Re-Accredited 'B++' 2.86 CGPA by NAAC
VEER NARMAD SOUTH GUJARAT UNIVERSITY
University Campus, Udhna-Magdalla Road, SURAT - 395 007, Gujarat, India.
વીર નર્મદ દક્ષિણ ગુજરાત યુનિવર્સિટી
યુનિવર્સિટી કેમ્પસ, ઉધના-મગદલ્લા રોડ, સુરત - ૩૯૫ ૦૦૭, ગુજરાત, ભારત.
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-:પરિપત્ર:-

યુનિવર્સિટીના વિજ્ઞાન વિદ્યાશાખા હેઠળના તમામ શૈક્ષણિક વિભાગોના વડાશ્રીઓ અને યુનિવર્સિટી સંલગ્ન વિજ્ઞાન વિદ્યાશાખા હેઠળની તમામ કોલેજોનાં આચાર્યશ્રીઓને જણાવવાનું કે, NEP-2020 અંતર્ગત શૈક્ષણિક વર્ષ ૨૦૨૬–૨૭ થી અમલમાં આવનાર B.Sc. Bioscience (Microbiology) Sem.-7 & 8 Honours (with OJT/without OJT) અને Honours with Research નો સુધારેલ અભ્યાસક્રમ જૈવ વિજ્ઞાન વિષય ની અભ્યાસ સમિતિના ચેરમેનશ્રીએ અભ્યાસ સમિતિવતી અને વિજ્ઞાન વિદ્યાશાખાના અધ્યક્ષશ્રીએ વિદ્યાશાખાવતી મંજૂર કરી એકેડેમિક કાઉન્સિલને કરેલ ભલામણ એકેડેમિક કાઉન્સિલની તા.૧૩/૦૭/૨૦૨૬ ની સભાના ઠરાવ ક્રમાંકઃ૬૪ થી મંજૂર કરેલ છે. જેનો અમલ કરવા આથી જાણ કરવામાં આવે છે.

(બિડાણઃઉપર મુજબ)

ક્રમાંકઃઓથો./પરિપત્ર/૧૫૬૮૫/૨૦૨૬
તા.૧૮/૦૭/૨૦૨૬

કુલસચિવ(ઇ.ચા.)

પ્રતિ,
(૧) યુનિવર્સિટીના વિજ્ઞાન વિદ્યાશાખા હેઠળના તમામ શૈક્ષણિક વિભાગોના વડાશ્રીઓ.
(૨) યુનિવર્સિટી સંલગ્ન વિજ્ઞાન વિદ્યાશાખા હેઠળની તમામ કોલેજોનાં આચાર્યશ્રીઓ.
... આપશ્રીના વિભાગ/કોલેજના સંબંધિત શિક્ષકો/વિદ્યાર્થીઓને જાણ કરી અમલ કરવા સારૂ.
(૩) અધ્યક્ષશ્રી, વિજ્ઞાન વિદ્યાશાખા.
(૪) પરીક્ષા નિયામકશ્રી,પરીક્ષા વિભાગ, વીર નર્મદ દ. ગુ. યુનિવર્સિટી, સુરત.
(૫) એકેડેમિક વિભાગ, વીર નર્મદ દક્ષિણ ગુજરાત યુનિવર્સિટી, સુરત.
(૬) અનુસ્નાતક વિભાગ, વીર નર્મદ દક્ષિણ ગુજરાત યુનિવર્સિટી, સુરત.
.....તરફ જાણ તેમજ અમલ સારૂ.

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

Undergraduate Program

In

BIOSCIENCE (Microbiology)

4 years (Honours with OJT/Research Project)

B. Sc. Sem 7 Syllabus

(Effective from Academic Year: 2026-27)

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT PROGRAM TITLE	
Name of Program	Bachelor of Science (Honours with OJT/RP) In Bioscience (Microbiology)
Program Abbreviation	B.Sc. BIOS-MB
Duration	One Year
Eligibility Criteria	As per university norms
Pre-requisite	Basic concepts in the field of microbiology
Medium of Instruction	English
Objective of Program	Objective of this program is to provide Fundamental and applied knowledge of Microorganism to students. To develop Laboratory skills and to train the students in scientific thinking to prepare for carriers like health care, pharmaceutical, biotechnology, diagnostics, industry and academia and to promote awareness to students of microbial application in the field of diseases prevention, environmental sustainability and technological innovation.
Program Outcome (PO)	**PO-01: Scientific Knowledge & Conceptual Understanding:** Develop a strong foundation in scientific principles, theories and concepts across disciplines, fostering interdisciplinary learning, advance knowledge and problem-solving abilities. **PO-02: Analytical & Critical Thinking:** Apply critical thinking and analytical reasoning to evaluate scientific data, hypotheses and real-world problems, leading to evidence-based conclusions. **PO-03: Research & Inquiry-based Learning:** Develop investigative skills through experimentation, data analysis and scientific inquiry to contribute to research and innovation. **PO-04: Laboratory & Technical Skills:** Gain hands-on experience with laboratory techniques, instrumentation and computational tools relevant to scientific research and industry applications. **PO-05: Digital & Computational Literacy:** Utilize digital tools, computational techniques and emerging technologies such as AI, bioinformatics and statistical modelling to enhance scientific learning and problem-solving. **PO-06: Environmental & Societal Responsibility:** Understand the role of science in addressing

	environmental, health and societal challenges, promoting sustainability and ethical responsibility. **PO-07: <u>Effective Communication & Collaboration</u>:** Develop proficiency in scientific communication, both written and oral, for effective dissemination of knowledge while collaborating in multidisciplinary teams. **PO-08: <u>Innovation & Entrepreneurship</u>:** Foster an entrepreneurial mind-set by applying scientific knowledge for innovation, technology development, and industry-oriented applications. Develop sustainable solutions to address real-world challenges in research and environmental management. **PO-09: <u>Lifelong Learning & Professional Growth</u>:** Cultivate curiosity and adaptability for continuous learning, equipping students for higher education, research, and professional careers. **PO-10: <u>Ethical Leadership & Value-based Education</u>:** Develop leadership qualities, ethical values, and a sense of responsibility in applying science for societal progress, aligning with Indian knowledge systems and global perspectives.
Program Specific Outcomes (PSO)	**PSO1 : <u>Core Knowledge in Microbiology:-</u>** • Understand the fundamental concepts of microbiology, including microbial diversity, structure, function and classification. • Explain the role of microorganism in human health, industry, agriculture and the environment. **PSO2 : <u>Practical and Laboratory Skills:-</u>** • Perform basic microbiological techniques such as microbial staining, culturing, isolation and enumeration. • Utilize aseptic techniques and biosafety measures in handling microorganisms. • Operate laboratory instruments effectively. **PSO3 : <u>Applied and Industrial Microbiology:-</u>** • Understand the role of microorganisms and their application in food, pharmaceuticals, biotechnology and environmental science. • Demonstrate knowledge of fermentation processes, microbial biotechnology and their industrial significance.

- Demonstrate the ability to work in teams and encourage innovation and entrepreneurship.

PSO4 : <u>Disease and Health-Related Microbiology:-</u>

- Identify pathogenic microorganisms and understand their role in infectious diseases.
- Explain antimicrobial resistance, immunity and the role of microbes in public health.

PSO5 : <u>Critical Thinking and Problem-Solving:-</u>

- Analyze scientific data, interpret experimental results and troubleshoot laboratory issues.
- Apply microbiological knowledge to solve real-world problems in healthcare, industry, environmental management and sustainability.

PSO6 : <u>Ethical and Professional Responsibilities:-</u>

- Follow ethical guidelines in microbiological research and laboratory work.
- Adhere to safety protocols and regulatory standards in microbiology-related fields.

Mapping between POs and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
PO1	■		■		■	
PO2		■			■	
PO3		■	■			
PO4				■		■
PO5		■		■	■	■
PO6			■		■	
PO7					■	■
PO8			■		■	
PO9	■	■	■	■	■	
PO10		■		■		■

STRUCTURE FOR ERP – BIOSCIENCE-MICROBIOLOGY – SEM – 7 Honours with OJT/RP - (UG)

Course Category	Course Code	Course Title	Mark sheet Title in English	Level of Course	Teaching Hours/Week		Exam Duration		Credit		Internal Marks		External Marks		Total	
					TH	PR	TH	PR	TH	PR	TH	PR	TH	PR	TH	PR
MAJOR 1	BIOS-MB – MJ - 701	MICROBIAL GENETICS	MICROBIAL GENETICS	400-499	02	04	01.00 h	06.00 h	02	02	25	25	25	25	50	50
MAJOR 2	BIOS-MB – MJ - 702	MICROBIAL METABOLISM & PHYSIOLOGICA L ADAPTATION	MICROBIAL METABOLISM & PHYSIOLOGICAL ADAPTATION	400-499	02	04	01.00 h	06.00 h	02	02	25	25	25	25	50	50
MAJOR 3	BIOS-MB – MJ - 703	MICROBIAL BIOTECHNOLO G Y	MICROBIAL BIOTECHNOLO GY	400-499	02	04	01.00 h	06.00 h	02	02	25	25	25	25	50	50
MINOR ELECTIVE	BIOS-MB-ME-701	FUNDAMENTALS OF CYBER SECURITY / RESEARCH METHODOLOGY	FUNDAMENTALS OF CYBER SECURITY	400-499	04	00	02.00 h	00 h	04	00	50	-	50	-	100	-
RP/OJT	BIOS-MB-RP / OJT-701	RESEARCH PROJECT / ON JOB TRAINING	RESEARCH PROJECT/ ON JOB TRAINING	400-499	12		-	-	06		75		75		150	

- Cyber security syllabus will be prepared by computer science faculty and of VNSGU, Surat.
- Research methodology-I syllabus will be prepared by Adhoc. Board of Research methodology, VNSGU, Surat.

[Subject code for Theory-2603000507016001]
[Subject code for Practical-2603000507016002]

BIOS-MB-MJ-701 MICROBIAL GENETICS	
Program Name	**B. Sc Honours BIOSCIENCE (Microbiology)**
Semester	**VII**
NCrF Credit Level	**06**
Course Type	**MAJOR**
Course Subtype	**MAJOR 1**
Subject Type	**Discipline Specific**
Course Code	**BIOS-MB-MJ-701**
Course Level	**400-499**
Course Title	**Microbial Genetics**
Credit	**02**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	After completing this course, students will be able to: **CO-1**: Explain the principles of molecular genetics including DNA replication, transcription, translation, protein processing, and genetic information flow in microorganisms. **CO-2**: Analyse mechanisms of microbial gene regulation including operon systems, transcriptional control, RNA-based regulation, and signal transduction pathways. **CO-3**: Analyse the causes of mutations, DNA damage, and repair mechanisms involved in maintaining genetic stability in microorganisms. **CO-4**: Interpret the structure, properties, and functions of plasmids, transposons, bacteriophages, and other mobile genetic elements in microbial systems. **CO-5**: Apply concepts of microbial genetics and gene transfer mechanisms in biotechnology, industrial microbiology, environmental microbiology, and microbial research applications.

Mapping between COs and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■					
CO2	■				■	
CO3	■	■				
CO4	■				■	
CO5	■	■	■		■	■

Course Content

UNIT 1: NUCLEIC ACID STRUCTURE AND SYNTHESIS

1.1	*Molecular Biology and Genetic Elements:* DNA and Genetic Information Flow, Genetic Elements: Chromosomes and Plasmids overview
1.2	*DNA Replication:* Templates, Enzymes, and Replication Fork, Bidirectional Replication, the Replisome, and Proofreading
1.3	*RNA Synthesis:* Transcription in Bacteria, in Archaea
1.4	*Protein Synthesis*: Translation, Amino Acids, Polypeptides, and Proteins, Transfer RNA, Genetic Code, Mechanism of Protein Synthesis
1.5	*Protein Processing, Secretion, and Targeting:* Assisted Protein Folding and Chaperones, Protein Secretion in Gram-Negative Systems
1.6	*DNA-Binding Proteins and Transcriptional Regulation*: DNA-Binding Proteins, Negative Control- Repression and Induction, Positive Control-Activation, Global Control and the *lac* Operon, Transcription Controls in Archaea
1.7	*RNA-Based Regulation*: Regulatory RNAs, Riboswitches, Attenuation
1.8	*Regulation of Enzymes and Other Proteins*: Feedback Inhibition, Post-Translational Regulation
UNIT 2: MUTATION, PLASMIDS, GENE TRANSFER AND GENOME REARRANGEMENT	
2.1	*Mutation and DNA repair:* The causes of mutations, Repair of mutations and other types of DNA damage
2.2	*Plasmid*: Functions Encoded, Structure, Properties of Plasmids
2.3	Transformation, Artificially Induced Competence- Chemical Induction, Electroporation and Protoplast Transformation
2.4	Transduction
2.5	Conjugation and Formation of Hfr Strains & Chromosome Mobilization, mapping genes by interrupted mating, Gene Transfer in Archaea,
2.6	*Recombination*: Homologous and site-specific recombination
2.7	*Transposition*: Transposition, Mechanisms of Transposition and General Properties of Transposons

References

- Brown, T. A. (2023). *Genomes 5* (5th ed.). CRC Press. ISBN: 978-0-367-67866-1
- Henkin, T. M., & Peters, J. E. (2020). *Snyder and Champness molecular genetics of bacteria* (5th ed.). ASM Press; John Wiley & Sons. ISBN 9781555819750
- Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2014). *Lewin's GENES XI* (11th ed.). Jones & Bartlett Learning. ISBN 9781449659851
- Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. (2018). *Brock biology of microorganisms* (15th ed.). Pearson. ISBN 13: 978-1-292-23510-3
- Willey, J. M., Sandman, K. M., & Wood, D. H. (2023). *Prescott's microbiology* (12th ed.). McGraw-Hill Education. ISBN 978-1-265-12303-1

Online references

- https://swayam.gov.in/
- https://swayam-plus.swayam2.ac.in/

Teaching Methodology The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.
Evaluation scheme 50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

PRACTICALS

BIOS-MBP-MJ-701 MICROBIAL GENETICS

Program Name	**B. Sc Honours In BIOSCIENCE (Microbiology)**
Semester	**VII**
NCrF Credit Level	**06**
Course Type	**MAJOR**
Course Subtype	**MAJOR 1**
Subject Type	**Discipline specific**
Course Code	**BIOS-MBP-MJ-701**
Course Level	**400-499**
Course Title	**Microbial Genetics Practical**
Credit	**02**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	Upon successful completion of this practical course, the students will be able to: **CO1:** Perform the isolation, purification and quantitative estimation of genomic DNA, plasmid DNA and RNA from microbial cells using standard molecular biology techniques. **CO2:** Execute microbial genetic experiments involving mutation induction, mutant isolation and gene expression analysis to understand microbial genetics and gene regulation. **CO3:** Demonstrate bacterial transformation techniques and interpret the role of gene transfer mechanisms in microbial genetic exchange. **CO4:** To demonstrate execution of lac-operon.

Mapping between Cos and PSOs		**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
	CO1 to CO4						

Course Content

1. Extraction of bacterial genomic DNA from bacteria and Quantitative estimation of DNA.
2. Extraction of RNA from yeast and Quantitative estimation of RNA.
3. Isolation of Plasmid DNA.
4. Isolation of Auxotrophic Mutants by Replica Plating technique.
5. Study of UV-Induced Mutation in Bacteria.
6. Induction of β-Galactosidase Activity (lac Operon Demonstration).
7. Bacterial Transformation testing using agar plate methods.

References

- Patel, R. J., & Patel, R. K. Experimental Microbiology, Vol. 1, 10th Edition, Aditya, 2022
- Patel, R.J., & Patel, R. K. Experimental Microbiology, Vol. 2, 10th Edition, Aditya, 2022.
- Aneja, K. R., Experiments in Microbiology 4thed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers, 2003.
- Cappuccino, J. G., Microbiology: A Laboratory Manual, 6Ed., Singapore Pearson Education Pvt. Ltd., 2005.
- Bossi, Camilli, Grundl, Experiments in Bacterial Genetics: A Laboratory Manual, Cold Spring Harbor Laboratory Press, 2023, ISBN 978-1621824497
- Tiwari, R. P., Hoondal, G. S., & Tewari, R. (2004). Laboratory techniques in microbiology & biotechnology (1st ed.). Abhishek Publications ISBN 81-8247-077-3

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive Discussion, seminars, assignments, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

[Subject code for Theory-26030005070260001]

BIOS-MB-MJ-702: MICROBIAL METABOLISM AND PHYSIOLOGICAL ADAPTATION

Program Name	**B. Sc Honours In BIOSCIENCE (Microbiology)**
Semester	**VII**
NCrF Credit Level	**06**
Course Type	**MAJOR**
Course Subtype	**MAJOR 2**
Subject Type	**Discipline Specific**
Course Code	**BIOS-MB-MJ-702**
Course Level	**400-499**
Course Title	**Microbial Metabolism and Physiological Adaptation**
Credit	**02**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	After completing this course, students will be able to: **CO-1**: Explain the fundamental principles of microbial metabolism, bioenergetics, ATP synthesis, redox reactions, and energy generation mechanisms in microorganisms. **CO-2**: Describe major catabolic pathways including aerobic respiration, anaerobic respiration, fermentation pathways, autotrophy, lithotrophy, methanogenesis, and phototrophy in microorganisms. **CO-3**: Explain anabolic processes including biosynthesis of amino acids, nucleotides, lipids, peptidoglycan, and inorganic metabolic pathways such as nitrogen and sulfur metabolism. **CO-4**: Demonstrate practical skills in microbial physiology techniques including growth curve analysis, fermentation tests, anaerobic cultivation, enzymatic assays, endospore staining, and biofilm studies. **CO-5**: Apply concepts of microbial metabolism and physiological adaptations in environmental microbiology, industrial microbiology, biotechnology, metabolic engineering, and sustainable microbial processes.

Mapping between Cos and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■					
CO2	■					
CO3	■	■	■		■	
CO4	■	■	■		■	
CO5	■	■	■		■	■

Course Content

UNIT 1: METABOLISM AND BIOENERGETICS

1.1	Introduction to Microbial Metabolism, Important Principles and Concepts, ATP- the Major Energy Currency
1.2	Redox Reactions, Sequential Redox Reactions, Biochemical Pathways- Sets of Linked Chemical Reactions, Enzymes and Ribozymes, Metabolism regulation to maintain Homeostasis
1.3	Cellular Mechanisms for ATP Synthesis, Chemiosmotic Theory, ATP Synthase, The Proton Motive Force (PMF) Quantifying PMF, Environmental impacts on PMF
1.4	Oxidative decarboxylation of pyruvate, TCA cycle, Glyoxylate cycle, anaplerotic reactions
1.5	Electron Transport and Oxidative Phosphorylation, Aerobic respiration, Anaerobic respiration, Energy yield comparison Fermentation Pathways:
1.6	Propionate, Acetate, Lactate, Mixed-Acid and Butanediol Fermentation, and Butyrate Fermentation, Syntrophy Autotrophic Pathways: Concept of autotrophy, Calvin cycle, Reverse TCA cycle
1.7	C1 Metabolism: Acetogenesis, Methanogenesis, Methanotrophy Phototrophy (Light Reactions in Oxygenic Photosynthesis and in Anoxygenic Photosynthesis, Rhodopsin-Based Phototrophy)
UNIT 2: MICROBIAL ANABOLISM AND PHYSIOLOGICAL ADAPTATION	
2.1	Lithotrophy: hydrogen-oxidizing bacteria, Ammonia-oxidizing bacteria, Nitrite-oxidizing bacteria, Sulfur-oxidizing prokaryotes, Iron-oxidizing bacteria
2.2	Inorganic metabolisms: Assimilation and Dissimilation of Nitrate and Sulfate, Nitrogen fixation: nitrogen-fixing systems and nitrogenase
2.3	Anabolism and Biosynthesis: concept of biosynthesis, Precursor Metabolites for Biosynthesis
2.4	Lipid Synthesis: Fatty Acids and Phospholipids, Sterols and Isoprenoid Lipids, Lipopolysaccharides, Synthesis of Peptidoglycan
2.5	Two component regulatory system
2.6	Microbial stress responses: oxidative stress, physiological response to oxidative stress in *E. coli*, heat shock response, sporulation, stages of sporulation, germination and regulation in *Bacillus subtilis*, resistance properties of endospores
2.7	Prevalence, Importance, Properties, and Regulation of Biofilm Formation, Quorum Sensing, Metabolic engineering of bacteria

References

- Kim, B. H., & Gadd, G. M. (2008). Bacterial physiology and metabolism (2nd ed.). Cambridge University Press. ISBN-13 978-0-511-39322-8
- Kumar, R. R., & Prasad, S. (2011). Metabolic engineering of bacteria. Indian Journal of Microbiology, 51(3), 403–409. https://doi.org/10.1007/s12088-011-0172-8
- Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M.,; Stahl, D. A. (2018). Brock biology of microorganisms (15th ed.). Pearson.
- Moat, A. G., Foster, J. W., & amp; Spector, M. P. (2002). Microbial physiology (4th ed.). Wiley-Liss.
- Stevens, A. M., Ditty, J. L., Parales, R. E., & amp; Merkel, S. M. (2023). Microbial physiology: Unity and diversity. ASM Books / Wiley. ISBN: 978-1683673675
- Stevens, A. M., Ditty, J. L., Parales, R. E., & Merkel, S. M. (2023). Microbial physiology: Unity and diversity. ASM Books / Wiley. ISBN: 978-1683673675
- White, D., Drummond, J., & Fuqua, C. (2012). The physiology and biochemistry of prokaryotes (4th ed.). Oxford University Press.
- Willey, J. M., Sandman, K. M., & Wood, D. H. (2023). Prescott's microbiology (12th ed.). McGraw-Hill Education. ISBN 978-1-265-12303-1

Online reference

- https://swayam.gov.in/
- https://swayam-plus.swayam2.ac.in/

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Evaluation scheme

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

[Subject code for Practical-2603000507026002]

PRACTICALS

BIOS-MBP-MJ-702 MICROBIAL METABOLISM AND PHYSIOLOGICAL ADAPTATION

Program Name	**B. Sc Honours In BIOSCIENCE (Microbiology)**
Semester	**VII**
NCrF Credit Level	**06**
Course Type	**MAJOR**
Course Subtype	**MAJOR 2**
Subject Type	**Discipline Specific**
Course Code	**BIOS-MBP-MJ-702**
Course Level	**400-499**
Course Title	**Microbial Metabolism and Physiological Adaptation Practical**
Credit	**02**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	After completing this course, students will be able to: **CO-1**: Gain practical skills to determine the growth curve of bacterial culture and analyse the effect of stress on the growth curve pattern. **CO-2**: Develop skill to estimate the sugar utilized by yeast culture. **CO-3**: Perform the technique of endospore staining and determination of the biofilm formation. **CO-4**: Demonstrate the effect of bile salts on gram positive and gram-negative bacteria.

Mapping between Cos and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1 to CO4						

Course Content

1. Study of Bacterial Growth Curve under stress conditions of temperature.
2. Study of Bacterial Growth Curve under stress conditions of pH.
3. Estimation of sugar utilization by yeast by DNSA method.
4. Study of Sporulation by Endospore Staining.
5. Study of Biofilm formation by tube method using crystal violet staining.
6. Determination of sensitivity of gram positive and gram-negative bacteria to bile salts.
7. Enrichment and microscopic observation of Photosynthetic Bacteria.

References

- Patel, R. J., & Patel, R. K. Experimental Microbiology, Vol. 1, 10th Edition, Aditya, 2022
- Patel, R.J., & Patel, R. K. Experimental Microbiology, Vol. 2, 10th Edition, Aditya, 2022.
- Aneja, K. R., Experiments in Microbiology 4thed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers, 2003.

- Cappuccino, J. G., Microbiology: A Laboratory Manual, 6Ed., Singapore Pearson Education Pvt. Ltd., 2005.
- Tiwari, R. P., Hoondal, G. S.,; Tewari, R. (2004). Laboratory techniques in microbiology ; biotechnology (1st ed.). Abhishek Publications ISBN 81-8247-077-3

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive Discussions, seminars, assignments, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

[Subject code for Theory-2603000507036001]
[Subject code for Practical-2603000507036002]

BIOS-MB-MJ-703: MICROBIAL BIOTECHNOLOGY

Program Name	**B. Sc Honours In BIOSCIENCE (Microbiology)**
Semester	**VII**
NCrF Credit Level	**06**
Course Type	**MAJOR**
Course Subtype	**MAJOR 3**
Subject Type	**Discipline specific**
Course Code	**BIOS-MB-MJ-703**
Course Level	**400-499**
Course Title	**Microbial Biotechnology**
Credit	**02**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	After completing this course, students will be able to: **CO-1**: Explain the role of industrial microorganisms and fermentation processes in the production of primary metabolites, industrial enzymes, and microbial products. **CO-2**: Describe the microbial production technologies of organic acids, solvents, amino acids, vitamins, antibiotics, and industrially important biomolecules. **CO-3**: Analyze the production and applications of secondary metabolites, biopolymers, biofuels, agricultural bioproducts, fermented beverages, and therapeutic microbial products. **CO-4**: Interpret advanced concepts of metabolic engineering, AI-driven enzyme design, gas fermentation, microbial electrosynthesis, and intelligent bioprocess technologies. **CO-5**: Apply principles of industrial microbiology and microbial biotechnology for sustainable production systems, environmental applications, industrial processes, and entrepreneurial opportunities.

Mapping between Cos and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■		■			
CO2	■		■			
CO3	■	■	■			
CO4	■	■	■		■	■
CO5	■	■	■		■	■

Course content

UNIT 1: INDUSTRIAL MICROBIAL PRODUCTS AND FERMENTATION TECHNOLOGIES

1.1	Important microbes used in industrial microbiology and biotechnology: High throughput screening .
1.2	Range of fermentation processes
1.3	Organic acids: Citric acid and Lactic acid
1.4	Amino acid: L-lysine; Vitamin: B12 & Riboflavin
1.5	Solvents: Ethanol and Bio-butanol
1.6	Biopolymers: PHAs and Exopolysaccharides: Xanthan.
1.7	Agricultural bioproducts: Microbial biopesticides, Siderophores and mycorrhizal biofertilizer
1.8	Alcohol-based fermented beverages: Beer and Wine
1.9	Therapeutics: mAbs, Insulin, Interferons, Antibiotics: Cephalosporins

UNIT 2: METABOLIC ENGINEERING AND INTELLIGENT PRODUCTION TECHNOLOGIES

2.1	Industrially important enzymes
2.2	Next generation biofuels from cyanobacteria and yeasts
2.3	AI-driven enzyme design: enzymes with tailored specificities
2.4	Glycoengineered microbes: humanized glycoproteins production
2.5	Gas fermentation by C1 pathway: industrial waste gases to bioplastics and SCPs
2.6	Microbial Electrosynthesis Systems: reduction of CO_2 into value-added chemicals
2.7	Process Analytical Technology: real-time monitoring of microbial product formation
2.8	Machine learning: reinforcement learning algorithms to maximize product yield

References

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- White, Chris, and Jamil Zainasheff. Yeast: The Practical Guide to Beer Fermentation. Boulder, Brewers Publications, 2010.

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- Guo, Peixuan, and Fazlul Haque, editors. RNA Nanotechnology and Therapeutics. Boca Raton, CRC Press, 2020.
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Online reference

- https://swayam.gov.in/
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Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Evaluation scheme

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

PRACTICALS

BIOS-MBP-MJ-703 MICROBIAL BIOTECHNOLOGY

Program Name	**B. Sc Honours In BIOSCIENCE (Microbiology)**
Semester	**VII**
NCrF Credit Level	**06**
Course Type	**MAJOR**
Course Subtype	**MAJOR 3**
Subject Type	**Discipline specific**
Course Code	**BIOS-MBP-MJ-703**
Course Level	**400-499**
Course Title	**Microbial Biotechnology Practical**
Credit	**02**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	After completing this course, students will be able to: **CO-1**: Gain practical skills in isolation and screening the metabolite producing microorganisms.

.	**CO-2**: Perform estimation of metabolites produced during fermentation. **CO-3**: Carry out fermentation of metabolites and enzyme production on large scale. **CO-4**: Demonstrate the industrial production of microbial products.

Mapping between Cos and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1 to CO4						

Course Content

1. Isolation and screening of citric acid & lactic acid producing fungi.
2. Isolation and screening of EPS producing bacteria.
3. Screening of amylase- and cellulase-producing microorganisms.
4. Production of amylase/ cellulase enzyme under solid & submerged fermentation.
5. Purification of amylase/ cellulase by ammonium sulphate and dialysis to determine specific activity and fold purification.
6. CAS assay for siderophore production.
7. Spectrophotometric estimation of Riboflavin /Vitamin B12.

References

- Patel, R. J., & Patel, R. K. Experimental Microbiology, Vol. 1, 10th Edition, Aditya, 2022
- Patel, R.J., & Patel, R. K. Experimental Microbiology, Vol. 2, 10th Edition, Aditya, 2022.
- Aneja, K. R., Experiments in Microbiology 4th ed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers, 2003.
- Cappuccino, J. G., Microbiology: A Laboratory Manual, 6th Ed., Singapore Pearson Education Pvt. Ltd., 2005.
- Bartzatt, R., & Wol, T. (2014). Detection and assay of vitamin B-12 (riboflavin) in alkaline borate buffer with UV/visible spectrophotometry. International Scholarly Research Notices, 2014, Article 453085.

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive Discussions, seminars, assignments, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

[Subject code-2603000507056001]

BIOS-MB-MJ-704 (BKS): TRADITIONAL PRACTICES IN MICROBIOLOGY

Program Name	**B. Sc Honours In BIOSCIENCE (Microbiology)**
Semester	**VII**
NCrF Credit Level	**06**
Course Type	**MAJOR (BKS)**
Course Subtype	**MAJOR 4**
Subject Type	**Discipline specific**
Course Code	**BIOS-MB-MJ-704**
Course Level	**400-499**
Course Title	**Traditional Practices in Microbiology**
Credit	**04**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	Upon successful completion of the course, students will be able to: **CO1:** Explain the scientific basis of traditional Indian knowledge systems related to agriculture, health and biotechnology. **CO2:** Evaluate traditional fermented foods and indigenous practices from microbiological and biotechnological perspectives. **CO3:** Interpret Ayurvedic concepts in relation to microbiome science and modern biomedical research. **CO4:** Analyse scientific evidence supporting Panchagavya, Panchakarma and fasting-based interventions. **CO5:** Appreciate the contributions of Indian scientists to microbiology, molecular biology and biotechnology. **CO6:** Explore opportunities for integrating indigenous knowledge with contemporary scientific research and innovation.

Mapping between COs and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	■						■	
CO2	■	■			■		■	
CO3	■	■			■	■	■	
CO4	■	■			■		■	■
CO5	■	■			■		■	■
CO6	■	■	■				■	

Course content

UNIT 1: HISTORICAL PERSPECTIVES & INDIGENOUS KNOWLEDGE IN MICROBIOLOGY

1.1	History of microbiology: from ancient traditional practices to modern science
1.2	Role of microorganisms in ancient civilizations: Vedic, Egyptian, Mesopotamian perspectives
1.3	Traditional Indian practices and their microbial connections (Ayurveda, Siddha, Unani)
1.4	Contributions of Indian scholars (Jagadish Chandra Bose, Birbal Sahni) to microbiology
1.5	Ethnomicrobiology: definition, scope, and significance and Documentation and preservation of traditional microbiological knowledge
UNIT 2: TRADITIONAL FERMENTATION PRACTICES	
2.1	Principles of fermentation: aerobic vs. anaerobic, homo- and hetero-fermentation
2.2	Traditional fermented foods of India: Idli, Dosa, Dhokla, Jalebi, Kanji, Ambali, and Fermented dairy products: Dahi (curd), Lassi, Shrikhand, Paneer, Buttermilk
2.3	Traditional beverages: Toddy, Rice beer (Handia), Mahua wine, Neera, and Traditional fermented foods of tribal communities in Gujarat and India
2.4	Vinegar production: traditional methods
2.5	Quality, safety, and nutritional aspects of traditionally fermented products and Comparison of traditional vs. industrial fermentation processes
UNIT 3: TRADITIONAL FOOD PRESERVATION, NATURAL ANTIMICROBIALS	
3.1	Ancient and traditional methods of food preservation: sun-drying, salting, pickling and smoking
3.2	Microbiological basis of food spoilage and preservation techniques; Traditional Indian pickles (Achaar), Murabba and Papad: microbiology and role of spices
3.3	Ethnomedicinal plants with antimicrobial properties: Aloe vera, Garlic, Neem and Tulsi
3.4	Traditional wound-healing practices and antimicrobial significance; Use of honey, ghee and herbal oils as traditional antimicrobial agents
3.5	Phytochemicals and their mode of antimicrobial action;
3.6	Modern scientific validation of traditional antimicrobial agents (evidence-based approach)
UNIT 4: TRADITIONAL AGRICULTURAL MICROBIOLOGY & MODERN RELEVANCE	
4.1	Traditional soil enrichment practices: green manuring, crop rotation, mixed cropping and Traditional composting: Nadep, Vermicomposting, Pit composting – microbiological basis
4.2	Indigenous biofertilizer knowledge: Rhizobium inoculation, Azolla-Anabaena, Blue-Green Algae, and Traditional biopesticide practices: Panchagavya, Dashparni Ark, Brahmastra
4.3	Cow-based microbiological practices (Panchagavya): scientific validation and applications
4.4	Role of traditional practices in sustainable agriculture and organic farming
4.5	Integration of traditional microbiological knowledge into modern biotechnology, Bioprospecting of traditional practices: IPR issues and ethical considerations, Future perspectives: blending ethnomicrobiology with modern microbiome research

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- Tamang, J. P. & Kailasapathy, K. (Eds.). Fermented Foods and Beverages of the World. CRC Press.
- Ministry of AYUSH, Government of India. Ayurveda: The Science of Life.
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- Suganthy, M., Renuka Rani, B. & Sharma, N. R. Natural Farming for Sustainable Agriculture.
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- Nobel Prize Outreach AB. Nobel Prize Educational Resources (Autophagy, Ribosome Structure, Genetic Code and CRISPR-related discoveries).
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- National Centre for Biological Sciences (NCBS), Bengaluru.
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- https://swayam-plus.swayam2.ac.in/
- https://nptel.ac.in

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Evaluation scheme

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

Undergraduate Program

In

BIOSCIENCE (Microbiology)

4 years (Honours with OJT/Research Project)

B. Sc. Sem 8 Syllabus

(Effective from Academic Year: 2026-27)

STRUCTURE FOR ERP BIOSCIENCE– MICROBIOLOGY SEM – 8 Honours with OJT (UG)																	
Course Category	Course Code	Course Title	Mark sheet Title in English	Level of Course	Teaching Hours/Week		Exam Duration		Credit		Internal Marks		External Marks		Total	
					TH	PR	TH	PR	TH	PR	TH	PR	TH	PR	TH	PR
MAJOR 1	BIOS-MB – MJ - 801	MOLECULAR BIOLOGY & GENOME ENGINEERING	MOLECULAR BIOLOGY & GENOME ENGINEERING	400-499	02	04	01.00 h	06.00 h	02	02	25	25	25	25	50	50
MAJOR 2	BIOS-MB – MJ - 802	ENVIRONMENTAL MICROBIOLOGY	ENVIRONMENTAL MICROBIOLOGY	400-499	02	04	01.00 h	06.00 h	02	02	25	25	25	25	50	50
MAJOR 3	BIOS-MB – MJ - 803	BIOPROCESS & FERMENTATION TECHNOLOGY	BIOPROCESS & FERMENTATION TECHNOLOGY	400-499	02	04	01.00 h	06.00 h	02	02	25	25	25	25	50	50
MAJOR -4	BIOS-MB-MJ-804	BIOPHYSICS, ANALYTICAL BIOCHEMISTRY AND INSTRUMENTATION	BIOPHYSICS, ANALYTICAL BIOCHEMISTRY AND INSTRUMENTATION	400-499	04	00	02.00 h	00 h	04	00	50	-	50	-	100	-
RP/OJT	BIOS-MB-RP/OJT- 801	RESEARCH PROJECT / ON JOB TRAINING	RESEARCH PROJECT/ ON JOB TRAINING	400-499	12		-	-	06		75		75		150	

[Subject code for Theory-*2703000508016001*]

BIOS-MB-MJ-801 MOLECULAR BIOLOGY & GENOME ENGINEERING	
Program Name	**B.Sc Honors In BIOSCIENCE (Microbiology)**
Semester	**VIII**
NCrF Credit Level	**06**
Course Type	**MAJOR**
Course Subtype	**MAJOR 1**
Subject Type	**Discipline Specific**
Course Code	**BIOS-MB-MJ-801**
Course Level	**400 - 499**
Course Title	**Molecular Biology & Genome Engineering**
Credit	**02**
Effective From	**Academic year: 2026-27**
Course Outcomes	Upon successful completion of this course, the students will be able to: **CO1:** Explain the principles of recombinant DNA technology, DNA manipulation, cloning vectors and gene transfer mechanisms used in genetic engineering. **CO2:** Apply the concepts of DNA cloning, recombinant selection and gene expression systems in microorganisms and other biological systems. **CO3:** Analyze the structure, function and applications of different cloning and expression vectors used in genetic engineering and biotechnology. **CO4:** Explain the principles and applications of protein engineering, directed evolution, mutagenesis and microarray technologies in biological research and industry. **CO5:**Evaluate the role of genome editing technologies, including CRISPR-Cas9 and computational approaches, in modern biotechnology and life sciences.

Mapping between Cos and PSOs		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
	CO1	■	■	■		■	
	CO2	■	■	■		■	
	CO3	■	■	■		■	
	CO4	■		■		■	
	CO5	■		■	■	■	■

Course Content

UNIT 1: GENETIC ENGINEERING

1.1	Preparation of total cell DNA, plasmid and bacteriophage DNA
1.2	DNA manipulative enzymes and restriction endonucleases, Ligation - joining DNA molecules
1.3	Uptake of DNA by bacterial cells and Identification of recombinants
1.4	Introduction of phage DNA into bacterial cells and non-bacterial cells
1.5	Cloning vectors based on E. coli plasmids, λ bacteriophage, vectors for synthesis of single-stranded DNA
1.6	Vectors for yeast, fungi, higher plants and for animals
1.7	Cosmids, phasmids, other advanced vectors, Expression vectors
1.8	Screening and differential screening strategies available for library screening, Manipulation of Gene Expression in Prokaryotes

UNIT 2: PROTEIN ENGINEERING AND GENOME EDITING TECHNOLOGIES

2.1	Introduction of Protein Structure and function
2.2	Concepts for Protein Engineering
2.3	Computer Simulations: A Tool for Investigating the Function of Complex Biological Macromolecules
2.4	Evolutionary Methods for Protein Engineering (Methods for the directed evolution of proteins)
2.5	Directed Mutagenesis Procedures and Protein Engineering in various enzymes
2.6	DNA and Protein Microarray technology
2.7	CRISPR-Cas9 genome editing

References

- Brown, T. A. (2021). *Gene cloning and DNA analysis: An introduction* (8th ed.). Wiley-Blackwell. ISBN 9781119640783
- Reece, R. J. (2004). *Analysis of genes and genomes*. John Wiley & Sons.
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- Pacesa, M., Pelea, O., & Jinek, M. (2024). Past, present, and future of CRISPR genome editing technologies. Cell, 187(5), 1076–1100. https://doi.org/10.1016/j.cell.2024.01.042
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- Addgene – https://www.addgene.org
- DNA Learning Center (CSHL) – https://dnalc.cshl.edu
- EMBL-EBI – https://www.ebi.ac.uk
- Protein Data Bank (PDB) – https://www.rcsb.org
- UniProt – https://www.uniprot.org
- AlphaFold Protein Structure Database – https://alphafold.ebi.ac.uk
- Broad Institute CRISPR Resources – https://www.broadinstitute.org/what-broad/areas-focus/project-spotlight/crispr
- NPTEL – https://nptel.ac.in
- SWAYAM – https://swayam.gov.in
- SWAYAM Plus- https://swayam-plus.swayam2.ac.in/

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

[Subject code for Practical-2703000508016002]

PRACTICALS

BIOS-MBP-MJ-801 MOLECULAR BIOLOGY & GENOME ENGINEERING

Program Name	**B. Sc Honours In BIOSCIENCE (Microbiology)**
Semester	**VIII**
NCrF Credit Level	**06**
Course Type	**MAJOR**
Course Subtype	**MAJOR 1**
Subject Type	**Discipline Specific**
Course Code	**BIOS-MBP-MJ-801**
Course Level	**400-499**
Course Title	**Molecular Biology & Genome Engineering Practical**
Credit	**02**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	Upon successful completion of this practical course, the students will be able to: **CO1:** Perform fundamental molecular biology techniques including restriction digestion, ligation and PCR amplification for manipulation and analysis of nucleic acids. **CO2:** Demonstrate protein extraction, quantification and protein folding studies using standard biochemical and molecular biology techniques. **CO3:** Apply molecular techniques such as site-directed mutagenesis and primer design for genetic modification and experimental planning. **CO4:** Carryout protein extraction and protein folding related experiments.

Mapping between Cos and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1 To CO4						

Course Content

1. Restriction digestion of DNA/ plasmid using restriction endonuclease.
2. Ligation of DNA molecules.
3. In vitro amplification of DNA by PCR.
4. PCR Mediated Site Directed mutagenesis.
5. Protein extraction from bacterial cells and estimation by Bradford/Lowry assay.
6. Protein folding- denaturation and renaturation by Urea method.

- **References**
- Sambrook, J., & Russell, D. W. (2001). *Molecular cloning: A laboratory manual* (3rd ed.). Cold Spring Harbor Laboratory Press.
- Green, M. R., & Sambrook, J. (2019). *Molecular Cloning: A Laboratory Manual* (4th ed.). Cold Spring Harbor Laboratory Press.
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- Bisen, P. S. (2014). *Laboratory protocols in applied life sciences*. CRC Press.
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Online References

- Addgene Protocols – https://www.addgene.org/protocols/
- New England Biolabs (NEB) Protocols and Tools – https://www.neb.com
- Benchling Molecular Biology Platform – https://www.benchling.com
- SnapGene Molecular Biology Resources – https://www.snapgene.com
- NCBI BLAST and ORF Finder – https://www.ncbi.nlm.nih.gov
- Primer3 for Primer Design – https://primer3.ut.ee
- ExPASy Bioinformatics Resource Portal – https://www.expasy.org
- SWISS-MODEL Homology Modelling Server – https://swissmodel.expasy.org
- RCSB Protein Data Bank (PDB) – https://www.rcsb.org
- AlphaFold Protein Structure Database – https://alphafold.ebi.ac.uk
- CHOPCHOP CRISPR Design Tool – https://chopchop.cbu.uib.no
- EMBL-EBI Training Portal – https://www.ebi.ac.uk/training

Teaching Methodology

The teaching methodology will involve laboratory experiments, and practical demonstrations to facilitate comprehensive experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on internal examination 50% SEE: External assessment based on semester-end university examination.

[Subject code for Theory-2703000508026001]

BIOS-MB-MJ-802 ENVIRONMENTAL MICROBIOLOGY

Program Name	**B.Sc Honors In BIOSCIENCE (Microbiology)**
Semester	**VIII**
NCrF Credit Level	**6.0**
Course Type	**MAJOR**
Course Subtype	**MAJOR 2**
Subject Type	**Discipline Specific**
Course Code	**BIOS-MB-MJ-802**
Course Level	**400 - 499**
Course Title	**Environmental Microbiology**
Credit	**02**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	After completing this course, students will be able to: **CO-1:** Explain the principles and mechanisms involved in microbial degradation of organic and inorganic pollutants, waste treatment processes and environmental bioremediation technologies for sustainable environmental management. **CO-2:** Analyze microbial processes involved in biofuel production, waste valorization, renewable bioenergy generation and circular bioeconomy applications. **CO-3:** Evaluate environmental risks associated with GMOs, biosafety issues, environmental regulations and microbial threats in relation to environmental protection and public health. **CO-4:** Assess the role of microorganisms in climate change mitigation, antimicrobial resistance dissemination, One Health approaches and ecosystem sustainability. **CO-5:** Apply microbiological and biotechnological approaches for resource recovery, environmental restoration, sustainable agriculture and innovative environmental solutions.

Mapping between COs and PSOs

	PSO1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO-1		■	■		■	
CO-2	■	■	■	■	■	
CO-3		■		■	■	■
CO-4	■			■	■	■
CO-5		■	■	■	■	

Course Content

UNIT 1: BIOREMEDIATION AND ENVIRONMENTAL WASTE MANAGEMENT TECHNOLOGIES

1.1	Degradation of hydrocarbons, Chlorinated Hydrocarbons and Aromatics, and Dioxins

1.2	Degradation of Xenobiotics Pesticides, Polymer and dye
1.3	Bioremediation with Inorganic Pollutants
1.4	Treatment of Waste from Organic Chemical Industries
1.5	Treatment of Waste from Food and Dairy Industries, Sugar and Distillery Waste, Paper and Pulp industries
1.6	Pharmaceuticals and Hospital Waste Treatment
1.7	Treatment and management of Solid Waste, Treatment of Municipal Waste
1.8	Insight of biofuel prospects From microalgae as Renewable energy source for Environmental sustainability
UNIT 2: BIOENERGY, ONE HEALTH AND SUSTAINABLE ENVIRONMENTAL BIOTECHNOLOGY	
2.1	Biodiesel, Transesterification for biodiesel, Biomethane and Biohydrogen
2.2	Conversion of Waste to Biofuels, Bioproducts, and Bioenergy
2.3	Cellulosic Ethanol Technology
2.4	Microbial Solutions for Climate Change Toward an Economically
2.5	Resilient Future, An Introduction to Sustainable Circular Bioeconomy,
2.6	Environmental risk assessment, biosafety, GMO release and environmental regulations. Microorganisms and Bioterrorism
2.7	A One-Health Perspective of Antimicrobial Resistance: Human, Animals and Environmental Health, The One Health resistome Microbially Induced Calcium Carbonate Precipitation (MICP) and Its Potential in Bioconcrete: Microbiological and Molecular Concepts

References

- Barton, L. L., & Northup, D. E. (2011). Microbial ecology. John Wiley & Sons.
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- Evans, G. M., & Furlong, J. C. (2010). Environmental biotechnology: Theory and application (2nd ed.). Wiley-Blackwell.
- Singh, V. (Ed.). (2025). Sustainable waste management towards circular bioeconomy: Components, design innovation and impact. Springer.

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- Maier, R. M., Pepper, I. L., & Gerba, C. P. (Eds.). (2009). Environmental microbiology (2nd ed.). Academic Press.
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- Majumdar, A., Bagchi, D., Kotta-Loizou, I., & Buck, M. (2026). The One Health resistome: Integrating environmental, microbial, and human antimicrobial resistance surveillance and risk analysis in the digital age. Journal of Hazardous Materials, 513, Article 142431.
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Online Resources

- SWAYAM https://swayam.gov.in
- NPTEL https://nptel.ac.in
- World Health Organization (WHO) https://www.who.int
- Food and Agriculture Organization (FAO) https://www.fao.org
- United Nations Environment Programme (UNEP) https://www.unep.org
- Bioremediation and biodegradation [https://youtu.be/OskyBh4MDy4?si=i-mD149KV2FdpOw0]
- Biodegradation of pesticides [https://youtu.be/tffTDCnuvwY?si=rqeiVGzYOIhKo5wB]
- Biodegradation of heavy metals [https://youtu.be/nO21I-UvA9I?si=Po7mWIuCxOZPj5Js]
- Biodegradation[https://youtu.be/qhqlLZKhsYQ?si=UKsVtqnvCwnFtzZD]
- https://frtr.gov/matrix/documents/Monitored-Natural-Attenuation/2006-In-Situ-and-Ex-Situ-Biodegradation-Technologies-for-Remediation-of-Contaminated-Sites.PDF

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

[Subject code for Practical-2703000508026002]

PRACTICALS

BIOS-MBP-MJ-802 ENVIRONMENTAL MICROBIOLOGY

Program Name	**B. Sc Honours in BIOSCIENCE (Microbiology)**
Semester	**VIII**
NCrF Credit Level	**06**
Course Type	**MAJOR**
Course Subtype	**MAJOR 2**
Subject Type	**Discipline specific**
Course Code	**BIOS-MBP-MJ-802**
Course Level	**400-499**
Course Title	**Environmental Microbiology**
Credit	**02**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	After completing this course, students will be able to: **CO-1:** Perform laboratory techniques for assessment of microbial tolerance to environmental pollutants, biodegradation of xenobiotics and evaluation of microbial remediation potential. **CO-2:** Analyze environmental quality parameters and microbial indicators using BOD, COD and antimicrobial susceptibility testing for environmental monitoring and public health assessment. **CO-3:** Isolate, characterize and evaluate environmentally significant microorganisms including microalgae and pollutant-degrading microbial communities. **CO-4:** Apply computational tools for community metagenomic analysis to assess microbial diversity, community structure and ecological functions in environmental samples. **CO-5:** Interpret functional metagenomic datasets to identify metabolic pathways, biodegradation potential and environmental applications of microbial communities.

Mapping between COs and PSOs

	PSO1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO-1 to CO 5	■	■	■		■	

Course Content

1. Study of heavy metal tolerance by environmental microorganisms.
2. Pesticide tolerance assay of environmental microorganisms.
3. Biodegradation of pesticide by microbial isolates.
4. Microbial degradation of synthetic dyes (methylene blue/crystal violet) and evaluation of decolourization efficiency.
5. Estimation of Biochemical Oxygen Demand (BOD).
6. Estimation of Chemical Oxygen Demand (COD).
7. Isolation and characterization of microalgae from environmental samples.
8. Antibiotic susceptibility testing of environmental isolates

References

- Ian L. Pepper, Charles P. Gerba, Terry J. Gentry, Environmental Microbiology: A Laboratory Manual, 2nd Ed. Academic Press
- Glazer Alexander N., Nikaido Hiroshi, Microbial Biotechnology: Fundamentals of Applied Microbiology, 2nd Edition, Cambridge University Press
- Agathos Spiros and Reineke Walter, Biotechnology for the Environment: Strategy and Fundamentals, Series: Advances in Biochemical Engineering/Biotechnology, Vol. 81, Springer.
- Cappuccino, J. G., & Welsh, C. (2018). Microbiology: A laboratory manual (11th global ed.). Pearson Education Limited.
- Bisen, P. S. (2014). *Laboratory protocols in applied life sciences*. CRC Press.
- Alexander, S. K., Strete, D., & Niles, M. J. (2003). *Laboratory exercises in organismal and molecular microbiology*. McGraw-Hill Higher Education
- Aneja, K. R., Experiments in Microbiology 4thed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers, 2003.
- Saxena, J., Baunthiyal, M., & Ravi, I. (2015). *Laboratory manual of microbiology, biochemistry and molecular biology,* Scientific Publishers.
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- Tiwari, R. P., Hoondal, G. S., & Tewari, R. (2004). *Laboratory techniques in microbiology & biotechnology* (1st ed.). Abhishek Publications ISBN 81-8247-077-3

Online references

- National Center for Biotechnology Information (NCBI) https://www.ncbi.nlm.nih.gov
- PubMed https://pubmed.ncbi.nlm.nih.gov
- United Nations Environment Programme (UNEP) https://www.unep.org
- World Health Organization (WHO) – One Health & Antimicrobial Resistance Resources https://www.who.int
- Food and Agriculture Organization (FAO) https://www.fao.org
- Intergovernmental Panel on Climate Change (IPCC) https://www.ipcc.ch
- Department of Biotechnology (DBT), Government of India https://dbtindia.gov.in
- Genetic Engineering Appraisal Committee (GEAC), Government of India https://geacindia.gov.in

Teaching Methodology

The teaching methodology will involve laboratory experiments, and practical demonstrations to facilitate comprehensive experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on internal examination 50% SEE: External assessment based on semester-end university examination.

[Subject code for Theory-27030005080360001]

BIOS-MB-MJ-803 BIOPROCESS & FERMENTATION TECHNOLOGY

Program Name	**B.Sc Honors In BIOSCIENCE (Microbiology)**
Semester	**VIII**
NCrF Credit Level	**06**
Course Type	**MAJOR**
Course Subtype	**MAJOR 3**
Subject Type	**Discipline Specific**
Course Code	**BIOS-MB-MJ-803**
Course Level	**400 - 499**
Course Title	**Bioprocess & Fermentation Technology**
Credit	**02**
Effective From	**Academic year: 2026-27**
Course Outcomes	Upon successful completion of this course, the students will be able to: **CO1:** Explain the principles of upstream bioprocessing, including microbial strain selection, strain improvement, culture preservation, fermentation media formulation and inoculum development for industrial fermentation processes **CO2:** Apply the concepts of microbial growth kinetics, fermentation strategies, solid-state fermentation and process optimization for efficient bioprocess developmen **CO3:** Analyze the roles of aeration, agitation, oxygen transfer, scale-up and scale-down strategies in industrial fermentation and bioreactor performance. **CO4:** Evaluate downstream processing techniques including cell separation, cell disruption, extraction, purification and product recovery used in industrial biotechnology **CO5:** Assess modern advances in bioprocess engineering, including heterologous protein production, synthetic biology, Bioprocessing 4.0 and integrated industrial biomanufacturing systems.

Mapping between Cos and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						
CO3						
CO4						
CO5						

Course Content	
UNIT 1: UPSTREAM PROCESSING AND FERMENTATION TECHNOLOGY	
1.1	Isolation of suitable microorganisms from the environment, Culture collections, Improvement of industrial microorganisms, Strain stability,
1.2	Culture preservation: Storage at reduced temperature, storage in a dehydrated form and quality control of preserved stock cultures
1.3	Fermentation media, formulation, Carbon sources Nitrogen source Minerals & others growth factor, precursors, inducers inhibitors, Oxygen requirement, Antifoam and Statistical media Optimization
1.4	Microbial growth kinetics: Batch culture, Continuous culture, Fed-batch culture
1.5	Inoculum development, inoculum transfer, Development of inocula for yeast processes and bacteria
1.6	Introduction to Solid-state fermentation, Suitability of Microorganisms for SSF Processes Biomass Measurement, Factors Affecting SSF, Scale-Up, Modeling in SSF, Types of SSF Bioreactors
1.7	Sterilization and Contamination Control: Sterilization of media, air and equipment; filtration systems; contamination sources; aseptic operation; biosafety and GMP considerations.
1.8	Process Monitoring and Control: Measurement and control of temperature, pH, dissolved oxygen, foam, pressure and biomass; sensors, biosensors and process automation
UNIT 2: DOWNSTREAM PROCESSING AND MODERN BIOPROCESS ENGINEERING	
2.1	Aeration and agitation: Introduction, Oxygen requirements of industrial fermentations, Oxygen supply, Determination of KLa values, Fluid rheology, Factors affecting KLa values in fermentation vessels,
2.2	Scale-Up and Scale-Down
2.3	Downstream Processing: Cell harvesting, filtration, centrifugation, cell disruption, extraction, precipitation, membrane separation, chromatography and product formulation.
2.4	Cell disruption by Physico-mechanical methods, Chemical and biological methods
2.5	Products purification: Liquid–liquid extraction, Solvent recovery, Two-phase aqueous extraction, Reversed micelle extraction, Supercritical fluid extraction, Adsorption, Removal of volatile products, Drying, Crystallization
2.6	Recent Advances and Impacts of Microtiter Plate-Based Fermentations in Synthetic Biology and Bioprocess Development
2.7	Emerging trends in bioprocess technology: microbiome microbiome-based biotechnology, omics-guided bioprocessing, AI-assisted fermentation, continuous biomanufacturing and Industry applications.

References

- Stanbury, P. F., Whitaker, A., & Hall, S. J. (2016). *Principles of fermentation technology* (3rd ed.). Elsevier Science & Technology.
- Waites, M. J., Morgan, N. L., Rockey, J. S., & Higton, G. (2001). *Industrial microbiology: An introduction*. Blackwell Science.
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Online References

- Addgene – https://www.addgene.org
- New England Biolabs (NEB) Protocols and Technical Resources – https://www.neb.com/tools-and-resources
- Thermo Fisher Scientific Learning Center – https://www.thermofisher.com
- Cytiva Bioprocess Resource Center – https://www.cytivalifesciences.com
- BioProcess International – https://www.bioprocessintl.com
- EMBL-EBI Training Portal – https://www.ebi.ac.uk/training
- NPTEL – https://nptel.ac.in
- SWAYAM – https://swayam.gov.in

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning and demonstrations to facilitate comprehensive theoretical understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination

[Subject code for Practical-2703000508036002]

PRACTICALS

BIOS-MBP-MJ-803 BIOPROCESS & FERMENTATION TECHNOLOGY

Program Name	**B. Sc Honours In BIOSCIENCE (Microbiology)**
Semester	**VIII**
NCrF Credit Level	**06**
Course Type	**MAJOR**
Course Subtype	**MAJOR 3**
Subject Type	**Discipline specific**
Course Code	**BIOS-MBP-MJ-803**
Course Level	**400-499**
Course Title	**Bioprocess & Fermentation Technology**
Credit	**02**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	Upon successful completion of this practical course, the students will be able to: **CO1:** Prepare and optimize fermentation media, cultivate industrial microorganisms and evaluate microbial growth and biomass production using standard bioprocess techniques. **CO2:** Perform fermentation processes for the production of industrially important metabolites and enzymes under submerged and solid-state fermentation conditions. **CO3:** Apply cell harvesting, product recovery and partial purification techniques used in downstream processing of microbial products. **CO4:** Operate and analyze laboratory-scale bioreactors, oxygen transfer parameters and fermentation performance using appropriate analytical methods.

Mapping between Cos and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1 To CO 4						

Course content

1. Preparation and optimization of fermentation media for microbial growth and product formation.
2. Cell harvesting by centrifugation and filtration techniques and Estimation of biomass concentration by spectrophotometric and dry cell weight methods.
3. Production and quantification of citric acid by Aspergillus niger fermentation.
4. Production and assay of industrially important enzymes (protease/cellulase) under submerged fermentation.

5. Production of microbial enzymes under solid-state fermentation using agro-industrial substrates.
6. Determination of oxygen transfer characteristics and estimation of volumetric oxygen transfer coefficient (kLa).
7. Recovery and partial purification of fermentation products by precipitation and membrane filtration methods.
8. Analysis of fermentation products using chromatographic or spectrophotometric methods.

References

- Walker, J. M. (Ed.). (2009). *The Protein Protocols Handbook* (3rd ed.). Humana Press.
- Cappuccino, J. G., & Welsh, C. (2018). Microbiology: A laboratory manual (11th global ed.). Pearson Education Limited.
- Bisen, P. S. (2014). *Laboratory protocols in applied life sciences*. CRC Press.
- Alexander, S. K., Strete, D., & Niles, M. J. (2003). *Laboratory exercises in organismal and molecular microbiology*. McGraw-Hill Higher Education
- Aneja, K. R., Experiments in Microbiology 4thed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers, 2003.
- Saxena, J., Baunthiyal, M., & Ravi, I. (2015). *Laboratory manual of microbiology, biochemistry and molecular biology,* Scientific Publishers.
- Bossi, Camilli, Grundl, Experiments in Bacterial Genetics: A Laboratory Manual, Cold Spring Harbor Laboratory Press, 2023, ISBN 978-1621824497
- Tiwari, R. P., Hoondal, G. S., & Tewari, R. (2004). *Laboratory techniques in microbiology & biotechnology* (1st ed.). Abhishek Publications ISBN 81-8247-077-3

Online References

- Addgene Protocols – https://www.addgene.org/protocols
- New England Biolabs (NEB) Protocols – https://www.neb.com/protocols
- Thermo Fisher Scientific Learning Center – https://www.thermofisher.com
- Cytiva Bioprocess Resource Center – https://www.cytivalifesciences.com
- EMBL-EBI Training Portal – https://www.ebi.ac.uk/training
- BioProcess International – https://www.bioprocessintl.com
- NPTEL Biotechnology Courses – https://nptel.ac.in
- SWAYAM – https://swayam.gov.in
- JMP Learning Library – https://www.jmp.com/en_us/learning-library.html

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, Laboratory exercises and practical, demonstrations to facilitate comprehensive theoretical understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, practical test, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination

[Subject code-2703000508056001]

BIOS-MB-MJ-804: BIOPHYSICS, ANALYTICAL BIOCHEMISTRY AND INSTRUMENTATION

Program Name	**B. Sc Honours BIOSCIENCE (Microbiology)**
Semester	**VIII**
NCrF Credit Level	**06**
Course Type	**MAJOR**
Course Subtype	**MAJOR 3**
Subject Type	**Discipline specific**
Course Code	**BIOS-MB-MJ-804**
Course Level	**400-499**
Course Title	**Biophysics, Analytical Biochemistry and Instrumentation**
Credit	**02**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	Upon successful completion of this practical course, the students will be able to: **CO-1:** Explain the principles of biophysical chemistry, chromatography, electrophoresis and their applications in biological and biochemical investigations. **CO-2:** Apply the principles of spectroscopic, microscopic and centrifugation techniques for analysis and characterization of biomolecules and biological systems. **CO-3:** Analyze molecular structure determination methods, advanced analytical techniques and nucleic acid quantification approaches used in modern biological research. **CO-4:** Evaluate the applications of mass spectrometry, PCR variants, flow cytometry, biosensors and imaging technologies in microbiology, biotechnology and biomedical sciences. **CO-5:** Assess immunological, radiolabeling and electrophysiological techniques and their significance in diagnostics, research and healthcare applications.

Mapping between Cos and PSOs

	PSO1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO-1	■			■		
CO-2	■			■		
CO-3	■			■		
CO-4		■		■		■
CO-5		■		■		■

Course content

UNIT 1: BIOPHYSICAL CHEMISTRY, CHROMATOGRAPHIC AND ELECTROPHORETIC TECHNIQUES

1.1	Principles of biophysical chemistry: pH, buffer, reaction kinetics, thermodynamics, colligative properties
1.2	An Introduction to Chromatographic Separations, Principle, instrumentation and applications of Paper chromatography, Thin Layer Chromatography (TLC),
1.3	Principle, instrumentation and applications of Adsorption chromatography, Partition chromatography, Ion Exchange Chromatography, Size Exclusion (Gel Filtration) Chromatography, Affinity Chromatography,
1.4	Principle, instrumentation and applications of Gas Chromatography (GC) and High-Performance Liquid Chromatography (HPLC)
1.5	Electrophoresis: General principles, support media and buffers, electrophoresis of proteins, electrophoresis of nucleic acids, capillary electrophoresis and microchip electrophoresis.
UNIT 2: SPECTROSCOPY, STRUCTURAL BIOLOGY AND ADVANCED ANALYTICAL TECHNIQUES	
2.1	Spectroscopic Techniques for Biomolecular Analysis: UV–Visible Spectroscopy, Fluorescence Spectroscopy, Circular Dichroism (CD) Spectroscopy, Electron Spin Resonance (ESR/EPR) Spectroscopy
2.2	Structural Biology and Molecular Structure Determination: X-ray Diffraction (X-ray Crystallography), Cryo-Electron Microscopy (Cryo-EM), Nuclear Magnetic Resonance (NMR) Spectroscopy in
2.3	Structure Determination Advanced Molecular Characterization and Interaction Analysis: Light Scattering Techniques, Mass Spectrometry and its Types,
2.4	Surface Plasmon Resonance (SPR) Advanced Analytical Techniques: MALDI-TOF Mass Spectrometry, Liquid Chromatography–Mass Spectrometry (LC-
2.5	MS) and Liquid Chromatography–Tandem Mass Spectrometry (LC-MS/MS) Principle of Centrifugation, Differential centrifugation, density-gradient centrifugation, ultracentrifugation
UNIT 3: MOLECULAR ANALYSIS, QUANTIFICATION AND IMAGING TECHNOLOGIES	
3.1	Infrared and Raman Spectroscopy and Atomic Spectroscopy, Fluorescence Spectroscopy
3.2	PCR, Q-PCR, ddPCR and other variants of PCR,
3.3	Spectrophotometric and fluorometric nucleic acid quantification (Nanodrop and Qubit), Nucleic acid hybridization,
3.4	Protein Sequencing: Significance, Methods, and Applications
3.5	Confocal microscopy, fluorescence imaging, transmission electron microscopy (TEM), scanning electron microscopy (SEM), cryo-electron microscopy (Cryo-EM), Atomic Force Microscopy (AFM)

UNIT 4: CELLULAR ANALYSIS, IMMUNOTECHNIQUES AND BIOMEDICAL INSTRUMENTATION	
4.1	Principles, instrumentation and application of flow cytometry
4.2	Radiolabeling techniques: Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines
4.3	Histochemical and Immunotechniques: ELISA, RIA, blotting techniques, immunofluorescence, immunoprecipitation, FISH and GISH techniques
4.4	Concept, types and application biosensors
4.5	Electrophysiological methods: Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT

References

- Nelson, D. L., Cox, M. M., Hoskins, A. A., & Lehninger, A. L. (2021). *Lehninger principles of biochemistry* (8th ed.). W. H. Freeman and Company
- Kumar, P. (2024). *Biophysics and molecular biology: Tools and techniques* (5th ed.). Pearson India.
- Kumar, P. (2018). *Fundamentals and techniques of biophysics and molecular biology* (2nd ed.). Pathfinder Publication.
- Kalidàs, C., & Sangaranarayanan, M. V. (2023). *Biophysical Chemistry: Techniques and Applications* (1st ed.). Springer International Publishing.
- Hofmann, A., & Clokie, S. J. (Eds.). (2018). *Wilson and Walker's principles and techniques of biochemistry and molecular biology* (8th ed.). Cambridge University Press.
- Skoog, D. A., Holler, F. J., & Crouch, S. R. (2018). *Principles of instrumental analysis* (7th ed.). Cengage Learning.
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- https://www.metwarebio.com/what-is-protein-sequencing/

sOnline References

- https://www.metwarebio.com/what-is-protein-sequencing/
- National Center for Biotechnology Information (NCBI) – https://www.ncbi.nlm.nih.gov
- EMBL-European Bioinformatics Institute (EMBL-EBI) – https://www.ebi.ac.uk
- ExPASy Bioinformatics Resource Portal – https://www.expasy.org
- Protein Data Bank (PDB) – https://www.rcsb.org
- UniProt Protein Knowledgebase – https://www.uniprot.org
- PubChem Chemical Database – https://pubchem.ncbi.nlm.nih.gov

- NIST Chemistry WebBook – https://webbook.nist.gov
- MicroscopyU (Nikon Microscopy Education) – https://www.microscopyu.com
- Thermo Fisher Learning Center – https://www.thermofisher.com/in/en/home/global/forms/life-science/learning-center.html
- NPTEL Courses – https://nptel.ac.in
- SWAYAM – https://swayam.gov.in

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning and demonstrations to facilitate comprehensive theoretical understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

Undergraduate Program

In

BIOSCIENCE (Microbiology)

4 years (Honours without OJT/Research Project)

B. Sc. Sem 7 Syllabus

(Effective from Academic Year: 2026-27)

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT PROGRAM TITLE	
Name of Program	Bachelor of Science (Honours with OJT/RP) In BIOSCIENCE (Microbiology)
Program Abbreviation	B.Sc. BIOS (MB)
Duration	One Year
Eligibility Criteria	As per university norms
Pre-requisite	Basic concepts in the field of microbiology
Medium of Instruction	English
Objective of Program	Objective of this program is to provide Fundamental and applied knowledge of Microorganism to students. To develop Laboratory skills and to train the students in scientific thinking to prepare for carriers like health care, pharmaceutical, biotechnology, diagnostics, industry and academia and to promote awareness to students of microbial application in the field of diseases prevention, environmental sustainability and technological innovation.
Program Outcome (PO)	**PO-01: Scientific Knowledge & Conceptual Understanding:** Develop a strong foundation in scientific principles, theories and concepts across disciplines, fostering interdisciplinary learning, advance knowledge and problem-solving abilities. **PO-02: Analytical & Critical Thinking:** Apply critical thinking and analytical reasoning to evaluate scientific data, hypotheses and real-world problems, leading to evidence-based conclusions. **PO-03: Research & Inquiry-based Learning:** Develop investigative skills through experimentation, data analysis and scientific inquiry to contribute to research and innovation. **PO-04: Laboratory & Technical Skills:** Gain hands-on experience with laboratory techniques, instrumentation and computational tools relevant to scientific research and industry applications. **PO-05: Digital & Computational Literacy:** Utilize digital tools, computational techniques and emerging technologies such as AI, bioinformatics and statistical modelling to enhance scientific learning and problem-solving.

	PO-06: <u>Environmental & Societal Responsibility</u>: Understand the role of science in addressing environmental, health and societal challenges, promoting sustainability and ethical responsibility. **PO-07: <u>Effective Communication & Collaboration</u>:** Develop proficiency in scientific communication, both written and oral, for effective dissemination of knowledge while collaborating in multidisciplinary teams. **PO-08: <u>Innovation & Entrepreneurship</u>:** Foster an entrepreneurial mind-set by applying scientific knowledge for innovation, technology development, and industry-oriented applications. Develop sustainable solutions to address real-world challenges in research and environmental management. **PO-09: <u>Lifelong Learning & Professional Growth</u>:** Cultivate curiosity and adaptability for continuous learning, equipping students for higher education, research, and professional careers. **PO-10: <u>Ethical Leadership & Value-based Education</u>:** Develop leadership qualities, ethical values, and a sense of responsibility in applying science for societal progress, aligning with Indian knowledge systems and global perspectives.
Program Specific Outcomes (PSO)	**PSO1 : <u>Core Knowledge in Microbiology:-</u>** • Understand the fundamental concepts of microbiology, including microbial diversity, structure, function and classification. • Explain the role of microorganism in human health, industry, agriculture and the environment. **PSO2 : <u>Practical and Laboratory Skills:-</u>** • Perform basic microbiological techniques such as microbial staining, culturing, isolation and enumeration. • Utilize aseptic techniques and biosafety measures in handling microorganisms. • Operate laboratory instruments effectively. **PSO3 : <u>Applied and Industrial Microbiology:-</u>** • Understand the role of microorganisms and their application in food, pharmaceuticals, biotechnology and environmental science. • Demonstrate knowledge of fermentation processes,

microbial biotechnology and their industrial significance.

- Demonstrate the ability to work in teams and encourage innovation and entrepreneurship.

PSO4 : <u>Disease and Health-Related Microbiology:-</u>

- Identify pathogenic microorganisms and understand their role in infectious diseases.
- Explain antimicrobial resistance, immunity and the role of microbes in public health.

PSO5 : <u>Critical Thinking and Problem-Solving:-</u>

- Analyze scientific data, interpret experimental results and troubleshoot laboratory issues.
- Apply microbiological knowledge to solve real-world problems in healthcare, industry, environmental management and sustainability.

PSO6 : <u>Ethical and Professional Responsibilities:-</u>

- Follow ethical guidelines in microbiological research and laboratory work.
- Adhere to safety protocols and regulatory standards in microbiology-related fields.

Mapping between POs and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
PO1	■		■		■	
PO2		■			■	
PO3		■	■			
PO4				■		■
PO5		■		■	■	■
PO6			■		■	
PO7					■	■
PO8			■		■	
PO9	■	■	■	■	■	
PO10		■		■		■

STRUCTURE FOR ERP – BIOSCIENCE (MICROBIOLOGY) – SEM – 7 [illegible]ours without OJT/RP - (UG)															
Course Category	Course Code	Course Title	Mark sheet Title in English	Level of Course	Teaching Hours/Week		Exam Duration		Credit		Internal Marks		External Marks		Total	
					TH	PR	TH	PR	TH	PR	TH	PR	TH	PR	TH	PR
MAJOR 1	BIOS-MB – MJ - 701	MICROBIAL GENETICS	MICROBIAL GENETICS	400-499	02	04	01.00 h	06.00 h	02	02	25	25	25	25	50	50
MAJOR 2	BIOS-MB – MJ - 702	MICROBIAL METABOLISM & PHYSIO LOGICAL ADAPTATION	MICROBIAL METABOLISM & PHYSIOLOGICAL ADAPTATION	400-499	02	04	01.00 h	06.00 h	02	02	25	25	25	25	50	50
MAJOR 3	BIOS-MB – MJ - 703	MICROBIAL BIOTECHNOLOGY	MICROBIAL BIOTECHNOLOGY	400-499	02	04	01.00 h	06.00 h	02	02	25	25	25	25	50	50
MAJOR 4	BIOS-MB – MJ - 704	TRADITIONAL PRACTICES IN MICROBIOLOGY	TRADITIONAL PRACTICES IN MICROBIOLOGY	400-499	04	00	02.00 h	00 h	04	00	50	-	50	-	100	-
ME	BIOS-ME-701	FUNDAMENTALS OF CYBER SECURITY	FUNDAMENTALS OF CYBER SECURITY	400-499	04	00	02.00 h	00 h	04	00	50	-	50	-	100	-
MAJOR 5	BIOS-MB-MJ-705	RESEARCH METHODOLOGY-I	RESEARCH METHODOLOGY-I	400-499	02	-	01	-	02		25		25		50	-

- Cyber security syllabus will be prepared by computer science faculty and of VNSGU, Surat.
- Research methodology-I syllabus will be prepared by Adhoc. Board of Research methodology, VNSGU, Surat.

[Subject code for Theory-2603000507016001]
[Subject code for Practical-2603000507016002]

BIOS-MB-MJ-701 MICROBIAL GENETICS	
Program Name	**B. Sc Honours BIOSCIENCE (Microbiology)**
Semester	**VII**
NCrF Credit Level	**06**
Course Type	**MAJOR**
Course Subtype	**MAJOR 1**
Subject Type	**Discipline Specific**
Course Code	**BIOS-MB-MJ-701**
Course Level	**400-499**
Course Title	**Microbial Genetics**
Credit	**02**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	After completing this course, students will be able to: **CO-1**: Explain the principles of molecular genetics including DNA replication, transcription, translation, protein processing, and genetic information flow in microorganisms. **CO-2**: Analyse mechanisms of microbial gene regulation including operon systems, transcriptional control, RNA-based regulation, and signal transduction pathways. **CO-3**: Analyse the causes of mutations, DNA damage, and repair mechanisms involved in maintaining genetic stability in microorganisms. **CO-4**: Interpret the structure, properties, and functions of plasmids, transposons, bacteriophages, and other mobile genetic elements in microbial systems. **CO-5**: Apply concepts of microbial genetics and gene transfer mechanisms in biotechnology, industrial microbiology, environmental microbiology, and microbial research applications.
Mapping between COs and PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■					
CO2	■				■	
CO3	■	■				
CO4	■				■	
CO5	■	■	■		■	■

Course Content
UNIT 1: NUCLEIC ACID STRUCTURE AND SYNTHESIS

1.1	*Molecular Biology and Genetic Elements:* DNA and Genetic Information Flow, Genetic Elements: Chromosomes and Plasmids overview
1.2	*DNA Replication:* Templates, Enzymes, and Replication Fork, Bidirectional Replication, the Replisome, and Proofreading
1.3	*RNA Synthesis:* Transcription in Bacteria, in Archaea
1.4	*Protein Synthesis*: Translation, Amino Acids, Polypeptides, and Proteins, Transfer RNA, Genetic Code, Mechanism of Protein Synthesis
1.5	*Protein Processing, Secretion, and Targeting:* Assisted Protein Folding and Chaperones, Protein Secretion in Gram-Negative Systems
1.6	*DNA-Binding Proteins and Transcriptional Regulation*: DNA-Binding Proteins, Negative Control- Repression and Induction, Positive Control-Activation, Global Control and the *lac* Operon, Transcription Controls in Archaea
1.7	*RNA-Based Regulation*: Regulatory RNAs, Riboswitches, Attenuation
1.8	*Regulation of Enzymes and Other Proteins*: Feedback Inhibition, Post-Translational Regulation
UNIT 2: MUTATION, PLASMIDS, GENE TRANSFER AND GENOME REARRANGEMENT	
2.1	*Mutation and DNA repair:* The causes of mutations, Repair of mutations and other types of DNA damage
2.2	*Plasmid*: Functions Encoded, Structure, Properties of Plasmids
2.3	Transformation, Artificially Induced Competence- Chemical Induction, Electroporation and Protoplast Transformation
2.4	Transduction
2.5	Conjugation and Formation of Hfr Strains & Chromosome Mobilization, mapping genes by interrupted mating, Gene Transfer in Archaea,
2.6	*Recombination*: Homologous and site-specific recombination
2.7	*Transposition*: Transposition, Mechanisms of Transposition and General Properties of Transposons

References

- Brown, T. A. (2023). *Genomes 5* (5th ed.). CRC Press. ISBN: 978-0-367-67866-1
- Henkin, T. M., & Peters, J. E. (2020). *Snyder and Champness molecular genetics of bacteria* (5th ed.). ASM Press; John Wiley & Sons. ISBN 9781555819750
- Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2014). *Lewin's GENES XI* (11th ed.). Jones & Bartlett Learning. ISBN 9781449659851
- Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. (2018). *Brock biology of microorganisms* (15th ed.). Pearson. ISBN 13: 978-1-292-23510-3
- Willey, J. M., Sandman, K. M., & Wood, D. H. (2023). *Prescott's microbiology* (12th ed.). McGraw-Hill Education. ISBN 978-1-265-12303-1

Online references

- https://swayam.gov.in/
- https://swayam-plus.swayam2.ac.in/

Teaching Methodology
The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.
Evaluation scheme
50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

PRACTICALS

BIOS-MBP-MJ-701 MICROBIAL GENETICS

Program Name	**B. Sc Honours In BIOSCIENCE (Microbiology)**
Semester	**VII**
NCrF Credit Level	**06**
Course Type	**MAJOR**
Course Subtype	**MAJOR 1**
Subject Type	**Discipline specific**
Course Code	**BIOS-MBP-MJ-701**
Course Level	**400-499**
Course Title	**Microbial Genetics Practical**
Credit	**02**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	Upon successful completion of this practical course, the students will be able to: **CO1:** Perform the isolation, purification and quantitative estimation of genomic DNA, plasmid DNA and RNA from microbial cells using standard molecular biology techniques. **CO2:** Execute microbial genetic experiments involving mutation induction, mutant isolation and gene expression analysis to understand microbial genetics and gene regulation. **CO3:** Demonstrate bacterial transformation techniques and interpret the role of gene transfer mechanisms in microbial genetic exchange. **CO4:** To demonstrate execution of lac-operon.

Mapping between Cos and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1 to CO4						

Course Content

1. Extraction of bacterial genomic DNA from bacteria and Quantitative estimation of DNA.
2. Extraction of RNA from yeast and Quantitative estimation of RNA.
3. Isolation of Plasmid DNA.
4. Isolation of Auxotrophic Mutants by Replica Plating technique.
5. Study of UV-Induced Mutation in Bacteria.
6. Induction of β-Galactosidase Activity (lac Operon Demonstration).
7. Bacterial Transformation testing using agar plate methods.

References

- Patel, R. J., & Patel, R. K. Experimental Microbiology, Vol. 1, 10th Edition, Aditya, 2022
- Patel, R.J., & Patel, R. K. Experimental Microbiology, Vol. 2, 10th Edition, Aditya, 2022.
- Aneja, K. R., Experiments in Microbiology 4thed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers, 2003.
- Cappuccino, J. G., Microbiology: A Laboratory Manual, 6Ed., Singapore Pearson Education Pvt. Ltd., 2005.
- Bossi, Camilli, Grundl, Experiments in Bacterial Genetics: A Laboratory Manual, Cold Spring Harbor Laboratory Press, 2023, ISBN 978-1621824497
- Tiwari, R. P., Hoondal, G. S., & Tewari, R. (2004). Laboratory techniques in microbiology & biotechnology (1st ed.). Abhishek Publications ISBN 81-8247-077-3

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive Discussion, seminars, assignments, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

[Subject code for Theory-2603000507026001]

BIOS-MB-MJ-702: MICROBIAL METABOLISM AND PHYSIOLOGICAL ADAPTATION

Program Name	**B. Sc Honours In BIOSCIENCE (Microbiology)**
Semester	**VII**
NCrF Credit Level	**06**
Course Type	**MAJOR**
Course Subtype	**MAJOR 2**
Subject Type	**Discipline Specific**
Course Code	**BIOS-MB-MJ-702**
Course Level	**400-499**
Course Title	**Microbial Metabolism and Physiological Adaptation**
Credit	**02**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	After completing this course, students will be able to: **CO-1**: Explain the fundamental principles of microbial metabolism, bioenergetics, ATP synthesis, redox reactions, and energy generation mechanisms in microorganisms. **CO-2**: Describe major catabolic pathways including aerobic respiration, anaerobic respiration, fermentation pathways, autotrophy, lithotrophy, methanogenesis, and phototrophy in microorganisms. **CO-3**: Explain anabolic processes including biosynthesis of amino acids, nucleotides, lipids, peptidoglycan, and inorganic metabolic pathways such as nitrogen and sulfur metabolism. **CO-4**: Demonstrate practical skills in microbial physiology techniques including growth curve analysis, fermentation tests, anaerobic cultivation, enzymatic assays, endospore staining, and biofilm studies. **CO-5**: Apply concepts of microbial metabolism and physiological adaptations in environmental microbiology, industrial microbiology, biotechnology, metabolic engineering, and sustainable microbial processes.

Mapping between Cos and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■					
CO2	■					
CO3	■	■	■		■	
CO4	■	■	■		■	
CO5	■	■	■		■	■

Course Content

UNIT 1: METABOLISM AND BIOENERGETICS

1.1	Introduction to Microbial Metabolism, Important Principles and Concepts, ATP- the Major Energy Currency
1.2	Redox Reactions, Sequential Redox Reactions, Biochemical Pathways- Sets of Linked Chemical Reactions, Enzymes and Ribozymes, Metabolism regulation to maintain Homeostasis
1.3	Cellular Mechanisms for ATP Synthesis, Chemiosmotic Theory, ATP Synthase, The Proton Motive Force (PMF) Quantifying PMF, Environmental impacts on PMF
1.4	Oxidative decarboxylation of pyruvate, TCA cycle, Glyoxylate cycle, anaplerotic reactions
1.5	Electron Transport and Oxidative Phosphorylation, Aerobic respiration, Anaerobic respiration, Energy yield comparison Fermentation Pathways:
1.6	Propionate, Acetate, Lactate, Mixed-Acid and Butanediol Fermentation, and Butyrate Fermentation, Syntrophy Autotrophic Pathways: Concept of autotrophy, Calvin cycle, Reverse TCA cycle
1.7	C1 Metabolism: Acetogenesis, Methanogenesis, Methanotrophy Phototrophy (Light Reactions in Oxygenic Photosynthesis and in Anoxygenic Photosynthesis, Rhodopsin-Based Phototrophy)
UNIT 2: MICROBIAL ANABOLISM AND PHYSIOLOGICAL ADAPTATION	
2.1	Lithotrophy: hydrogen-oxidizing bacteria, Ammonia-oxidizing bacteria, Nitrite-oxidizing bacteria, Sulfur-oxidizing prokaryotes, Iron-oxidizing bacteria
2.2	Inorganic metabolisms: Assimilation and Dissimilation of Nitrate and Sulfate, Nitrogen fixation: nitrogen-fixing systems and nitrogenase
2.3	Anabolism and Biosynthesis: concept of biosynthesis, Precursor Metabolites for Biosynthesis
2.4	Lipid Synthesis: Fatty Acids and Phospholipids, Sterols and Isoprenoid Lipids, Lipopolysaccharides, Synthesis of Peptidoglycan
2.5	Two component regulatory system
2.6	Microbial stress responses: oxidative stress, physiological response to oxidative stress in *E. coli*, heat shock response, sporulation, stages of sporulation, germination and regulation in *Bacillus subtilis*, resistance properties of endospores
2.7	Prevalence, Importance, Properties, and Regulation of Biofilm Formation, Quorum Sensing, Metabolic engineering of bacteria

References

- Kim, B. H., & Gadd, G. M. (2008). Bacterial physiology and metabolism (2nd ed.). Cambridge University Press. ISBN-13 978-0-511-39322-8
- Kumar, R. R., & Prasad, S. (2011). Metabolic engineering of bacteria. Indian Journal of Microbiology, 51(3), 403–409. https://doi.org/10.1007/s12088-011-0172-8
- Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M.,; Stahl, D. A. (2018). Brock biology of microorganisms (15th ed.). Pearson.
- Moat, A. G., Foster, J. W., & amp; Spector, M. P. (2002). Microbial physiology (4th ed.). Wiley-Liss.
- Stevens, A. M., Ditty, J. L., Parales, R. E., & amp; Merkel, S. M. (2023). Microbial physiology: Unity and diversity. ASM Books / Wiley. ISBN: 978-1683673675
- Stevens, A. M., Ditty, J. L., Parales, R. E., & Merkel, S. M. (2023). Microbial physiology: Unity and diversity. ASM Books / Wiley. ISBN: 978-1683673675
- White, D., Drummond, J., & Fuqua, C. (2012). The physiology and biochemistry of prokaryotes (4th ed.). Oxford University Press.
- Willey, J. M., Sandman, K. M., & Wood, D. H. (2023). Prescott's microbiology (12th ed.). McGraw-Hill Education. ISBN 978-1-265-12303-1

Online reference

- https://swayam.gov.in/
- https://swayam-plus.swayam2.ac.in/

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Evaluation scheme

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

[Subject code for Practical-2603000507026002]

PRACTICALS

BIOS-MBP-MJ-702 MICROBIAL METABOLISM AND PHYSIOLOGICAL ADAPTATION

Program Name	**B. Sc Honours In BIOSCIENCE (Microbiology)**
Semester	**VII**
NCrF Credit Level	**06**
Course Type	**MAJOR**
Course Subtype	**MAJOR 2**
Subject Type	**Discipline Specific**
Course Code	**BIOS-MBP-MJ-702**
Course Level	**400-499**
Course Title	**Microbial Metabolism and Physiological Adaptation Practical**
Credit	**02**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	After completing this course, students will be able to: **CO-1**: Gain practical skills to determine the growth curve of bacterial culture and analyse the effect of stress on the growth curve pattern. **CO-2**: Develop skill to estimate the sugar utilized by yeast culture. **CO-3**: Perform the technique of endospore staining and determination of the biofilm formation. **CO-4**: Demonstrate the effect of bile salts on gram positive and gram-negative bacteria.

Mapping between Cos and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1 to CO4						

Course Content

1. Study of Bacterial Growth Curve under stress conditions of temperature.
2. Study of Bacterial Growth Curve under stress conditions of pH.
3. Estimation of sugar utilization by yeast by DNSA method.
4. Study of Sporulation by Endospore Staining.
5. Study of Biofilm formation by tube method using crystal violet staining.
6. Determination of sensitivity of gram positive and gram-negative bacteria to bile salts.
7. Enrichment and microscopic observation of Photosynthetic Bacteria.

References

- Patel, R. J., & Patel, R. K. Experimental Microbiology, Vol. 1, 10th Edition, Aditya, 2022
- Patel, R.J., & Patel, R. K. Experimental Microbiology, Vol. 2, 10th Edition, Aditya, 2022.
- Aneja, K. R., Experiments in Microbiology 4thed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers, 2003.

- Cappuccino, J. G., Microbiology: A Laboratory Manual, 6Ed., Singapore Pearson Education Pvt. Ltd., 2005.
- Tiwari, R. P., Hoondal, G. S.,; Tewari, R. (2004). Laboratory techniques in microbiology ; biotechnology (1st ed.). Abhishek Publications ISBN 81-8247-077-3

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive Discussions, seminars, assignments, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

[Subject code for Theory-2603000507036001]

[Subject code for Practical-2603000507036002]

BIOS-MB-MJ-703: MICROBIAL BIOTECHNOLOGY

Program Name	**B. Sc Honours In BIOSCIENCE (Microbiology)**
Semester	**VII**
NCrF Credit Level	**06**
Course Type	**MAJOR**
Course Subtype	**MAJOR 3**
Subject Type	**Discipline specific**
Course Code	**BIOS-MB-MJ-703**
Course Level	**400-499**
Course Title	**Microbial Biotechnology**
Credit	**02**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	After completing this course, students will be able to: **CO-1**: Explain the role of industrial microorganisms and fermentation processes in the production of primary metabolites, industrial enzymes, and microbial products. **CO-2**: Describe the microbial production technologies of organic acids, solvents, amino acids, vitamins, antibiotics, and industrially important biomolecules. **CO-3**: Analyze the production and applications of secondary metabolites, biopolymers, biofuels, agricultural bioproducts, fermented beverages, and therapeutic microbial products. **CO-4**: Interpret advanced concepts of metabolic engineering, AI-driven enzyme design, gas fermentation, microbial electrosynthesis, and intelligent bioprocess technologies. **CO-5**: Apply principles of industrial microbiology and microbial biotechnology for sustainable production systems, environmental applications, industrial processes, and entrepreneurial opportunities.

Mapping between Cos and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■		■			
CO2	■		■			
CO3	■	■	■			
CO4	■	■	■		■	■
CO5	■	■	■		■	■

Course content

UNIT 1: INDUSTRIAL MICROBIAL PRODUCTS AND FERMENTATION TECHNOLOGIES

1.1	Important microbes used in industrial microbiology and biotechnology: High throughput screening
1.2	Range of fermentation processes
1.3	Organic acids: Citric acid and Lactic acid
1.4	Amino acid: L-lysine; Vitamin: B12 & Riboflavin
1.5	Solvents: Ethanol and Bio-butanol
1.6	Biopolymers: PHAs and Exopolysaccharides: Xanthan.
1.7	Agricultural bioproducts: Microbial biopesticides, Siderophores and mycorrhizal biofertilizer
1.8	Alcohol-based fermented beverages: Beer and Wine
1.9	Therapeutics: mAbs, Insulin, Interferons, Antibiotics: Cephalosporins

UNIT 2: METABOLIC ENGINEERING AND INTELLIGENT PRODUCTION TECHNOLOGIES

2.1	Industrially important enzymes
2.2	Next generation biofuels from cyanobacteria and yeasts
2.3	AI-driven enzyme design: enzymes with tailored specificities
2.4	Glycoengineered microbes: humanized glycoproteins production
2.5	Gas fermentation by C1 pathway: industrial waste gases to bioplastics and SCPs
2.6	Microbial Electrosynthesis Systems: reduction of CO_2 into value-added chemicals
2.7	Process Analytical Technology: real-time monitoring of microbial product formation
2.8	Machine learning: reinforcement learning algorithms to maximize product yield

References

- Stanbury, P. F., Whitaker, A., & Hall, S. J. (2016). Principles of fermentation technology (3rd ed.). Elsevier.
- Okafor, Nduka, and Benedict C. Okeke. *Modern Industrial Microbiology and Biotechnology*. Boca Raton, CRC Press, 2017.
- Waites, M. J., N. L. Morgan, et al. *Industrial Microbiology: An Introduction*. Oxford, Blackwell Science, 2001.
- Aehle, Wolfgang, editor. *Enzymes in Industry: Production and Applications*. 3rd ed., Weinheim, Wiley-VCH, 2007.
- Stephanopoulos, Gregory, Aristos A. Aristidou, and Jens Nielsen. *Metabolic Engineering: Principles and Methodologies*. San Diego, Academic Press, 1998.
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- Kaplan, David L., editor. Biopolymers from Renewable Resources. Berlin, Springer, 1998
- Pandey, Ashok, D. J. Lee, et al., editors. Biofuels from Algae. Amsterdam, Elsevier, 2014.
- White, Chris, and Jamil Zainasheff. Yeast: The Practical Guide to Beer Fermentation. Boulder, Brewers Publications, 2010.

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- Guo, Peixuan, and Fazlul Haque, editors. RNA Nanotechnology and Therapeutics. Boca Raton, CRC Press, 2020.
- Köpke, Michael, and Sean Simpson, editors. Gas Fermentation: Carbon Capture and Utilization. Cham, Springer, 2022.
- Raghavan, P., and S. Ghosh. Machine Learning and Data Science in the Power Generation and Process Industries. Amsterdam, Elsevier, 2022.
- Smolke, Christina D., editor. The Metabolic Pathway Engineering Handbook: Fundamentals and Applications. Boca Raton, CRC Press, 2010.

Online reference

- https://swayam.gov.in/
- https://swayam-plus.swayam2.ac.in/

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Evaluation scheme

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

PRACTICALS

BIOS-MBP-MJ-703 MICROBIAL BIOTECHNOLOGY

Program Name	**B. Sc Honours In BIOSCIENCE (Microbiology)**
Semester	**VII**
NCrF Credit Level	**06**
Course Type	**MAJOR**
Course Subtype	**MAJOR 3**
Subject Type	**Discipline specific**
Course Code	**BIOS-MBP-MJ-703**
Course Level	**400-499**
Course Title	**Microbial Biotechnology Practical**
Credit	**02**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	After completing this course, students will be able to: **CO-1**: Gain practical skills in isolation and screening the metabolite producing microorganisms.

	CO-2: Perform estimation of metabolites produced during fermentation. **CO-3**: Carry out fermentation of metabolites and enzyme production on large scale. **CO-4**: Demonstrate the industrial production of microbial products.

Mapping between Cos and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1 to CO4						

Course Content

1. Isolation and screening of citric acid & lactic acid producing fungi.
2. Isolation and screening of EPS producing bacteria.
3. Screening of amylase- and cellulase-producing microorganisms.
4. Production of amylase/ cellulase enzyme under solid & submerged fermentation.
5. Purification of amylase/ cellulase by ammonium sulphate and dialysis to determine specific activity and fold purification.
6. CAS assay for siderophore production.
7. Spectrophotometric estimation of Riboflavin /Vitamin B12.

References

- Patel, R. J., & Patel, R. K. Experimental Microbiology, Vol. 1, 10th Edition, Aditya, 2022
- Patel, R.J., & Patel, R. K. Experimental Microbiology, Vol. 2, 10th Edition, Aditya, 2022.
- Aneja, K. R., Experiments in Microbiology 4th ed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers, 2003.
- Cappuccino, J. G., Microbiology: A Laboratory Manual, 6th Ed., Singapore Pearson Education Pvt. Ltd., 2005.
- Bartzatt, R., & Wol, T. (2014). Detection and assay of vitamin B-12 (riboflavin) in alkaline borate buffer with UV/visible spectrophotometry. International Scholarly Research Notices, 2014, Article 453085.

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive Discussions, seminars, assignments, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

[Subject code-2603000507056001]

BIOS-MB-MJ-704 (BKS): TRADITIONAL PRACTICES IN MICROBIOLOGY

Program Name	**B. Sc Honours In BIOSCIENCE (Microbiology)**
Semester	**VII**
NCrF Credit Level	**06**
Course Type	**MAJOR (BKS)**
Course Subtype	**MAJOR 4**
Subject Type	**Discipline specific**
Course Code	**BIOS-MB-MJ-704**
Course Level	**400-499**
Course Title	**Traditional Practices in Microbiology**
Credit	**04**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	Upon successful completion of the course, students will be able to: **CO1:** Explain the scientific basis of traditional Indian knowledge systems related to agriculture, health and biotechnology. **CO2:** Evaluate traditional fermented foods and indigenous practices from microbiological and biotechnological perspectives. **CO3:** Interpret Ayurvedic concepts in relation to microbiome science and modern biomedical research. **CO4:** Analyse scientific evidence supporting Panchagavya, Panchakarma and fasting-based interventions. **CO5:** Appreciate the contributions of Indian scientists to microbiology, molecular biology and biotechnology. **CO6:** Explore opportunities for integrating indigenous knowledge with contemporary scientific research and innovation.

Mapping between COs and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	■						■	
CO2	■	■			■		■	
CO3	■	■			■	■	■	
CO4	■	■			■		■	■
CO5	■	■			■		■	■
CO6	■	■	■				■	

Course content

UNIT 1: HISTORICAL PERSPECTIVES & INDIGENOUS KNOWLEDGE IN MICROBIOLOGY

1.1	History of microbiology: from ancient traditional practices to modern science
1.2	Role of microorganisms in ancient civilizations: Vedic, Egyptian, Mesopotamian perspectives
1.3	Traditional Indian practices and their microbial connections (Ayurveda, Siddha, Unani)
1.4	Contributions of Indian scholars (Jagadish Chandra Bose, Birbal Sahni) to microbiology
1.5	Ethnomicrobiology: definition, scope, and significance and Documentation and preservation of traditional microbiological knowledge
UNIT 2: TRADITIONAL FERMENTATION PRACTICES	
2.1	Principles of fermentation: aerobic vs. anaerobic, homo- and hetero-fermentation
2.2	Traditional fermented foods of India: Idli, Dosa, Dhokla, Jalebi, Kanji, Ambali, and Fermented dairy products: Dahi (curd), Lassi, Shrikhand, Paneer, Buttermilk
2.3	Traditional beverages: Toddy, Rice beer (Handia), Mahua wine, Neera, and Traditional fermented foods of tribal communities in Gujarat and India
2.4	Vinegar production: traditional methods
2.5	Quality, safety, and nutritional aspects of traditionally fermented products and Comparison of traditional vs. industrial fermentation processes
UNIT 3: TRADITIONAL FOOD PRESERVATION, NATURAL ANTIMICROBIALS	
3.1	Ancient and traditional methods of food preservation: sun-drying, salting, pickling and smoking
3.2	Microbiological basis of food spoilage and preservation techniques; Traditional Indian pickles (Achaar), Murabba and Papad: microbiology and role of spices
3.3	Ethnomedicinal plants with antimicrobial properties: Aloe vera, Garlic, Neem and Tulsi
3.4	Traditional wound-healing practices and antimicrobial significance; Use of honey, ghee and herbal oils as traditional antimicrobial agents
3.5	Phytochemicals and their mode of antimicrobial action;
3.6	Modern scientific validation of traditional antimicrobial agents (evidence-based approach)
UNIT 4: TRADITIONAL AGRICULTURAL MICROBIOLOGY & MODERN RELEVANCE	
4.1	Traditional soil enrichment practices: green manuring, crop rotation, mixed cropping and Traditional composting: Nadep, Vermicomposting, Pit composting – microbiological basis
4.2	Indigenous biofertilizer knowledge: Rhizobium inoculation, Azolla-Anabaena, Blue-Green Algae, and Traditional biopesticide practices: Panchagavya, Dashparni Ark, Brahmastra
4.3	Cow-based microbiological practices (Panchagavya): scientific validation and applications
4.4	Role of traditional practices in sustainable agriculture and organic farming
4.5	Integration of traditional microbiological knowledge into modern biotechnology, Bioprospecting of traditional practices: IPR issues and ethical considerations, Future perspectives: blending ethnomicrobiology with modern microbiome research

References

- Tamang, J. P. (Ed.). Ethnic Fermented Foods and Beverages of India: Science, History and Culture. Springer.
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- Ministry of AYUSH, Government of India. Ayurveda: The Science of Life.
- Ministry of AYUSH, Government of India. Ayurvedic Standard Treatment Guidelines.
- Suganthy, M., Renuka Rani, B. & Sharma, N. R. Natural Farming for Sustainable Agriculture.
- National Institute of Agricultural Extension Management (MANAGE). Study Material on Natural Farming.
- National Centre for Organic and Natural Farming (NCOF). Comprehensive Training Manual on Natural Farming.
- Swaminathan, M. S. From Green Revolution to Evergreen Revolution.
- Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M. & Losick, R. Molecular Biology of the Gene.
- Alberts, B. et al. Molecular Biology of the Cell.

Online References

- Kaur, A. & Joshi, N. (2023). Panchagavya in Human Life and Health: A Review. International Journal of Research in Ayurveda and Pharmacy.
- Chandran, D. et al. (2023). Potential Benefits and Therapeutic Applications of Panchgavya Therapy (Cowpathy) for Human and Animal Health: Current Scientific Knowledge. Journal of Experimental Biology and Agricultural Sciences.
- Narwal, N. et al. Antimicrobial Properties of Panchgavya in Curing Plant Disease.
- Nobel Prize Outreach AB. Nobel Prize Educational Resources (Autophagy, Ribosome Structure, Genetic Code and CRISPR-related discoveries).
- Ministry of AYUSH, Government of India.
- Indian Knowledge Systems (IKS) Division, Ministry of Education, Government of India.
- National Centre for Organic and Natural Farming (NCOF).
- National Institute of Agricultural Extension Management (MANAGE).
- Indian Council of Agricultural Research (ICAR).
- National Centre for Biological Sciences (NCBS), Bengaluru.
- https://swayam.gov.in/
- https://swayam-plus.swayam2.ac.in/
- https://nptel.ac.in

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Evaluation scheme

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

Undergraduate Program

In

BIOSCIENCE (Microbiology)

4 years (Honours without OJT/Research Project)

B. Sc. Sem 8 Syllabus

(Effective from Academic Year: 2026-27)

STRUCTURE FOR ERP –BIOSCIENCE- MICROBIOLOGY – SEM – 8 Honours without OJT (UG)																	
Course Category	Course Code	Course Title	Mark sheet Title in English	Level of Course	Teaching Hours/Week		Exam Duration		Credit		Internal Marks		External Marks		Total	
					TH	PR	TH	PR	TH	PR	TH	PR	TH	PR	TH	PR
MAJOR 1	BIOS-MB – MJ - 801	MOLECULAR BIOLOGY & GENOME ENGINEERING	MOLECULAR BIOLOGY & GENOME ENGINEERING	400-499	02	04	01.00 h	06.00 h	02	02	25	25	25	25	50	50
MAJOR 2	BIOS-MB – MJ - 802	ENVIRONMENTAL MICROBIOLOGY	ENVIRONMENTAL MICROBIOLOGY	400-499	02	04	01.00 h	06.00 h	02	02	25	25	25	25	50	50
MAJOR 3	BIOS-MB – MJ - 803	BIOPROCESS & FERMENTATION TECHNOLOGY	BIOPROCESS & FERMENTATION TECHNOLOGY	400-499	02	04	01.00 h	06.00 h	02	02	25	25	25	25	50	50
MAJOR -4	BIOS-MB-MJ 804	BIOPHYSICS, ANALYTICAL BIOCHEMISTRY AND INSTRUMENTATION	BIOPHYSICS, ANALYTICAL BIOCHEMISTRY AND INSTRUMENTATION	400-499	04	00	02.00 h	00 h	04	00	50	-	50	-	100	-
ME	BIOS-ME-801	ENTREPRENEURSHIP	ENTREPRENEURSHIP	400-499	04	00	02.00 h	00 h	04	00	50	-	50	-	100	-
MAJOR 5	BIOS-MB-MJ-705	RESEARCH METHODOLOGY-II	RESEARCH METHODOLOGY-II	400-499	02	-	01	-	02		25		25		50	-

[Subject code for Theory-2703000508016001]
[Subject code for Practical-2703000508016002]

BIOS-MB-MJ-801 MOLECULAR BIOLOGY & GENOME ENGINEERING	
Program Name	**B.Sc Honors In BIOSCIENCE (Microbiology)**
Semester	**VIII**
NCrF Credit Level	**06**
Course Type	**MAJOR**
Course Subtype	**MAJOR 1**
Subject Type	**Discipline Specific**
Course Code	**BIOS-MB-MJ-801**
Course Level	**400 - 499**
Course Title	**Molecular Biology & Genome Engineering**
Credit	**02**
Effective From	**Academic year: 2026-27**
Course Outcomes	Upon successful completion of this course, the students will be able to: **CO1:** Explain the principles of recombinant DNA technology, DNA manipulation, cloning vectors and gene transfer mechanisms used in genetic engineering. **CO2:** Apply the concepts of DNA cloning, recombinant selection and gene expression systems in microorganisms and other biological systems. **CO3:** Analyze the structure, function and applications of different cloning and expression vectors used in genetic engineering and biotechnology. **CO4:** Explain the principles and applications of protein engineering, directed evolution, mutagenesis and microarray technologies in biological research and industry. **CO5:**Evaluate the role of genome editing technologies, including CRISPR-Cas9 and computational approaches, in modern biotechnology and life sciences.

Mapping between Cos and PSOs		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
	CO1	■	■	■		■	
	CO2	■	■	■		■	
	CO3	■	■	■		■	
	CO4	■		■		■	
	CO5	■		■	■	■	■

Course Content

UNIT 1: GENETIC ENGINEERING

1.1	Preparation of total cell DNA, plasmid and bacteriophage DNA
1.2	DNA manipulative enzymes and restriction endonucleases, Ligation - joining DNA molecules
1.3	Uptake of DNA by bacterial cells and Identification of recombinants
1.4	Introduction of phage DNA into bacterial cells and non-bacterial cells
1.5	Cloning vectors based on E. coli plasmids, λ bacteriophage, vectors for synthesis of single-stranded DNA
1.6	Vectors for yeast, fungi, higher plants and for animals
1.7	Cosmids, phasmids, other advanced vectors, Expression vectors
1.8	Screening and differential screening strategies available for library screening, Manipulation of Gene Expression in Prokaryotes

UNIT 2: PROTEIN ENGINEERING AND GENOME EDITING TECHNOLOGIES

2.1	Introduction of Protein Structure and function
2.2	Concepts for Protein Engineering
2.3	Computer Simulations: A Tool for Investigating the Function of Complex Biological Macromolecules
2.4	Evolutionary Methods for Protein Engineering (Methods for the directed evolution of proteins)
2.5	Directed Mutagenesis Procedures and Protein Engineering in various enzymes
2.6	DNA and Protein Microarray technology
2.7	CRISPR-Cas9 genome editing

References

- Brown, T. A. (2021). *Gene cloning and DNA analysis: An introduction* (8th ed.). Wiley-Blackwell. ISBN 9781119640783
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- Brown, T. A. (2021). Gene cloning and DNA analysis: An introduction (8th ed.). Wiley-Blackwell. ISBN 9781119640783
- Primrose, S. B., & Twyman, R. M. (2006). *Principles of gene manipulation and genomics* (7th ed.). Blackwell Publishing.
- Glick, B. R., Pasternak, J. J., & Patten, C. L. (2010). *Molecular biotechnology: Principles and applications of recombinant DNA* (4th ed.). ASM Press.
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- Aparna, G. M., & Tetala, K. K. R. (2023). Recent progress in development and application of DNA, protein, peptide, glycan, antibody, and aptamer microarrays. *Biomolecules*, *13*(4), Article 602. https://doi.org/10.3390/biom13040602
- Pacesa, M., Pelea, O., & Jinek, M. (2024). Past, present, and future of CRISPR genome editing technologies. Cell, 187(5), 1076–1100. https://doi.org/10.1016/j.cell.2024.01.042
- Li, T., Yang, Y., Qi, H., Cui, W., Zhang, L., Fu, X., He, X., Liu, M., Li, P.-F., & Yu, T. (2023). CRISPR/Cas9 therapeutics: Progress and prospects. *Signal Transduction and Targeted Therapy*, *8*(1), Article 36. https://doi.org/10.1038/s41392-023-01309-7

Rastogi, S., & Pathak, N. (2009). *Genetic engineering*. Oxford University Press, ISBN: 978-0195696578

Online References

- NCBI – https://www.ncbi.nlm.nih.gov
- Addgene – https://www.addgene.org
- DNA Learning Center (CSHL) – https://dnalc.cshl.edu
- EMBL-EBI – https://www.ebi.ac.uk
- Protein Data Bank (PDB) – https://www.rcsb.org
- UniProt – https://www.uniprot.org
- AlphaFold Protein Structure Database – https://alphafold.ebi.ac.uk
- Broad Institute CRISPR Resources – https://www.broadinstitute.org/what-broad/areas-focus/project-spotlight/crispr
- NPTEL – https://nptel.ac.in
- SWAYAM – https://swayam.gov.in
- SWAYAM Plus- https://swayam-plus.swayam2.ac.in/

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

PRACTICALS

BIOS-MBP-MJ-801 MOLECULAR BIOLOGY & GENOME ENGINEERING

Program Name	**B. Sc Honours In BIOSCIENCE (Microbiology)**
Semester	**VIII**
NCrF Credit Level	**06**
Course Type	**MAJOR**
Course Subtype	**MAJOR 1**
Subject Type	**Discipline Specific**
Course Code	**BIOS-MBP-MJ-801**
Course Level	**400-499**
Course Title	**Molecular Biology & Genome Engineering Practical**
Credit	**02**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	Upon successful completion of this practical course, the students will be able to: **CO1:** Perform fundamental molecular biology techniques including restriction digestion, ligation and PCR amplification for manipulation and analysis of nucleic acids. **CO2:** Demonstrate protein extraction, quantification and protein folding studies using standard biochemical and molecular biology techniques. **CO3:** Apply molecular techniques such as site-directed mutagenesis and primer design for genetic modification and experimental planning. **CO4:** Carryout protein extraction and protein folding related experiments.

Mapping between Cos and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1 To CO4						

Course Content

1. Restriction digestion of DNA/ plasmid using restriction endonuclease.
2. Ligation of DNA molecules.
3. In vitro amplification of DNA by PCR.
4. PCR Mediated Site Directed mutagenesis.
5. Protein extraction from bacterial cells and estimation by Bradford/Lowry assay.
6. Protein folding- denaturation and renaturation by Urea method.

- **References**
- Sambrook, J., & Russell, D. W. (2001). *Molecular cloning: A laboratory manual* (3rd ed.). Cold Spring Harbor Laboratory Press.
- Green, M. R., & Sambrook, J. (2019). *Molecular Cloning: A Laboratory Manual* (4th ed.). Cold Spring Harbor Laboratory Press.
- Brown, T. A. (2020). *Gene Cloning and DNA Analysis: An Introduction* (8th ed.). Wiley-Blackwell.
- Walker, J. M. (Ed.). (2009). *The Protein Protocols Handbook* (3rd ed.). Humana Press.

- Cappuccino, J. G., & Welsh, C. (2018). Microbiology: A laboratory manual (11th global ed.). Pearson Education Limited.
- Bisen, P. S. (2014). *Laboratory protocols in applied life sciences*. CRC Press.
- Alexander, S. K., Strete, D., & Niles, M. J. (2003). *Laboratory exercises in organismal and molecular microbiology*. McGraw-Hill Higher Education
- Aneja, K. R., Experiments in Microbiology 4thed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers, 2003.
- Saxena, J., Baunthiyal, M., & Ravi, I. (2015). *Laboratory manual of microbiology, biochemistry and molecular biology,* Scientific Publishers.
- Bossi, Camilli, Grundl, Experiments in Bacterial Genetics: A Laboratory Manual, Cold Spring Harbor Laboratory Press, 2023, ISBN 978-1621824497
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- Baxevanis, A. D., & Ouellette, B. F. F. (Eds.). (2005). Bioinformatics: A practical guide to the analysis of genes and proteins (3rd ed.). Wiley-Interscience.
- Mount, D. W. (2021). *Bioinformatics: Sequence and Genome Analysis* (5th ed.). Cold Spring Harbor Laboratory Press.
- Lesk, A. M. (2019). *Introduction to Bioinformatics* (5th ed.). Oxford University Press.

Online References

- Addgene Protocols – https://www.addgene.org/protocols/
- New England Biolabs (NEB) Protocols and Tools – https://www.neb.com
- Benchling Molecular Biology Platform – https://www.benchling.com
- SnapGene Molecular Biology Resources – https://www.snapgene.com
- NCBI BLAST and ORF Finder – https://www.ncbi.nlm.nih.gov
- Primer3 for Primer Design – https://primer3.ut.ee
- ExPASy Bioinformatics Resource Portal – https://www.expasy.org
- SWISS-MODEL Homology Modelling Server – https://swissmodel.expasy.org
- RCSB Protein Data Bank (PDB) – https://www.rcsb.org
- AlphaFold Protein Structure Database – https://alphafold.ebi.ac.uk
- CHOPCHOP CRISPR Design Tool – https://chopchop.cbu.uib.no
- EMBL-EBI Training Portal – https://www.ebi.ac.uk/training

Teaching Methodology

The teaching methodology will involve laboratory experiments, and practical demonstrations to facilitate comprehensive experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on internal examination 50% SEE: External assessment based on semester-end university examination.

[Subject code for Theory-2703000508026001]

BIOS-MB-MJ-802 ENVIRONMENTAL MICROBIOLOGY

Program Name	**B.Sc Honors In BIOSCIENCE (Microbiology)**
Semester	**VIII**
NCrF Credit Level	**6.0**
Course Type	**MAJOR**
Course Subtype	**MAJOR 2**
Subject Type	**Discipline Specific**
Course Code	**BIOS-MB-MJ-802**
Course Level	**400 - 499**
Course Title	**Environmental Microbiology**
Credit	**02**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	After completing this course, students will be able to: **CO-1:** Explain the principles and mechanisms involved in microbial degradation of organic and inorganic pollutants, waste treatment processes and environmental bioremediation technologies for sustainable environmental management. **CO-2:** Analyze microbial processes involved in biofuel production, waste valorization, renewable bioenergy generation and circular bioeconomy applications. **CO-3:** Evaluate environmental risks associated with GMOs, biosafety issues, environmental regulations and microbial threats in relation to environmental protection and public health. **CO-4:** Assess the role of microorganisms in climate change mitigation, antimicrobial resistance dissemination, One Health approaches and ecosystem sustainability. **CO-5:** Apply microbiological and biotechnological approaches for resource recovery, environmental restoration, sustainable agriculture and innovative environmental solutions.

Mapping between COs and PSOs

	PSO1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO-1		■	■		■	
CO-2	■	■	■	■	■	
CO-3		■		■	■	■
CO-4	■			■	■	■
CO-5		■	■	■	■	

Course Content

UNIT 1: BIOREMEDIATION AND ENVIRONMENTAL WASTE MANAGEMENT TECHNOLOGIES

1.1	Degradation of hydrocarbons, Chlorinated Hydrocarbons and Aromatics, and Dioxins

1.2	Degradation of Xenobiotics Pesticides, Polymer and dye
1.3	Bioremediation with Inorganic Pollutants
1.4	Treatment of Waste from Organic Chemical Industries
1.5	Treatment of Waste from Food and Dairy Industries, Sugar and Distillery Waste, Paper and Pulp industries
1.6	Pharmaceuticals and Hospital Waste Treatment
1.7	Treatment and management of Solid Waste, Treatment of Municipal Waste
1.8	Insight of biofuel prospects From microalgae as Renewable energy source for Environmental sustainability
UNIT 2: BIOENERGY, ONE HEALTH AND SUSTAINABLE ENVIRONMENTAL BIOTECHNOLOGY	
2.1	Biodiesel, Transesterification for biodiesel, Biomethane and Biohydrogen
2.2	Conversion of Waste to Biofuels, Bioproducts, and Bioenergy
2.3	Cellulosic Ethanol Technology
2.4	Microbial Solutions for Climate Change Toward an Economically
2.5	Resilient Future, An Introduction to Sustainable Circular Bioeconomy,
2.6	Environmental risk assessment, biosafety, GMO release and environmental regulations. Microorganisms and Bioterrorism
2.7	A One-Health Perspective of Antimicrobial Resistance: Human, Animals and Environmental Health, The One Health resistome Microbially Induced Calcium Carbonate Precipitation (MICP) and Its Potential in Bioconcrete: Microbiological and Molecular Concepts

References

- Barton, L. L., & Northup, D. E. (2011). Microbial ecology. John Wiley & Sons.
- Doble, M. & Anil kumar. (2005). Biotreatment of industrial effluents. Butterworth Heinemannan imprint of Elsevier. (ISBN; 9780080456218)
- Maddela, N. R., Eller, L. K. W., & Prasad, R. (Eds.). (2023). Microbiology for cleaner production and environmental sustainability. CRC Press.
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- Sangeetha, J., Thangadurai, D., David, M., & Abdullah, M. A. (Eds.). (2016). Environmental biotechnology: Biodegradation, bioremediation, and bioconversion of xenobiotics for sustainable development. Apple Academic Press.
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- Evans, G. M., & Furlong, J. C. (2010). Environmental biotechnology: Theory and application (2nd ed.). Wiley-Blackwell.
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- Castro-Alonso, M. J., Montañez-Hernandez, L. E., Sanchez-Muñoz, M. A., Macias Franco, M. R., Narayanasamy, R., & Balagurusamy, N. (2019). Microbially induced calcium carbonate precipitation (MICP) and its potential in bioconcrete: Microbiological and molecular concepts. Frontiers in Materials, 6, Article 126.

Online Resources

- SWAYAM https://swayam.gov.in
- NPTEL https://nptel.ac.in
- World Health Organization (WHO) https://www.who.int
- Food and Agriculture Organization (FAO) https://www.fao.org
- United Nations Environment Programme (UNEP) https://www.unep.org
- Bioremediation and biodegradation [https://youtu.be/OskyBh4MDy4?si=i-mD149KV2FdpOw0]
- Biodegradation of pesticides [https://youtu.be/tffTDCnuvwY?si=rqeiVGzYOIhKo5wB]
- Biodegradation of heavy metals [https://youtu.be/nO21I-UvA9I?si=Po7mWIuCxOZPj5Js]
- Biodegradation[https://youtu.be/qhqlLZKhsYQ?si=UKsVtqnvCwnFtzZD]
- https://frtr.gov/matrix/documents/Monitored-Natural-Attenuation/2006-In-Situ-and-Ex-Situ-Biodegradation-Technologies-for-Remediation-of-Contaminated-Sites.PDF

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

[Subject code for Practical-2703000508026002]

PRACTICALS

BIOS-MBP-MJ-802 ENVIRONMENTAL MICROBIOLOGY

Program Name	**B. Sc Honours in BIOSCIENCE (Microbiology)**
Semester	**VIII**
NCrF Credit Level	**06**
Course Type	**MAJOR**
Course Subtype	**MAJOR 2**
Subject Type	**Discipline specific**
Course Code	**BIOS-MBP-MJ-802**
Course Level	**400-499**
Course Title	**Environmental Microbiology**
Credit	**02**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	After completing this course, students will be able to: **CO-1:** Perform laboratory techniques for assessment of microbial tolerance to environmental pollutants, biodegradation of xenobiotics and evaluation of microbial remediation potential. **CO-2:** Analyze environmental quality parameters and microbial indicators using BOD, COD and antimicrobial susceptibility testing for environmental monitoring and public health assessment. **CO-3:** Isolate, characterize and evaluate environmentally significant microorganisms including microalgae and pollutant-degrading microbial communities. **CO-4:** Apply computational tools for community metagenomic analysis to assess microbial diversity, community structure and ecological functions in environmental samples. **CO-5:** Interpret functional metagenomic datasets to identify metabolic pathways, biodegradation potential and environmental applications of microbial communities.

Mapping between COs and PSOs

	PSO1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO-1 to CO 5						

Course Content

1. Study of heavy metal tolerance by environmental microorganisms.
2. Pesticide tolerance assay of environmental microorganisms.
3. Biodegradation of pesticide by microbial isolates.
4. Microbial degradation of synthetic dyes (methylene blue/crystal violet) and evaluation of decolourization efficiency.
5. Estimation of Biochemical Oxygen Demand (BOD).
6. Estimation of Chemical Oxygen Demand (COD).
7. Isolation and characterization of microalgae from environmental samples.
8. Antibiotic susceptibility testing of environmental isolates

References

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- Glazer Alexander N., Nikaido Hiroshi, Microbial Biotechnology: Fundamentals of Applied Microbiology, 2nd Edition, Cambridge University Press
- Agathos Spiros and Reineke Walter, Biotechnology for the Environment: Strategy and Fundamentals, Series: Advances in Biochemical Engineering/Biotechnology, Vol. 81, Springer.
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- National Center for Biotechnology Information (NCBI) https://www.ncbi.nlm.nih.gov
- PubMed https://pubmed.ncbi.nlm.nih.gov
- United Nations Environment Programme (UNEP) https://www.unep.org
- World Health Organization (WHO) – One Health & Antimicrobial Resistance Resources https://www.who.int
- Food and Agriculture Organization (FAO) https://www.fao.org
- Intergovernmental Panel on Climate Change (IPCC) https://www.ipcc.ch
- Department of Biotechnology (DBT), Government of India https://dbtindia.gov.in
- Genetic Engineering Appraisal Committee (GEAC), Government of India https://geacindia.gov.in

Teaching Methodology

The teaching methodology will involve laboratory experiments, and practical demonstrations to facilitate comprehensive experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on internal examination 50% SEE: External assessment based on semester-end university examination.

[Subject code for Theory-2703000508036001]

BIOS-MB-MJ-803 BIOPROCESS & FERMENTATION TECHNOLOGY

Program Name	**B.Sc Honors In BIOSCIENCE (Microbiology)**
Semester	**VIII**
NCrF Credit Level	**06**
Course Type	**MAJOR**
Course Subtype	**MAJOR 3**
Subject Type	**Discipline Specific**
Course Code	**BIOS-MB-MJ-803**
Course Level	**400 - 499**
Course Title	**Bioprocess & Fermentation Technology**
Credit	**02**
Effective From	**Academic year: 2026-27**
Course Outcomes	Upon successful completion of this course, the students will be able to: **CO1:** Explain the principles of upstream bioprocessing, including microbial strain selection, strain improvement, culture preservation, fermentation media formulation and inoculum development for industrial fermentation processes **CO2:** Apply the concepts of microbial growth kinetics, fermentation strategies, solid-state fermentation and process optimization for efficient bioprocess developmen **CO3:** Analyze the roles of aeration, agitation, oxygen transfer, scale-up and scale-down strategies in industrial fermentation and bioreactor performance. **CO4:** Evaluate downstream processing techniques including cell separation, cell disruption, extraction, purification and product recovery used in industrial biotechnology **CO5:** Assess modern advances in bioprocess engineering, including heterologous protein production, synthetic biology, Bioprocessing 4.0 and integrated industrial biomanufacturing systems.

Mapping between Cos and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						
CO3						
CO4						
CO5						

Course Content	
UNIT 1: UPSTREAM PROCESSING AND FERMENTATION TECHNOLOGY	
1.1	Isolation of suitable microorganisms from the environment, Culture collections, Improvement of industrial microorganisms, Strain stability,
1.2	Culture preservation: Storage at reduced temperature, storage in a dehydrated form and quality control of preserved stock cultures
1.3	Fermentation media, formulation, Carbon sources Nitrogen source Minerals & others growth factor, precursors, inducers inhibitors, Oxygen requirement, Antifoam and Statistical media Optimization
1.4	Microbial growth kinetics: Batch culture, Continuous culture, Fed-batch culture
1.5	Inoculum development, inoculum transfer, Development of inocula for yeast processes and bacteria
1.6	Introduction to Solid-state fermentation, Suitability of Microorganisms for SSF Processes Biomass Measurement, Factors Affecting SSF, Scale-Up, Modeling in SSF, Types of SSF Bioreactors
1.7	Sterilization and Contamination Control: Sterilization of media, air and equipment; filtration systems; contamination sources; aseptic operation; biosafety and GMP considerations.
1.8	Process Monitoring and Control: Measurement and control of temperature, pH, dissolved oxygen, foam, pressure and biomass; sensors, biosensors and process automation
UNIT 2: DOWNSTREAM PROCESSING AND MODERN BIOPROCESS ENGINEERING	
2.1	Aeration and agitation: Introduction, Oxygen requirements of industrial fermentations, Oxygen supply, Determination of KLa values, Fluid rheology, Factors affecting KLa values in fermentation vessels,
2.2	Scale-Up and Scale-Down
2.3	Downstream Processing: Cell harvesting, filtration, centrifugation, cell disruption, extraction, precipitation, membrane separation, chromatography and product formulation.
2.4	Cell disruption by Physico-mechanical methods, Chemical and biological methods
2.5	Products purification: Liquid–liquid extraction, Solvent recovery, Two-phase aqueous extraction, Reversed micelle extraction, Supercritical fluid extraction, Adsorption, Removal of volatile products, Drying, Crystallization
2.6	Recent Advances and Impacts of Microtiter Plate-Based Fermentations in Synthetic Biology and Bioprocess Development
2.7	Emerging trends in bioprocess technology: microbiome microbiome-based biotechnology, omics-guided bioprocessing, AI-assisted fermentation, continuous biomanufacturing and Industry applications.

References

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- Okafor, N., & Okeke, B. C. (2017). *Modern industrial microbiology and biotechnology* (2nd ed.). CRC Press.
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- Isoko, K., Cordiner, J. L., Kis, Z., & Moghadam, P. Z. (2024). Bioprocessing 4.0: A pragmatic review and future perspectives. *Digital Discovery*, *3*(9), 1662–1681. https://doi.org/10.1039/d4dd00127c

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- Addgene – https://www.addgene.org
- New England Biolabs (NEB) Protocols and Technical Resources – https://www.neb.com/tools-and-resources
- Thermo Fisher Scientific Learning Center – https://www.thermofisher.com
- Cytiva Bioprocess Resource Center – https://www.cytivalifesciences.com
- BioProcess International – https://www.bioprocessintl.com
- EMBL-EBI Training Portal – https://www.ebi.ac.uk/training
- NPTEL – https://nptel.ac.in
- SWAYAM – https://swayam.gov.in

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning and demonstrations to facilitate comprehensive theoretical understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination

[Subject code for Practical-2703000508036002]

PRACTICALS

BIOS-MBP-MJ-803 BIOPROCESS & FERMENTATION TECHNOLOGY

Program Name	**B. Sc Honours In BIOSCIENCE (Microbiology)**
Semester	**VIII**
NCrF Credit Level	**06**
Course Type	**MAJOR**
Course Subtype	**MAJOR 3**
Subject Type	**Discipline specific**
Course Code	**BIOS-MBP-MJ-803**
Course Level	**400-499**
Course Title	**Bioprocess & Fermentation Technology**
Credit	**02**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	Upon successful completion of this practical course, the students will be able to: **CO1:** Prepare and optimize fermentation media, cultivate industrial microorganisms and evaluate microbial growth and biomass production using standard bioprocess techniques. **CO2:** Perform fermentation processes for the production of industrially important metabolites and enzymes under submerged and solid-state fermentation conditions. **CO3:** Apply cell harvesting, product recovery and partial purification techniques used in downstream processing of microbial products. **CO4:** Operate and analyze laboratory-scale bioreactors, oxygen transfer parameters and fermentation performance using appropriate analytical methods.
Mapping between Cos and PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1 To CO 4						

Course content

1. Preparation and optimization of fermentation media for microbial growth and product formation.
2. Cell harvesting by centrifugation and filtration techniques and Estimation of biomass concentration by spectrophotometric and dry cell weight methods.
3. Production and quantification of citric acid by Aspergillus niger fermentation.
4. Production and assay of industrially important enzymes (protease/cellulase) under submerged fermentation.

5. Production of microbial enzymes under solid-state fermentation using agro-industrial substrates.
6. Determination of oxygen transfer characteristics and estimation of volumetric oxygen transfer coefficient (kLa).
7. Recovery and partial purification of fermentation products by precipitation and membrane filtration methods.
8. Analysis of fermentation products using chromatographic or spectrophotometric methods.

References

- Walker, J. M. (Ed.). (2009). *The Protein Protocols Handbook* (3rd ed.). Humana Press.
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- New England Biolabs (NEB) Protocols – https://www.neb.com/protocols
- Thermo Fisher Scientific Learning Center – https://www.thermofisher.com
- Cytiva Bioprocess Resource Center – https://www.cytivalifesciences.com
- EMBL-EBI Training Portal – https://www.ebi.ac.uk/training
- BioProcess International – https://www.bioprocessintl.com
- NPTEL Biotechnology Courses – https://nptel.ac.in
- SWAYAM – https://swayam.gov.in
- JMP Learning Library – https://www.jmp.com/en_us/learning-library.html

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, Laboratory exercises and practical, demonstrations to facilitate comprehensive theoretical understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, practical test, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination

[Subject code-2703000508056001]

BIOS-MB-MJ-804: BIOPHYSICS, ANALYTICAL BIOCHEMISTRY AND INSTRUMENTATION

Program Name	**B. Sc Honours BIOSCIENCE (Microbiology)**
Semester	**VIII**
NCrF Credit Level	**06**
Course Type	**MAJOR**
Course Subtype	**MAJOR 4**
Subject Type	**Discipline specific**
Course Code	**BIOS-MB-MJ-804**
Course Level	**400-499**
Course Title	**Biophysics, Analytical Biochemistry and Instrumentation**
Credit	**04**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	Upon successful completion of this practical course, the students will be able to: **CO-1:** Explain the principles of biophysical chemistry, chromatography, electrophoresis and their applications in biological and biochemical investigations. **CO-2:** Apply the principles of spectroscopic, microscopic and centrifugation techniques for analysis and characterization of biomolecules and biological systems. **CO-3:** Analyze molecular structure determination methods, advanced analytical techniques and nucleic acid quantification approaches used in modern biological research. **CO-4:** Evaluate the applications of mass spectrometry, PCR variants, flow cytometry, biosensors and imaging technologies in microbiology, biotechnology and biomedical sciences. **CO-5:** Assess immunological, radiolabeling and electrophysiological techniques and their significance in diagnostics, research and healthcare applications.

Mapping between Cos and PSOs

	PSO1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO-1	■			■		
CO-2	■			■		
CO-3	■			■		
CO-4		■		■		■
CO-5		■		■		■

Course content

UNIT 1: BIOPHYSICAL CHEMISTRY, CHROMATOGRAPHIC AND ELECTROPHORETIC TECHNIQUES

1.1	Principles of biophysical chemistry: pH, buffer, reaction kinetics, thermodynamics, colligative properties
1.2	An Introduction to Chromatographic Separations, Principle, instrumentation and applications of Paper chromatography, Thin Layer
1.3	Chromatography (TLC), Principle, instrumentation and applications of Adsorption chromatography, Partition chromatography, Ion Exchange
1.4	Chromatography, Size Exclusion (Gel Filtration) Chromatography, Affinity Chromatography,
1.5	Principle, instrumentation and applications of Gas Chromatography (GC) and High-Performance Liquid Chromatography (HPLC) Electrophoresis: General principles, support media and buffers, electrophoresis of proteins, electrophoresis of nucleic acids, capillary electrophoresis and microchip electrophoresis.
UNIT 2: SPECTROSCOPY, STRUCTURAL BIOLOGY AND ADVANCED ANALYTICAL TECHNIQUES	
2.1	Spectroscopic Techniques for Biomolecular Analysis: UV–Visible Spectroscopy, Fluorescence Spectroscopy, Circular Dichroism (CD) Spectroscopy, Electron Spin Resonance (ESR/EPR) Spectroscopy
2.2	Structural Biology and Molecular Structure Determination: X-ray Diffraction (X-ray Crystallography), Cryo-Electron Microscopy (Cryo-EM), Nuclear Magnetic Resonance (NMR) Spectroscopy in
2.3	Structure Determination Advanced Molecular Characterization and Interaction Analysis: Light Scattering Techniques, Mass Spectrometry and its Types,
2.4	Surface Plasmon Resonance (SPR) Advanced Analytical Techniques: MALDI-TOF Mass Spectrometry, Liquid Chromatography–Mass Spectrometry (LC-
2.5	MS) and Liquid Chromatography–Tandem Mass Spectrometry (LC-MS/MS) Principle of Centrifugation, Differential centrifugation, density-gradient centrifugation, ultracentrifugation
UNIT 3: MOLECULAR ANALYSIS, QUANTIFICATION AND IMAGING TECHNOLOGIES	
3.1	Infrared and Raman Spectroscopy and Atomic Spectroscopy, Fluorescence Spectroscopy
3.2	PCR, Q-PCR, ddPCR and other variants of PCR,
3.3	Spectrophotometric and fluorometric nucleic acid quantification (Nanodrop and Qubit), Nucleic acid hybridization,
3.4	Protein Sequencing: Significance, Methods, and Applications
3.5	Confocal microscopy, fluorescence imaging, transmission electron microscopy (TEM), scanning electron microscopy (SEM), cryo-electron microscopy (Cryo-EM), Atomic Force Microscopy (AFM)

UNIT 4: CELLULAR ANALYSIS, IMMUNOTECHNIQUES AND BIOMEDICAL INSTRUMENTATION	
4.1	Principles, instrumentation and application of flow cytometry
4.2	Radiolabeling techniques: Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines
4.3	Histochemical and Immunotechniques: ELISA, RIA, blotting techniques, immunofluorescence, immunoprecipitation, FISH and GISH techniques
4.4	Concept, types and application biosensors
4.5	Electrophysiological methods: Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT

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- Thermo Fisher Learning Center – https://www.thermofisher.com/in/en/home/global/forms/life-science/learning-center.html
- NPTEL Courses – https://nptel.ac.in
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