TECHNO INDIA UNIVERSITY

WEST BENGAL

Curriculum for 2-year M.Sc in Microbiology

Department of Microbiology

Techno India University, West Bengal

EM-4, EM Block, Sector V, Bidhannagar, Kolkata, West Bengal 700091

Course Curriculum For All Semester

SEMESTER 1

Department of Microbiology, General Microbiology (Theory)

Program: M. Sc. in Microbiology	**Year, Semester:** 1st Yr., 1st Sem
Course Title: General Microbiology (Theory)	**Subject Code:** TIU-PMB-T101
Contact Hours/Week: 2–1–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

1. To introduce the historical development of microbiology
2. To classify and understand various microorganisms
3. To explore microbial interactions with pollutants, water, and environmental contaminants

COURSE OUTCOME :

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

CO-1:	Describe the historical development of microbiology	K1
CO-2:	Explain the classification and nomenclature of microorganisms	K2
CO-3:	Analyze the impact of environmental factors	K4
CO-4:	Evaluate microbial roles in water microbiology	K5
CO-5:	Assess the significance of marine microbes	K5
CO-6:	Develop biotechnological solutions using microbes	K6

COURSE CONTENT :

MODULE 1:	**HISTORY OF MICROBIOLOGY**	**3 Hours**
History of microbiology		
MODULE 2:	**CLASSIFICATION**	**6 Hours**
Nomenclature and classification of microorganisms. General account of Cyanobacteria		
MODULE 3:	**Extremophile**	**6Hours**
Anaerobes, halophiles, acidophile, alkalophile, tharmophile, barophile; Community structure and organization. Effect of heavy metal and xenobiotic substances on microbes; biological magnification of toxic substances.		
MODULE 4:	**Aeromicrobiology**	**6 Hours**
Microbes of indoor and outdoor environment, pathways, enumeration, Extramural and intramural, control, bioterrorism. Eutrophication, Biosafety.		
MODULE 5:	**Water microbiology**	**6 Hours**
Significance of microbes in water quality. Test for portability of water. Microbial treatment of sewage; application of wastewater in land; composting of biosolids and domestic solid waste.		
MODULE 6:	**Marine microbes**	**6 Hours**
Marine microbes and their applications.		
MODULE 7:	**Pollutants**	**6 Hours**
Microorganism and metal pollutants; biodegradation of TNT, PCB; Bioremediation: bioventing, biofiltration, bioaugmentation, problems and advantages.		
MODULE 8:	**Bioleaching**	**6 Hours**
Bioleaching: mineral extraction, oil recovery.		
TOTAL LECTURES		**45 Hours****

CO-PO-PSO MAPPING:

CO \ PO / PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	–	–	–	2	–	–	–	3	2	–
CO2	3	2	–	–	2	–	–	–	3	3	–
CO3	3	3	2	3	–	–	2	–	3	3	2
CO4	3	3	2	3	–	–	2	–	3	3	3
CO5	3	3	2	3	–	–	2	–	3	3	3
CO6	3	3	3	3	3	2	2	3	3	3	3

'3' – Strongly correlated; '2' – Moderately correlated; '1' – Slightly correlated; ' - ' Not applicable

Books:

1. Topley and Wilson's Principles of Bacteriology; Virology; and Immunity
2. Graham Wilson, Williams & Wilkins, 7th edition (December 1983) Pelzer Microbiology
3. Prescott Microbiology

Department of Microbiology, Bacterial physiology (Theory)

Program: M. Sc. in Microbiology	**Year, Semester:** 1st Yr., 1st Sem
Course Title: Bacterial physiology (Theory)	**Subject Code:** TIU-PMB-T113
Contact Hours/Week: 2–1–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

1. To provide fundamental knowledge of bacterial characterization
2. To develop an understanding of bacterial cultivation techniques
3. To explore bacterial cell division mechanisms, ultra-structural features, and biosynthesis pathways

COURSE OUTCOME :

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

CO-1:	Identify and describe bacterial characteristics	K1
CO-2:	Differentiate bacterial growth requirements	K2
CO-3:	Demonstrate cultivation techniques	K3
CO-4:	Analyze growth kinetics and cell division strategies	K4
CO-5:	Evaluate bacterial cell structures	K5
CO-6:	Design experimental approaches	K6

COURSE CONTENT :

MODULE 1:	**Characterization of bacteria**	**9 Hours**
Characterization of bacteria: (i) morphological: shape, Gram stain, endo-spore stain, capsule stain, acid-fast stain, flagella stain; (ii) cultural: growth in different carbon sources (media); (iii) biochemical test: catalase, peroxidase, nitrate reduction, fermentation of sugar.		
MODULE 2:	**Cultivation of bacteria**	**9 Hours**
Cultivation of bacteria: aerobic, anaerobic, and facultative. Pure culture and its characteristics. Nutritional types. Enrichment culture technique for specific bacterial types: endospore forming, nitrogen fixing, nitrifying, starch degrading, cellulose degrading, casein degrading, phosphate solubilizing. Unculturable and culturable bacteria- conventional, metagenomic approaches.		
MODULE 3:	**Strategies of cell division**	**9 Hours**
Strategies of cell division, growth kinetics, generation time, asynchronous, synchronous, batch, continuous culture, measurement of growth, and factors affecting growth. Mechanism of cell division.		
MODULE 4:	**Ultra-structure of bacteria**	**9 Hours**
Ultra-structure of bacteria: cytoplasmic and outer membrane, capsule, flagella, pilli, endospore, and special organelle. Gram-negative, Gram-positive, and acid-fast bacteria. Wall-deficient organisms, including L-form		
MODULE 5:	**Cell wall**	**9 Hours**
Cell wall synthesis, flagellar synthesis.		
TOTAL LECTURES		**45 Hours****

CO-PO-PSO MAPPING:

CO \ PO / PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	–	–	2	–	–	–	3	2	–
CO2	3	3	–	2	–	–	–	–	3	3	–
CO3	3	3	2	3	2	–	–	2	3	3	3

CO4	3	3	2	3	–	–	–	2	3	3	2
CO5	3	2	–	2	–	–	–	–	3	2	2
CO6	3	3	3	3	3	2	2	3	3	3	3

'3' – Strongly correlated; '2' – Moderately correlated; '1' – Slightly correlated; ' - ' Not applicable

Books:

1. Topley and Wilson's Principles of Bacteriology; Virology; and Immunity
2. Graham Wilson, Williams & Wilkins, 7th edition (December 1983) Pelzer Microbiology
3. Prescott Microbiology

Department of Microbiology, Phycology, Mycology and Virology (Theory)

Program: M. Sc. in Microbiology	**Year, Semester:** 1st Yr., 1st Sem
Course Title: Phycology, Mycology and Virology (Theory)	**Subject Code:** TIU-PMB-T115
Contact Hours/Week: 2–1–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

1. Understanding Microbial Diversity and Applications
2. Pathological and Industrial Significance
3. Advanced Microbial Interactions and Biocontrol

COURSE OUTCOME :

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

CO-1:	Comprehend Microbial Diversity.	K2
CO-2:	Analyze Beneficial Roles of Microorganisms	K4
CO-3:	Understand Microbial Pathogenesis	K2

CO-4:	Apply Disease Control Strategies	K3
CO-5:	Explore Special Microorganisms and Symbiosis	K5
CO-6:	Develop Research and Practical Skills	K5

COURSE CONTENT :

MODULE 1:	**Algae**	**11 Hours**
General account of algae, types of algae, Beneficial role of algae and pathologically important algae in bacteria, plant and animal, Anti algal agent.		
MODULE 2:	**Fungi**	**11 Hours**
General account of fungi, types of fungi, beneficial role of fungi and pathologically important fungi in bacteria, plant and animal, Antifungal agent		
MODULE 3:	**Virus**	**11 Hours**
General account of Virus, types of Virus, Beneficial role of Virus-Phage Therapy and pathologically important virus in bacteria, plant and animal, Antiviral agent		
MODULE 4:	**Special microorganism**	**12 Hours**
Mycorrhiza, Lichen, Virion, Viroid, prion		
TOTAL LECTURES		**45 Hours****

CO-PO-PSO MAPPING:

CO \ PO / PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	–	–	2	–	–	–	3	2	–
CO2	3	3	2	2	2	–	2	–	3	3	2
CO3	3	3	–	2	2	–	2	–	3	3	2
CO4	3	3	2	3	2	–	3	2	3	3	3

CO5	3	2	2	2	–	–	2	–	3	2	2
CO6	3	3	3	3	3	2	2	3	3	3	3

'3' – Strongly correlated; '2' – Moderately correlated; '1' – Slightly correlated; ' - ' Not applicable

Books:

1. Arora, D.R. and Brij Bala Arora. Medical Mycology. New Delhi: CBS Publishers, 2013.
2. Alexopolous, J. and W. M. Charles. 1988. Introduction to Mycology. Wiley Eastern,New Delhi.
3. Mckane, L. and K. Judy.1996. Microbiology–Essentials and Applications. McGraw Hill,NewYork.
4. Pandey, B. P. 2001. College Botany, Vol. I: Algae, Fungi, Lichens, Bacteria, Viruses, Plant Pathology, Industrial Microbiology and Bryophyta. S. Chand & Company Ltd, New Delhi.
5. Pandey, B. P.2007. Botany for Degree Students: Diversity of Microbes, Cryptogams, Cell Biology and Genetics. S. Chand & Company Ltd, New Delhi.
6. Sambamurthy, A. V. S. S.2006. A Textbook of Plant Pathology. I.K. International Pvt. Ltd., New Delhi.
7. Sambamurthy, A. V. S. S.2006. A Textbook of Algae. I. K. International Pvt. Ltd., New Delhi. Sharma, O. P.1992. Textbook of Thallophyta. McGraw Hill Publihing Co., New Delhi.

Department of Microbiology, Biochemistry (Theory)

Program: M. Sc. in Microbiology	**Year, Semester:** 1st Yr., 1st Sem
Course Title: Phycology, Mycology and Virology (Theory)	**Subject Code:** TIU-PMB-T107
Contact Hours/Week: 2–1–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

1. Understand the Fundamentals of Biochemistry
2. Explore Biomolecular Composition and Functions
3. Develop Insights into Bioenergetics and Enzyme Kinetics

COURSE OUTCOME :

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

CO-1:	Explain the Fundamental Principles of Biochemistry	K2
CO-2:	Analyze the Properties and Functions of Biomolecules	K4
CO-3:	Apply Biophysical and Chemical Principles in Biological Processes	K3
CO-4:	Evaluate Enzyme Mechanisms and Kinetics	K5
CO-5:	Illustrate Energy Metabolism and Bioenergetics Pathways	K6
CO-6:	Demonstrate Problem-Solving Skills in Biochemistry	K3

COURSE CONTENT :

MODULE 1:	**Atoms**	**7 Hours**
Structure of atoms, molecules and chemical bonds.		
MODULE 2:	**Principles of Biophysical Chemistry**	**7 Hours**
Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties)		
MODULE 3:	**Biomolecules**	**7 Hours**
Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins)		
MODULE 4:	**Stabilizing Interactions**	**7 Hours**
Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.).		
MODULE 5:	**Stabilizing Interactions**	**7 Hours**

Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes	
MODULE 6: Stabilizing Interactions	**10 Hours**
Bioenergetics, glycolysis, TCA, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers	
TOTAL LECTURES	**45 Hours****

CO-PO-PSO MAPPING:

CO \ PO / PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	–	–	2	–	–	–	3	2	–
CO2	3	3	–	2	–	–	–	–	3	3	–
CO3	3	3	2	3	2	–	–	–	3	3	2
CO4	3	3	2	3	–	–	–	–	3	3	2
CO5	3	3	2	2	–	–	–	–	3	3	2
CO6	3	3	3	3	3	2	2	3	3	3	3

'3' – Strongly correlated; '2' – Moderately correlated; '1' – Slightly correlated; ' - ' Not applicable

Books:

1. Cell (A Molecular approach): Cooper, G. M.
2. Cell and Molecular Biology (1996) Karp, G.
3. Cell and Molecular Biology: deRobertis and deRobertis
4. Principle of Biochemistry: Leninger , A. L.
5. Biochemistry (1995) Lubert Stryer

Department of Microbiology, Biophysics and Instrumentation (Theory)

Program: M. Sc. in Microbiology	**Year, Semester:** 1st Yr., 1st Sem
Course Title: Biophysics and Instrumentation (Theory)	**Subject Code:** TIU-PMB-T109
Contact Hours/Week: 2–1–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

1. To introduce the fundamental principles and applications of microscopy
2. To explore molecular analysis techniques
3. To provide knowledge on separation techniques

COURSE OUTCOME :

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

CO-1:	Describe the principles and applications of different microscopy techniques	K1
CO-2:	Explain molecular analysis techniques	K2
CO-3:	Demonstrate the working principles of chromatography methods	K3
CO-4:	Analyze biomolecular structures using advanced techniques	K4
CO-5:	Evaluate electrophoresis techniques for biomolecular separation	K5
CO-6:	Develop experimental protocols using chromatography and electrophoresis	K6

COURSE CONTENT :

MODULE 1:	**Microscopy**	**11 Hours**
Microscopy: Principle and applications of light, phase contrast and fluorescence, Electron microscopy -scanning, transmission, confocal, atomic force microscope. Methods of sample processing for EM		
MODULE 2:	**Molecular Analysis**	**11 Hours**

Molecular analysis using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy Molecular structure determination using X-ray diffraction and NMR, Molecular analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods		
MODULE 3:	**Chromatography**	**11 Hours**
Chromatography- TLC, ion exchange, affinity, reverse phase, gel filtration. Principle and application of High Performance Liquid Chromatography, Fast protein liquid chromatography, ELISA-Reader, Autoanalyzer, FACS		
MODULE 4:	**Electrophoresis**	**12 Hours**
Electrophoresis – principle, paper, gel, SDS PAGE.		
TOTAL LECTURES		**45 Hours****

CO-PO-PSO MAPPING:

CO \ PO / PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	–	2	2	–	–	–	3	2	–
CO2	3	3	2	2	2	–	–	–	3	3	2
CO3	3	2	2	2	2	–	–	–	3	2	2
CO4	3	3	2	3	–	–	–	–	3	3	2
CO5	3	3	2	2	–	–	–	–	3	3	2
CO6	3	3	3	3	3	2	2	3	3	3	3

'3' – Strongly correlated; '2' – Moderately correlated; '1' – Slightly correlated; ' - ' Not applicable

Books:

1. Bioanalytical Chemistry (Susan R. Mikkelsen and Eduardo Cortón; Wiley-Interscience; 2004; ISBN 0-471-54447-7
2. Biophysical Chemistry- Friedfielder
3. Spectrometric Identification of Organic compounds by R M Silverstein and F X Webster; Sixth edition (2002)
4. Introduction to Spectroscopy by D Pavia; G Lampman; G Kriz; Second edition (1996)

Department of Microbiology, Career Advancement and Skill Development

Program: M. Sc. in Microbiology	**Year, Semester:** 1st Yr., 1st Sem
Course Title: Career Advancement Skill Development (CASD)	**Subject Code:** TIU-PEN-S101
Contact Hours/Week: 2–1–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

1. Develop Effective Communication Skills
2. Enhance Linguistic Proficiency
3. Improve Professional and Academic Writing

COURSE OUTCOME :

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

CO-1:	Explain fundamental concepts of communication	K1
CO-2:	Analyze the role of language in communication	K4
CO-3:	Use appropriate language in different contexts	K3
CO-4:	Demonstrate proficiency in professional writing	K6
CO-5:	Evaluate different writing styles	K5
CO-6:	Enhance clarity and coherence in writing	K3

COURSE CONTENT :

MODULE 1:	**Concepts**	**17 Hours**
Concepts in Communication: Communication as sharing; context of communication; the speaker/writer and the listener/reader; medium of communication; barriers to communication; accuracy, brevity, clarity and appropriateness in communication, Non-verbal skills, Paralanguage and Body language		
MODULE 2:	**Semantics**	**14 Hours**

Semantics: A selected list of Synonyms, Antonyms, Homophones and Homonyms. Form and function of words. Syntax: Sentence structures, Verb patterns and their usage		
MODULE 3:	**Writing Skills**	**14 Hours**
Writing Skills: Types of writing (Expository, Descriptive, Analytic, Argumentative, Narrative etc) and their main features. Resumes and CV's and Cover letters. Memos and Notices. Basics of Formal Reports		
TOTAL LECTURES		**45 Hours****

CO-PO-PSO MAPPING:

CO \ PO / PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	–	–	3	1	–	–	2	2	–
CO2	2	3	–	–	3	1	–	–	2	2	–
CO3	2	3	2	–	3	1	–	2	2	2	2
CO4	2	3	–	–	3	1	–	2	2	3	2
CO5	2	3	–	–	3	–	–	2	2	3	2
CO6	2	3	2	–	3	–	–	3	2	3	2

'3' – Strongly correlated; '2' – Moderately correlated; '1' – Slightly correlated; ' - ' Not applicable

Department of Microbiology, General Microbiology Lab

Program: B. Sc. in Microbiology	**Year, Semester:** 1st Yr., 1st Sem
Course Title: General Microbiology Lab	**Subject Code:** TIU-PMB-L101
Contact Hours/Week: 0–0–2 (L–T–P)	**Credit: 2**

COURSE OBJECTIVE :

Enable the student to:

1. To develop practical skills in microbial culture techniques
2. To train students in microscopy and staining techniques
3. To analyze bacterial growth patterns

COURSE OUTCOME :

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

CO-1:	Prepare and sterilize different culture media	K3
CO-2:	Isolate pure bacterial cultures	K3
CO-3:	Demonstrate the use of light microscopy	K3
CO-4:	Perform simple and differential staining techniques	K4
CO-5:	Analyze microbial diversity in water samples	K4
CO-6:	Evaluate bacterial growth kinetics	K5

COURSE CONTENT :

MODULE 1:	**MICROBIAL CULTURE**	**30 Hours**
1. Preparation of culture media 2. Isolation of pure culture by a streak plate preparation 3. Isolation of pure culture by a pour plate preparation 4. Yeast and mold isolation 5. Operation of light microscopy 6. Simple staining 7. Gram staining 8. Isolation of bacteria from water sample by a pour plate technique 9. Growth curve of bacteria		
TOTAL LECTURES		**30 Hours****

CO-PO-PSO MAPPING:

CO \ PO / PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	2	–	–	–	2	3	2	2
CO2	3	2	3	2	–	2	–	2	3	2	3

CO3	3	2	2	2	–	–	–	2	3	2	2
CO4	3	2	2	2	–	–	–	2	3	2	2
CO5	3	3	2	3	–	–	2	2	3	3	3
CO6	3	3	3	3	–	–	–	3	3	3	3

'3' – Strongly correlated; '2' – Moderately correlated; '1' – Slightly correlated; ' - ' Not applicable

Department of Microbiology, Biochemistry Lab

Program: B. Sc. in Microbiology	**Year, Semester:** 1st Yr., 1st Sem
Course Title: Biochemistry Lab	**Subject Code:** TTIU-PMB-L107
Contact Hours/Week: 0–0–2 (L–T–P)	**Credit: 2**

COURSE OBJECTIVE :

Enable the student to:

1. Master Quantitative Biomolecular Analysis
2. Interpret Microbial Biochemical Tests
3. Apply Enzyme Kinetics and Protein Characterization Techniques

COURSE OUTCOME :

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

CO-1:	Perform Quantitative Biomolecular Estimations	K3
CO-2:	Execute and Interpret Microbial Biochemical Tests	K4

CO-3:	Conduct Enzyme Activity Assays Under Variable Conditions	K3
CO-4:	Calculate and Analyze Enzyme Kinetic Parameters	K4
CO-5:	Determine Protein Molecular Weight Using PAGE	K3
CO-6:	ntegrate Laboratory Techniques to Design Comprehensive Microbial Analysis Experiments	K6

COURSE CONTENT :

MODULE 1:	**Study of Macromolecules**	**30 Hours**
1. Estimation of total carbohydrate, protein of a bacterial cell. 2. Estimation of total DNA and RNA of a bacterial cell. 3. Coagulase tests, Catalase Tests, Oxidase test, Indole test, Methyl Red test, Urease Test, Biochemical reactions on triple sugar iron agar (TSI). 4. Determination of activity of amylase, protease. Effect of pH, temperature on enzyme activity; Enzyme kinetics. 5. Determination of MW of protein by PAGE		
TOTAL LECTURES		**30 Hours****

CO-PO-PSO MAPPING:

CO \ PO / PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	2	–	–	–	2	3	2	2
CO2	3	3	2	3	–	–	–	2	3	3	2
CO3	3	3	2	3	–	–	–	3	3	3	3
CO4	3	3	2	3	–	–	–	3	3	3	3
CO5	3	2	2	2	–	–	–	2	3	3	2
CO6	3	3	3	3	–	2	–	3	3	3	3

‘3’ – Strongly correlated; ‘2’ – Moderately correlated; ‘1’ – Slightly correlated; ‘ - ’ Not applicable

Program: B. Sc. in Microbiology	**Year, Semester:** 1st Yr., 1st Sem
Course Title: Biophysics and Instrumentation Lab	**Subject Code:** TIU-PMB-L109
Contact Hours/Week: 0–0–2 (L–T–P)	**Credit: 2**

COURSE OBJECTIVE :

Enable the student to:

1. To familiarize students with microbiology laboratory rules and safety protocols
2. To introduce the basic tools and equipment used in microbiology laboratories
3. To develop hands-on skills in handling microbiological instruments

COURSE OUTCOME :

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

CO-1:	**Recognize and follow laboratory safety rules and biosafety guidelines**	K21
CO-2:	Explain the principles and applications of key microbiological tools and equipment	K2
CO-3:	Demonstrate the correct usage of microscopy techniques	K3
CO-4:	Operate essential microbiological instruments	K3
CO-5:	Analyze biological samples using electrophoresis techniques	K4
CO-6:	Evaluate experimental data using spectrophotometric and gel documentation techniques	K5

COURSE CONTENT :

MODULE 1:	**Study of Different Instruments**	**30 Hours**

1. Microbiology laboratory rules 2. Basic tools in a microbiological laboratory. 3. Basic equipments in laboratory 4. Microscopy: Light microscopy, Phase contrast microscopy, Fluorescence microscopy 5. Laminar air flow, Autoclave, Hot air oven. 6. Incubator, Orbital shaking incubator,Water bath 7. Weighing balance, Ph meter, Centrifuge machine, Distillation apparatus. 8. Spectrophotometer 9. Agarose gel electrophoresis, Uv-transilluminator 10. Polyacrylamide gel electrophoresis (PAGE) and Gel documentation System 11. Sonicator

TOTAL LECTURES	**30 Hours****

CO-PO-PSO MAPPING:

CO \ PO / PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	2	2	–	–	–	2	3	3	2	2	–
CO2	3	2	–	2	–	–	–	2	3	2	2
CO3	3	2	–	2	–	–	–	2	3	2	2
CO4	3	2	–	2	–	–	–	2	3	2	2
CO5	3	2	–	2	–	–	–	2	3	2	2
CO6	3	3	2	3	–	–	–	3	3	3	3

‘3’ – Strongly correlated; ‘2’ – Moderately correlated; ‘1’ – Slightly correlated; ‘ - ’ Not applicable

Program: B. Sc. in Microbiology	**Year, Semester:** 1st Yr., 1st Sem
Course Title: Entrepreneurship Skill Development (ESD)	**Subject Code:** TIU-PES-S199
Contact Hours/Week: 0–0–2 (L–T–P)	**Credit: 2**

COURSE OBJECTIVE :

Enable the student to:

1. Understand Entrepreneurial Concepts
2. Enhance Business Planning and Management Skills
3. Develop Innovation and Problem-Solving Abilities

COURSE OUTCOME :

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

CO-1:	Explain key entrepreneurial concepts	K1
CO-2:	Identify and evaluate business opportunities	K4
CO-3:	Demonstrate business planning skills	K3
CO-4:	Assess financial and resource management strategies	K5
CO-5:	Develop innovative solutions to entrepreneurial challenges	K6
CO-6:	Apply leadership and decision-making skills	K3

COURSE CONTENT :

MODULE 1:	**Study of Different Instruments**	**30 Hours**
Development of Entrepreneurship Skills		
TOTAL LECTURES		**30 Hours****

CO-PO-PSO MAPPING:

CO \ PO / PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	2	2	–	–	2	2	2	2	1	2	–
CO2	3	3	2	2	2	2	2	2	2	3	2
CO3	2	3	3	3	2	3	2	3	2	3	3
CO4	2	3	2	2	2	3	2	3	2	2	2
CO5	2	2	3	2	2	2	2	2	2	3	3
CO6	2	3	3	2	2	3	2	3	2	3	3

‘3’ – Strongly correlated; ‘2’ – Moderately correlated; ‘1’ – Slightly correlated; ‘ - ’ Not applicable