCUMENTATION AND PRESENTATION OF BIOLOGICAL DATA**	**8 Hours**
Application of microbes in different areas of everyday use and research.The art of making presentations for oral and poster sessions in seminars/conferences/scientific meets. The art of scientific writing: numbers, units, abbreviations and nomenclature used in scientific writing. Types of scientific writings: Original Research articles, Short communications, Perspectives, Review/mini-reviews, Introduction to Academic misconduct/ plagiarism, development of practices to avoid plagiarism (including self-plagiarism)		
TOTAL LECTURES		**45 Hours****

Books:

1. Wilson and Walker's Principles and Techniques of Biochemistry And Molecular Biology Edited by Andreas Hofmann , Samuel Clokie First published 2018
2. Biostatistics & Research Methodology: G Nageswara Rao PharmaMed Press, 2018
3. Research Methodology for Biological science, Gurumani, N, MJP Publishers, 2020
4. Introduction to Biostatistics, Pranab K. Banerjee, S. Chand Publication, 2007
5. IPR, Biosafety And Bioethics 2013 Edition by Goel, Pearson

ESSENTIAL TOOLS IN BIOLOGICAL RESEARCH (Practical)

Program: B. Sc. in Microbiology	**Year, Semester:** 4th Yr., 7th Sem
Course Title: ESSENTIAL TOOLS IN BIOLOGICAL RESEARCH (Practical)	**Subject Code:** TIU-UMB-MJ-L41402
Contact Hours/Week: 0–0–1 (L–T–P)	**Credit: 1**

COURSE OBJECTIVE :

Enable the student to:

1. Understand fundamental bioinformatics tools and statistical approaches used in biological research for data analysis and interpretation.
2. Explain key principles and applications of bioinformatics and statistical methods in processing biological datasets.
3. Apply computational and statistical techniques to analyze biological data, identify patterns, and establish meaningful relationships.
4. Develop research-based problem-solving skills by integrating bioinformatics tools and statistical approaches to address biological questions effectively

COURSE OUTCOME :

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

CO-1:	Recall fundamental bioinformatics tools and statistical approaches used in biological research.	K1
CO-2:	Explain the principles and applications of bioinformatics in analyzing biological data.	K3
CO-3:	Apply bioinformatics tools and statistical methods to process and interpret biological datasets.	K4
CO-4:	Analyze biological data using computational approaches to identify patterns, relationships, and trends.	K3
CO-5:	Design a research project incorporating bioinformatics tools and statistical approaches to address a specific biological question.	K5
CO-6:	Interpret the results obtained from bioinformatics analyses and statistical tests to derive meaningful biological conclusions.	K6

COURSE CONTENT :

MODULE 1:	**DEVELOPMENT OF MICROBIAL CULTURE AND OBSERVATION**	**15 Hours**
Students will have to submit a project by using bioinformatic tools and statistical approaches on any aspect of biology. The project will be evaluated by the teachers of the college where the student is enrolled.		
TOTAL LECTURES		**15 Hours****

MEDICAL BIOTECHNOLOGY (Theory)

Program: B. Sc. in Microbiology	**Year, Semester:** 4th Yr., 7th Sem
Course Title: Medical Biotechnology (Theory)	**Subject Code:** TIU-UMB-MJ-T41403

Contact Hours/Week: 2–1–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

1. Understand the principles and advancements in vaccine development including different vaccine types, adjuvants, and novel vaccine technologies for infectious diseases.
2. Explain the molecular mechanisms of cancer progression including oncogenes, tumor suppressor genes, metastasis, and emerging cancer therapies.
3. Analyze gene therapy strategies and vector systems for genetic disease treatment, distinguishing between viral and non-viral delivery methods
4. Explore cell culture techniques and genetic engineering tools such as CRISPR, TALEN, and ZFN for therapeutic applications in biotechnology and medicine.

COURSE OUTCOME :

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

CO-1:	Understand the Concept of Vaccine Development and Immunological Assays	K1
CO-2:	Be able to explore the concept of Cancer and cancer-mediated therapy	K2
CO-3:	Make understanding of Gene Therapy and therapeutic approaches	K1
CO-4:	Define the process of Cell Culture techniques and application on biomedical research	K3
CO-5:	Demonstrate the Gene Editing process and application	K2
CO-6:	Illustrate the multigenetic approaches and editing techniques followed by by applying on current need	K4

COURSE CONTENT :

MODULE 1:	**VACCINE DEVELOPMENT**	**10 Hours**
Active and passive immunization; Live, killed, attenuated, sub unit vaccines; Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein-based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines; Antibody genes and antibody engineering- chimeric and hybrid monoclonal antibodies; Transfusion of immunocompetent cells, Stem cell therapy; Cell based vaccines. Introduction to immunodiagnostics – RIA, ELISA. New approaches for vaccine delivery; Engineering virus vectors for vaccination; Vaccines for specific targets; Tuberculosis Vaccine; Malaria Vaccine; HIV vaccine		
MODULE 2:	**CANCER**	**10 Hours**
Regulation of cell cycle, mutations that cause changes in signal molecules, effects on receptor, signal switches, tumour suppressor genes, modulation of cell cycle in cancer, and different forms of cancers. Origin and Terminology, Oncogenes and Cancer Induction,		

Proto-Oncogenes and Oncogene, Metastasis and Malignant Transformation of Cells Cancer. Growth factors related to transformation. Telomerases. Detection using biochemical assays and tumor markers. Different forms of therapy, chemotherapy, radiation therapy, detection of cancers, prediction of aggressiveness of cancer, advances in cancer detection. Use of signal targets towards therapy of cancer		
MODULE 3:	**GENE THERAPY**	**7 Hours**
Somatic cell gene therapy and germline therapy, ex vivo and in vivo therapies; vectors used in gene therapy: viral vector: retroviruses, adenoviruses, adeno-associated viruses, lentiviruses; non-viral vector: naked DNA, polymersomes, polyplexes		
MODULE 4:	**CELL CULTURE**	**10 Hours**
Introduction, cell culture laboratory-design, layout and maintenance. Equipment and Instrumentation. Methods of sterilization, types of culture media, composition, preparation and metabolic functions. Role of CO2, Serum, supplements, growth factors (EGF, PDGF). Serum and protein free defined media. Culture and maintenance of primary and established cell lines. Biology of cultured cells and culture environment, cell adhesion, cell proliferation and differentiation. Characterization of cultured cells, viability, cytotoxicity, growth parameters, cell death and Apoptosis. Expression of culture efficiency.		
MODULE 5:	**GENE EDITING**	**8 Hours**
Introduction to genetics and genetic engineering; RNA interference, limitations of genetic engineering; Genome engineering using Zinc Finger Nuclease (ZFN) Technology; Transcription activator-like effector nuclease (TALEN) Technology; Clustered regularly interspaced short palindromic repeats (CRISPR)/Cas9 technology: target identification, gRNA design, donor design, Applications in treating human diseases: Human cell engineering-Thalassemia, SCID, Hemophilia, etc; Disease modeling-Cancer, iPSc and animal models; Engineered immune cells for cancer therapy.		
TOTAL LECTURES		**45 Hours****

Books:

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.
2. Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002.
3. Watson J.D.et al. Molecular Biology of Gene (6th Ed.) Publisher Benjamin Cummings, 2007.
4. Glick, B.R. and Pasternak J.J. Molecular Biotechnology.ASM Press, Washington DC, 2003.
5. Weinberg, R.A. "The Biology of Cancer" Garland Science, 2007
6. McDonald, F etal., " Molecular Biology of Cancer" IInd Edition. Taylor & Francis, 2004

MEDICAL BIOTECHNOLOGY (Practical)

Program: B. Sc. in Microbiology	**Year, Semester:** 4th Yr., 7th Sem
Course Title: MEDICAL BIOTECHNOLOGY (Practical)	**Subject Code:** TIU-UMB-MJ-L41403
Contact Hours/Week: 0–0–1 (L–T–P)	**Credit: 1**

COURSE OBJECTIVE :

Enable the student to:

1. Demonstrate comprehensive knowledge of cell culture principles and safety practices through the development and delivery of informative PowerPoint presentations.
2. Analyze and document the operational procedures and equipment observed during a tissue culture laboratory visit, relating practical experiences to theoretical knowledge.
3. Critically evaluate and synthesize information from scientific literature on cancer-related topics, producing well-structured and concise short reviews.
4. Apply effective communication skills in both oral (PowerPoint presentation) and written (short review) formats to convey scientific information clearly and accurately.

COURSE OUTCOME :

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

CO-1:	Recall the fundamental safety aspects, types of cell cultures, and protocols involved in cell culture techniques.	K1
CO-2:	Explain the process of cell line sourcing and commonly used methods for cell culture through PowerPoint presentations.	K2
CO-3:	Demonstrate practical exposure to tissue culture techniques by visiting a tissue culture laboratory and documenting observations.	K3
CO-4:	Analyze research articles on cancer-related topics to extract key findings and summarize critical insights.	K4
CO-5:	Evaluate the significance of cell culture methodologies and their applications in cancer research and biotechnology.	K5
CO-6:	Create a well-structured short review paper on a cancer-related topic, demonstrating their ability to synthesize information from scientific literature	K6

COURSE CONTENT :

MODULE 1:	**DEVELOPMENT OF MICROBIAL CULTURE AND**	**15 Hours**

	OBSERVATION	
Evaluation will be done internally on short review and PowerPoint presentation. 1. PowerPoint presentations on Safety aspects of cell culture, cell types and culture, knowledge about cell line sourcing, and common methods and protocols for cell culture. 2. Visit a tissue culture laboratory for exposure. 3. Submission of a short review on any cancer-related topic to expose the students on how to review journal papers and make a comprehensive summary.		
TOTAL LECTURES		**15 Hours****

DISSERTATION/ RESEARCH WORK

Program: B. Sc. in Microbiology	**Year, Semester:** 4th Yr., 7th Sem
Course Title: DISSERTATION/ RESEARCH WORK	**Subject Code:** TIU-UMB-SEC-D4101
Contact Hours/Week: 0–0–4 (L–T–P)	**Credit: 4**

COURSE OBJECTIVE :

Enable the student to:

1. To develop independent research skills by identifying a relevant research problem, formulating hypotheses, and designing a structured study.

2. To enhance critical thinking and analytical abilities by reviewing scientific literature, selecting appropriate methodologies, and interpreting data effectively.

3. To foster proficiency in scientific writing and documentation by preparing a well-structured dissertation that follows academic and ethical standards.

4. To cultivate technical and experimental competencies by applying laboratory techniques, statistical analysis, or computational tools relevant to the chosen research area.

5. To improve presentation and communication skills by effectively defending research findings through oral presentations, reports, and publications.

COURSE OUTCOME :

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

CO-1:	**Identify and formulate a research problem** by conducting a comprehensive literature review and defining research objectives.	K1

CO-2:	**Apply appropriate research methodologies** to design experiments, collect data, and utilize relevant analytical tools for data interpretation.	K3
CO-3:	**Critically analyze and synthesize scientific findings** to draw meaningful conclusions and contribute to existing knowledge in the chosen field.	K4
CO-4:	**Demonstrate proficiency in scientific writing and reporting** by structuring a well-documented dissertation following ethical and academic guidelines.	K6
CO-5:	**Present and defend research findings** effectively through oral presentations, seminars, or viva-voce, using appropriate communication skills.	K5
CO-6:	**Remember problem-solving and decision-making skills** by addressing research challenges, troubleshooting experimental errors, and proposing future research directions.	K1

FOR B.SC (HONS IN MICROBIOLOGY WITHOUT RESEARCH)

MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT (Theory)

Program: B. Sc. in Microbiology	**Year, Semester:** 4th Yr., 7th Sem
Course Title: MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT(Theory)	**Subject Code:** TIU-UMB-MJ-T41404
Contact Hours/Week: 2–1–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

1. Explain the role of soil microorganisms in nutrient cycling and soil health, and analyze the impact of sustainable farming practices on soil microbial communities.
2. Describe the processes of mineralization of organic and inorganic matter in soil by microorganisms and evaluate the production and control of greenhouse gases from agricultural soils.
3. Apply the principles of secondary agricultural biotechnology to the production of biotech feed, silage, bio-manure, biogas, and biofuels, and assess their advantages and processing parameters
4. Evaluate the benefits and risks associated with genetically modified (GM) crops, including pest and disease resistance, safety considerations, and public perception, using examples such as Bt crops, golden rice, and rainbow papaya.

COURSE OUTCOME :

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

CO-1:	Describe the significance of agriculture in food production and the need for sustainable farming practices.	K1
CO-2:	Explain the microbial diversity in soil, their role in soil formation, and their distribution across different soil profiles.	K2
CO-3:	Illustrate the process of mineralization of organic and inorganic matter in soil, including cellulose, lignin, phosphates, and nitrates.	K3
CO-4:	Analyze the microbial activity in soil and its impact on greenhouse gas emissions such as carbon dioxide, methane, and nitrous oxide.	K4
CO-5:	Evaluate the role of biotechnology in secondary agriculture, including the production and advantages of biotech feed, bio-manure, and biofuels.	K5
CO-6:	Critically assess the benefits, risks, and public perceptions of genetically modified (GM) crops, with examples like Bt crops, golden rice, and rainbow papaya.	K6

COURSE CONTENT:

MODULE 1:	**INTRODUCTION TO AGRICULTURE AND SUSTAINABLE FARMING PRACTICES**	**8 Hours**
An overview of agriculture, its significance in food production, and the need for sustainable farming practices.		
MODULE 2:	**SOIL MICROBIOLOGY**	**7 Hours**
Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil		

MODULE 3:	**MINERALIZATION OF ORGANIC & INORGANIC MATTER IN SOIL**	**8 Hours**
Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium		
MODULE 4:	**MICROBIAL ACTIVITY IN SOIL AND GREENHOUSE GASES**	**7 Hours**
Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control		
MODULE 5:	**SECONDARY AGRICULTURE BIOTECHNOLOGY**	**8 Hours**
Biotech feed, Silage, Bio manure, biogas, biofuels – advantages and processing parameters		
MODULE 6:	**GM CROPS**	**7 Hours**
Benefits, pest and disease resistance, safety, public perception and debate, examples-Bt crops, golden rice, rainbow papaya.		
TOTAL LECTURES		**45 Hours****

Books:

1. Agrios GN. (2006). Plant Pathology.5th edition. Academic press, San Diego,
2. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.
3. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,
4. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4 th edition. Benjamin/Cummings Science Publishing, USA
5. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
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. Altman A (1998). Agriculture Biotechnology, Ist edition, Marcel Decker Inc.
10. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.
11. Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, Scientific Publishers.
12. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG

MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT (Practical)

Program: B. Sc. in Microbiology	**Year, Semester:** 4th Yr., 7th Sem
Course Title: MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT (Practical)	**Subject Code:** TIU-UMB-MJ-L41404
Contact Hours/Week: 0–0–1 (L–T–P)	**Credit: 1**

COURSE OBJECTIVE :

Enable the student to:

1. Understand the role and mechanisms of plant growth-promoting rhizobacteria (PGPR) in enhancing plant growth through nitrogen fixation, siderophore production, and phosphate solubilization.
2. Apply microbiological techniques to isolate and characterize PGPR from soil and plant roots, evaluating their efficiency based on biochemical and physiological traits
3. Analyze the potential applications of PGPR in sustainable agriculture, suggesting practical uses based on the characterization of different rhizobacterial strains.

COURSE OUTCOME :

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

CO-1:	Recall the concept of plant growth-promoting rhizobacteria (PGPR) and their role in enhancing plant growth.	K1
CO-2:	Describe the mechanisms by which PGPR contribute to nitrogen fixation, siderophore production, and phosphate solubilization.	K2
CO-3:	Demonstrate the isolation techniques for PGPR from soil and plant roots using appropriate microbiological methods.	K3
CO-4:	Compare the efficiency of different PGPR strains based on their biochemical and physiological characteristics.	K3
CO-5:	Design an experimental approach to assess the plant growth-promoting potential of different rhizobacterial isolates.	K4
CO-6:	Interpret the results obtained from PGPR characterization and suggest potential applications in sustainable agriculture.	K5

COURSE CONTENT :

MODULE 1:	**RHIZOBACTERIAL ISOLATES: NITROGEN FIXATION, SIDEROPHORE, AND PHOSPHATE SOLUBILIZATION**	**15 Hours**
Isolation of plant growth promoting rhizobacteria-characterize by nitrogen fixing, siderophore production and phosphate solubilization potential.		
TOTAL LECTURES		**15 Hours****