M. C. E. Society's
Abeda Inamdar Senior College

of Arts, Science and Commerce, Camp, Pune-1
(Autonomous)
Affiliated to Savitribai Phule Pune University
NAAC accredited 'A' Grade

To be implemented from Academic Year 2026-2027
Board of Studies (Microbiology)
Program Structure
(Choice Based Credit System, Under NEP Guidelines)
M.Sc. Microbiology (Semester 1)

Course Code (MSc I)	Course Title
26SMMB11MM	Microbial Taxonomy
26SMMB12MM	Quantitative Biology
26SMMB13MM	Molecular Biology I
26SMMB14MM	Enzymology & Protein Biochemistry
26SMMB15MM	Practicals based on Microbial Taxonomy and Molecular Biology
26SMMB16MM	Practicals based on Quantitative Biology and Enzymology
26SMMB17MM	Practicals based on Immunology and Waste Water Management
26SMMB11MEA	Immunology **OR** Experimental Design
26SMMB11MEB	
26SMMB12MEA	Waste Water Management **OR** Cell Biology and Membrane Transport
26SMMB12MEB	
26SMMB11RM	Research Methodology

M: Mandatory

E: Elective

P: Practical

RM: Research Methodology

Syllabus passed in BOS Microbiology and Biotechnology meeting held on 24th Jan 2026

M.Sc. Sem I (NEP – Autonomy 2026 Pattern)

Course Title	Microbial Taxonomy	
Course Code: 26SMMB11MM		**No. of Credits: 2**
Course Type: M1		**Total Teaching Hours: 30**

Course Objectives	
1.	To enable students to understand, describe and explain fundamental principles and terminology of microbial systematics
2.	To help students differentiate between culturable and unculturable bacteria and apply appropriate methods for their study and characterization.
3.	To familiarize students with the concepts of microbial diversity and enable them to analyze and evaluate microbial diversity using classical and modern approaches
4.	To help students to explain the concept and ecological significance of unculturable microbial diversity

Course Outcome	
CO1	Students will be able to describe and explain the basic principles and classification criteria involved in microbial systematics
CO2	Students will be able to differentiate and illustrate characteristics of culturable and unculturable bacteria and techniques used for their identification.
CO3	Students will be able to analyze various forms of microbial diversity and evaluate methods used to study microbial populations in different environment
CO4	Students will be able to evaluate merits and limitations of various techniques used in microbial classification and diversity studies.
CO5	Students will be able to design and propose basic strategies or approaches for studying unculturable microorganisms and assessing microbial diversity.
CO6	Students will be able to classify microorganisms based on phenotypic, genotypic, and phylogenetic characteristics

Syllabus		
Credit I	**Bacterial Systematics & Microbial Diversity**	15 hours
	i. Species concept in prokaryotes and eukaryotes ii. 5-Kingdom classification system iii. 3-Domain classification system iv. Determinative Bacteriology (Phenetic Approach) v. Systematic Bacteriology (Phylogenetic Approach) vi. Polyphasic Approach vii. Molecular clocks, phylogeny and molecular distances viii. Taxonomy, binomial nomenclature, types of bacterial classification systems, new approaches to bacterial taxonomy (numerical taxonomy, ribotyping, rRNA sequencing, fatty acid profile) ix. Bergey's manual of systematic bacteriology x. Microbial diversity- molecular chronometers xi. Phylogenetic trees and three domain universal phylogenetic tree	
Credit II	**Exploration of Unculturable microbial diversity**	15 hours
	i. Concept of 'unculturable' bacterial diversity ii. Strategies for culture of 'unculturable' bacteria iii. Culture independent molecular methods for Identifying unculturable bacteria (PCR, RFLP, ARDRA,DGGE, TGGE, RAPD, Microarray, FISH,RISA) iv. Methods of extracting total bacterial DNA from a habitat and metagenome analysis	

Syllabus passed in BOS Microbiology and Biotechnology meeting held on 24th Jan 2026

Suggested Readings:

1. Microbial Diversity: Form and Function in Prokaryotes, Published Online:30 NOV 2007.DOI: 10.1002/9780470750490.ch1 Copyright © 2005 by Blackwell Science Ltd
2. Carl R. Woese. The archaeal concept and the world it lives in: a retrospective. Photosynthesis Research 80: 361 – 372, 2004. Kluver Academic Publishers
3. Species Divergence and the measurement of microbial diversity. Catherine Lozupone and Rob Knight. FEMS Microbiol. Rev. 32 (2008) 557 –578
4. Keller M. and Zengler K. (2004) Tapping in to Microbial Diversity. Nature Reviews
5. Breed and Buchanan. Bergey's Manual of Determinative Bacteriology. 9th Edition, 1982.
6. Breed and Buchanan. Bergey's Manual of Systematic Bacteriology. 2nd Edition, (Volumes.1– 5) (2001 – 2003).
7. Jacquelyn G. Black(2013) Microbiology: Principles and Explorations,6thEdition, John Wiley & Sons, Inc
8. Species Divergence and the measurement of microbial diversity. Catherine Lozupone and Rob Knight. FEMS Microbiol. Rev. 32 (2008) 557 –578.
9. Brown James. Principles of Microbial Diversity.ASM Press, 2014.
10. Pace N.(1997)A Molecular View of Microbial Diversity and the Biosphere,Science,276,734- 740.

M.Sc. Sem I (NEP – Autonomy 2026 Pattern)

Course Title	**Quantitative Biology**
Course Code: 26SMMB12MM	**No. of Credits: 2**
Course Type: M2	**Total Teaching Hours: 30**

Course Objectives	
1.	To enable students to understand and explain the basic concepts and principles of Biostatistics.
2.	To help students apply and analyze hypothesis testing concepts using appropriate parametric and non-parametric statistical tests.
3.	To familiarize students with concepts of significance testing and enable them to interpret and evaluate statistical data effectively.

Course Outcome	
CO1	Students will be able to describe and explain the fundamental concepts of statistics, including population and sample parameters, types of data, variables, sampling methods, and sources of data.
CO2	Students will be able to compute and interpret measures of central tendency and dispersion for different types of data sets.
CO3	Students will be able to analyze and interpret relationships between variables using simple linear regression and correlation techniques.
CO4	Students will be able to formulate and test statistical hypotheses by applying concepts of null and alternate hypotheses, significance levels, p-values, and types of errors.
CO5	Students will be able to apply and evaluate appropriate parametric and non-parametric statistical tests for comparison and inference from given data sets.
CO6	Students will be able to analyze and interpret experimental data using chi-square tests and analysis of variance (one-way and two-way ANOVA) for comparison of multiple samples.

Syllabus		
Credit I	**Descriptive Statistics**	15 hours
	i. Fundamental concepts –Sample Statistics and Population parameter, data (qualitative and quantitative data, discrete and continuous series data), data sources, variables, sampling methods and sampling errors ii. Measures of central tendency – Mean Mode, median iii. Measures of dispersion – Mean deviation, Standard deviation and Variance iv. Simple linear Regression and correlation	
Credit II	**Inferential Statistics**	15 hours
	i. The concepts of null hypothesis, alternate hypothesis, Test statistics, P-value significance level, type I and type II errors, one tailed and two tailed tests, degrees of freedom, ii. Parametric statistical test: Z-test, t-test and F-test iii. Test of Significance: Chi square test (Goodness of fit and Independence), iv. Comparison of 3 or more samples – ANOVA One way and two way v. Nonparametric Tests:, Sign test, Wilcoxon's signed rank test and Mann-Whitney U Test	

Syllabus passed in BOS Microbiology and Biotechnology meeting held on 24th Jan 2026

Suggested Readings:

1. Irfan Ali Khan and AtiyaKhanum, Fundamentals of Biostatistics. 3rd Ed. Ukaaz, Publications, Hyderabad
2. Norman T.J.Bailey Statistical methods in biology, 3rd Ed. Cambridge University Press
3. Goon, Gupta and Dasgupta Fundamentals of statistics, World Press, Kolkata. Lindgren B.W. Statistical Theory, Macmillan Publishing Co. Inc. 4. Wayne Daniel (2007)
4. Montgomery D.C. Design and analysis of experiments, John Wiley &Sons
5. Stephen Newman, Biostatistical methods in Epidemiology. Wiley Interscience Publication
6. Aviva Petrie and Carolene Sabin, 2005, Medical Statistics at a glance, 2nd Edition, Blackwell
7. Haefner James W. (1996) Modeling Biological Systems: Principles and Applications, Kluwer Academic Publications
8. David Brown & Peter Rothery. Models in biology: Mathematics, statistics ,and computing John Wiley & Sons, USA
9. Practical Fermentation Technology Edited by Brian McNeil and Linda M. Harvey 2008 John Wiley & Sons, Ltd. ISBN:978-0-470-01434-9
10. Bioprocess Engineering Principles by Pauline M. Doran (1995), Elsevier Science & Technology Books, ISBN:0122208552

M.Sc. Sem I (NEP – Autonomy 2026 Pattern)

Course Title	**Molecular Biology I**
Course Code: 26SMMB13MM	**No. of Credits: 2**
Course Type: M3	**Total Teaching Hours: 30**

Course Objectives	
1.	To enable students to understand and explain fundamental concepts of genomics, including gene sequencing, conserved genes, genomic variation and their biological significance.
2.	To familiarize students with mechanisms of gene regulation, alternative gene expression, DNA imprinting, and epigenetic modifications.
3.	To develop students' ability to analyze genomic variations, especially SNPs, and their role in diseases, aging, and medical therapies in both prokaryotic and eukaryotic systems.
4.	To provide hands-on conceptual knowledge of molecular biology tools and techniques used for studying protein–DNA interactions, gene expression, and genome analysis.

Course Outcome	
CO1	Students will be able to define and explain the principles of genomics, including gene sequencing, conserved genes, and identification of gene base sequences.
CO2	Learners will understand mechanisms of alternative gene expression, including DNA imprinting and epigenetic regulation.
CO3	Students will be able to explain genomic variations such as SNPs and analyze their role in diseases, aging, and associated evolutionary trade-offs in prokaryotes and eukaryotes.
CO4	Learners will demonstrate knowledge of SNP detection methods and evaluate their applications in medical therapies.
CO5	Learners will understand the construction and applications of DNA microarrays (genomic, cDNA, and oligo arrays) in gene expression analysis.
CO6	Students will be able to understand and interpret epigenomic techniques, such as bisulfite sequencing, methylation-specific PCR, and histone modification profiling.

Syllabus		
Unit I	**Genomics**	15 hours
	i. Gene sequencing, conserved genes, finding base sequences which form genes ii. Many proteins from one gene, alternative gene expression: DNA imprinting and Epigenetics iii. Genomic variation-SNPs, SNPS and diseases, SNPS detection and medical therapies. Eukaryotic and prokaryotic SNPs iv. Role of genomic variation in aging, Recognition of trades offs associated with genomic variation	
Unit II	**Tools and techniques in Molecular Biology**	15 hours
	1. Study of protein-DNA interactions: electrophoretic mobility shift assay; DMS footprinting, Dnase footprinting, Protein footprinting, methyl interference assay and its modifications. 2. DNA microarray, Construction of microarrays – genomic arrays, cDNA arrays and oligo arrays. Applications of microarray 3. PCR variants: i. RT-PCR ii. qPCR (Real-time PCR) iii. Multiplex PCR iv. Nested PCR v. Hot start PCR 4. Sequence tagged sites, Filter binding assay, finding the replicon, DNA fingerprinting, Measuring transcription rates 5. Epigenomics Techniques: i. Bisulfite sequencing for DNA methylation ii. Methylation-specific PCR **iii.** Histone modification profiling	

Suggested Readings:

1. Benjamin Lewin. (2008) *Genes IX*, Jones and Bartelett Publishers Inc.
2. S.B Primrose and R M Twyman 2006 7th edition. Blackwell publishing
3. James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann,
4. Michael Levine, Richard Loswick (2004) *Molecular Biology of the Gene*, 5th Edition, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc.
5. Molecular Biology of the Cell, Bruce Albert et. al., 6th Ed., Garland Sciences.
6. Molecular Biology, Loddishet. al., 7th Edn, W. H. Freeman,2012
7. Weaver R., (2007) *Molecular Biology*, 4th Edition, McGrew Hill Science
8. Genomes. 2nd edition, Brown TA, Oxford: Wiley-Liss; 2002
9. Gene TherapyTools and Potential Applications-Francisco Martin Molina (2013) Janeza Trdine , 51000 Rijeka, Croatia (online book)
10. Molecular Cell Biology-Lodish ,Berk, 5th Edn. Freeman 2003
11. Molecular Biology of the Cell, 5th edn, Alberts 2008, Grandland science
12. Genes IX - Lewin B. 2004, Prentice Hall
13. Cell & Molecular & William & Wilkins 2006
14. DNA repair mutagenesis: Friedberg E. C. ASM press 1995.
15. B.R.Glick,J.J Pasternak J. J. (1998) Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington D C, ASM Press. 3rdEd

Syllabus passed in BOS Microbiology and Biotechnology meeting held on 24th Jan 2026

M.Sc.Sem I (NEP – Autonomy 2026 Pattern)

Course Title	Enzymology & Protein Biochemistry		
Course Code: 26SMMB14MM			**No. of Credits: 2**
Course Type: M4			**Total Teaching Hours: 30**

Course Objectives	
1.	To enable students to understand and explain the fundamental concepts and principles of Enzymology.
2.	To familiarize students with protein biochemistry and enable them to understand and describe the concepts of protein structure.
3.	To enable students to understand, explain, and analyze protein sequencing techniques and the biological significance of proteins.

Course Outcome	
CO1	Students will be able to describe and explain the chemical basis of protein structure, including peptide bond formation, resonance, cis–trans isomerism, and levels of protein organization.
CO2	Students will be able to explain and illustrate methods used for the determination of the primary structure of proteins, including N-terminal and C-terminal analysis and peptide sequencing techniques.
CO3	Students will be able to analyze and interpret protein secondary, tertiary, quaternary, and super-secondary structures using concepts such as the Ramachandran plot.
CO4	Students will be able to explain and evaluate the structural and functional significance of metalloproteins, motor proteins, and membrane proteins in biological systems.
CO5	Students will be able to apply and analyze enzyme kinetic principles to distinguish between different types of reversible inhibition and determine inhibition constants using primary and secondary plots.
CO6	Students will be able to explain and evaluate the concepts of allosterism and cooperativity by comparing classical models of allosteric enzymes and applying the Hill equation to enzyme systems.

Syllabus		
Credit I	**Structure and significance of proteins**	15 hours
	i. Peptide linkage, partial double bond nature of peptide bond, Resonance forms of the peptide group, cis/trans isomers of peptide group ii. Determination of primary structure of polypeptide (N-terminal, C-terminal determination, methods of sequencing of peptides) iii. Protein Secondary Structure iv. Tertiary, Quaternary and Super-secondary structure of proteins v. Ramachandran plot vi. Significance of Metalloprotein, motor proteins and membrane proteins	
Credit II	**Enzymology**	15 hours
	A. Kinetics of reversible inhibitions: i. Competitive, uncompetitive, non-competitive ii. Primary and secondary plots, Determination of Ki using secondary plots iii. Significance of inhibitors **B. King Altman approach** to derive two substrate enzyme catalyzed reactions **C. Concept of allosterism**: i. Positive and negative cooperativity ii. Examples of allosteric enzymes iii. Models of allosteric enzymes (Monad, Wyman and Changeux and Koshland, Nemethy and Filmer model) iv. Hill equation	

Suggested Readings:

1. Nelson D. L. and Cox M. M. (2002) Lehninger's Principles of Biochemistry, 4th edition, Mac Millan Worth Pub. Co. New Delhi.
2. Segel Irvin H. (1997). Biochemical Calculations. 2nd Ed. John Wiley and Sons, NY.
3. Garrett, R. H. and Grisham, C. M. (2004) Biochemistry. 3rd Ed. Brooks/Cole, Publishing Company, California.
4. Donald Voet (Author), Judith G. Voet (2011). Biochemistry, 4th Edition, Kindle Edition
5. Biochemistry by U. Satyanarayan and U. Chakrapani 5th edition
6. ENZYMES: Biochemistry, Biotechnology, Clinical Chemistry by Trevor Palmer
7. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis, 2nd Edition by Robert A. Copeland

Syllabus passed in BOS Microbiology and Biotechnology meeting held on 24th Jan 2026

M.Sc.Sem I (NEP – Autonomy 2026 Pattern)

Course Title	Microbial Taxonomy and Molecular Biology
Course Code: 26SMMB15MM	**No. of Credits: 2**
Course Type: P1	**Total Teaching Hours: 60**

Course Objectives	
1.	To provide students with hands-on knowledge of microbial taxonomy, focusing on enrichment, isolation, and identification of extremophiles from natural samples.
2.	To enable students to understand and apply taxonomic principles and standard reference systems such as Bergey's Manual for bacterial identification.
3.	To train students in core molecular biology techniques, including DNA digestion, electrophoresis, PCR amplification, and sequence analysis.
4.	To develop the ability to analyze molecular data for sequence similarity and evolutionary relationships using bioinformatics tools.

Course Outcome	
CO1	Students will be able to explain the principles and applications of restriction enzymes, PCR, and DNA sequencing.
CO2	Learners will understand restriction digestion of DNA and resolve DNA fragments using agarose gel electrophoresis.
CO3	Students will be able to estimate molecular weight of DNA fragments using appropriate molecular markers.
CO4	Learners will amplify specific DNA sequences using Polymerase Chain Reaction (PCR).
CO5	Students will analyze nucleotide sequences and perform sequence matching using BLAST.
CO6	Learners will be capable of constructing and interpreting phylogenetic trees using bioinformatics software such as MEGA or PHYLIP.

Syllabus		
Credit I	**Microbial Taxonomy**	30 hours
	Enrichment, Isolation and identification of the extremophiles from natural samples. Identification of the bacteria to at least the Genus level using the Bergey's Manual. The identification key must be designed for each isolate: i. Thermophiles ii. Alkaliphile iii. Acidophiles iv. Halophiles	
Credit II	**Molecular Biology**	30 hours
	i. Digestion of DNA using restriction endonucleases. ii. Resolution and molecular weight estimation of fragmented DNA using agarose gel electrophoresis. iii. Amplification of known DNA sequences by Polymerase Chain Reaction. iv. Sequence matching by BLAST analysis. v. Drawing phylogenetic tree using related sequences (Using standard software like Phylip, Mega etc)	

Suggested Readings:

1. Karp G. (2015) Cell and Molecular Biology: Concepts and Experiments.5th Edition. John Wiley Publication.
2. Christopler H. (1995) Gene cloning and Manipulating, Cambridge University Press
3. Nicholl, D.S.T (1994) An Introduction of Genetic Engineering, Cambridge University Press.
4. Dubey,R.C and Maheswari,D.K (2002)Practical Microbiology S.Chand Ltd
5. Cappuccino,J.G.,Sherman,S(2002) Microbiology. A Laboratory Manual Benjamin Cummings Publishing Company
6. Carl R. Woese. The archaeal concept and the world it lives in: a retrospective.Photosynthesis Research 80: 361 – 372, 2004. Kluver Academic Publishers
7. Species Divergence and the measurement of microbial diversity. Catherine Lozupone and Rob Knight. FEMS Microbiol. Rev. 32 (2008) 557 –578
8. Keller M. and Zengler K. (2004) Tapping into Microbial Diversity. NatureReviews
9. Breed and Buchanan. Bergey's Manual of Determinative Bacteriology. 9th Edition,1982.
10. Breed and Buchanan. Bergey's Manual of Systematic Bacteriology. 2nd Edition, (Volumes.1– 5) (2001 – 2003).

M.Sc. Sem I (NEP – Autonomy 2026 Pattern)

Course Title	Quantitative Biology and Enzymology	
Course Code: 26SMMB16MM		**No. of Credits: 2**
Course Type: P2		**Total Teaching Hours: 60**

Course Objectives	
1.	To introduce students to the applications of computers and relevant software tools in Biostatistics for data analysis and interpretation.
2.	To provide students with a comprehensive understanding of protein purification techniques and the principles governing their selection and application.
3.	To enhance students' understanding of the effects of various physical and chemical parameters on enzyme activity and stability.

Course Outcome	
CO1	Students will be able to organize, manage, and present biological data using spreadsheets by applying appropriate data sorting and visualization techniques.
CO2	Students will be able to generate and interpret graphical representations of biological data, including bar charts, line graphs, pie charts, and error bars, using Microsoft Excel.
CO3	Students will be able to apply and analyze basic statistical tests using Microsoft Excel to evaluate experimental biological data.
CO4	Students will be able to explain and demonstrate the principles and methodologies involved in enzyme production, purification, and quantification.
CO5	Students will be able to determine and analyze enzyme kinetic parameters such as Km and Vmax and document purification efficiency using enzyme purification charts and SDS-PAGE analysis.
CO6	Students will be able to evaluate the effect of pH, temperature, and inhibitors on enzyme activity and interpret experimental outcomes.

Syllabus		
Credit I	**Quantitative Biology**	30 hours
	A. Computer applications for Data Presentation and analysis: i. Using data sheets and sorting data with different parameters ii. Plotting graphs – bar charts, line graphs, pie charts, adding error bars. (Using Microsoft Excel) B. Statistical analysis of data using Microsoft Excel: i. Student's t test ii. ANOVA iii. Chi square test iv. F-test	
Credit II	**Enzymology**	30 hours
	A. Enzyme production and purification: i. Production, purification and quantification of bacterial/ fungal amylase/protease ii. Determination of Km and Vm of purified enzyme iii. Construction of enzyme purification chart iv. SDS-PAGE B. Study of various parameters on enzyme activity: i. pH ii. Temperature iii. Inhibitor	

Suggested Readings:

1. Rodney F. Boyer(2000) Modern Experimental Biochemistry 3rd edition.,Benjamin Cummings
2. https://www.sciencedirect.com/science/article/pii/S2213020914000068
3. Gel Electrophoresis of Proteins, Edited by Michael J, Dunn.
4. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis, 2nd Edition by Robert A.Copeland
5. Richard Levin & David S. Rubin (2012): Statistics for Management, 7th Edition, Pearson.
6. J K Sharma (2012); Business statistics, Second Edition- Pearson Education.
7. K.V.S. Sarma: Statistics made simple: do it yourself on PC. PHI

Syllabus passed in BOS Microbiology and Biotechnology meeting held on 24th Jan 2026

M.Sc. Sem I (NEP – Autonomy 2026 Pattern)

Course Title	**Practicals Based on Waste Water Management & Immunology**
Course Code: 26SMMB17MM	**No. of Credits: 2**
Course Type: P3	**Total Teaching Hours: 60**

Course Objectives	
1.	To familiarize students with aspects of principles and importance of wastewater management in industrial context.
2.	To develop knowledge and skills for learning estimation of physico-chemical characteristics of industrial wastewater.
3.	To enable students to understand the concept of agglutination and precipitation reactions
4.	To extend knowledge about various immunological assays

Course Outcome	
CO1	Students will be able to define and explain principles and significance of wastewater management and treatment methods.in industrial applications.
CO2	Learners will understand the relevance of estimation and analysis of physico-chemical characteristics of industrial wastewater.
CO3	Learners will be capable of designing layout of waste water treatment plant
CO4	Students will demonstrate the steps in Western Blotting for detection of HIV proteins
CO5	Learners will be able to compare & analyze various agglutination and precipitation reactions
CO6	Students will assess importance and clinical significance of agglutination titer

Syllabus		
Credit I	**Waste Water Management**	**30 hours**
	1.Estimation of physical characteristics of Industrial Wastewater 2.Determination of Biochemical Oxygen Demand (BOD) 3.Comparison of Chemical Oxygen Demand (COD) and Theoretical COD (ThOD)	
Credit II	**Immunology**	**30 hours**
	1. Precipitation reactions of Antigen - Antibody: Single radial immunodiffusion. 2. Rocket Immunoelectrophoresis. 3. Agglutination techniques: Determination of iso- antibodies titer to human blood group antigens. 4. Western Blotting	

Suggested Readings:

1. American Public Health Association, American Water Works Association, Water Environment Federation (2023). Standard Methods for the Examination of Water and Wastewater. 24th ed. Washington, DC: APHA Press.

2.Metcalf & Eddy (2014) Wastewater Engineering: Treatment and Resource Recovery. 5th Edition, McGraw-Hill, New York.

3.McGraw-Hill textbook "Environmental Engineering" by Howard S. Peavy, Donald R. Rowe, and George Tchobanoglous.

4.Chemistry for Environmental Engineering and Science,' 5th Edition, by Clair N. Sawyer, Perry L. McCarty, and Gene F. Parkin.

5.Biological Process Design for Wastewater Treatment Larry D. Benefield, Clifford W. Randall Prentice-Hall, 1980 - Technology & Engineering

6.Axelsen N. H., Kroll J. and Weeke B. (1973) A manual of quantitative immunoelectrophoresis: methods and applications. Scand. J. Immunol. 2(Suppl. 1): 37- 46

7.Galvão de França N.D., Cristovão Poli M.C., Almeida Ramos P.G., Rocha Borsoi C.S. and Colella R. (2011) Titers of ABO antibodies in group O blood donors.Rev Bras HematolHemoter. 259–262

8.Kang S.J., Lim Y.A. and Baik S.Y. (2014) Comparison of ABO antibody titers on the basis of the antibody detection method used. Ann Lab Med. 34:300–306.

9.Laurell C. B. (1966) Quantitative estimation of proteins by electrophoresis in agarose gel containing antibodies. Anal.Biochem. 15:45–52

10. Vaerman J. P. (1981). Single radial immunodiffusion, in methods in enzymology: 73 (Langone, J. J. And Van Vunakis, H, Eds.) New York: 291-305

M.Sc. Sem I (NEP – Autonomy 2026 Pattern)

Course Title	**Immunology**
Course Code: 26SMMB11MEA	**No. of Credits: 2**
Course Type: E1	**Total Teaching Hours: 30**

Course Objectives	
1.	To familiarize students with cell surface molecules , receptors and regulation of immune response
2.	To develop knowledge about diverse signal transduction pathways
3.	To enable students to understand regulation of complement system
4.	To extend knowledge about biological response modifiers as therapeutics for autoimmune disorders and cancer

Course Outcome	
CO1	Students will be able to define the meaning and role of diverse cell surface molecules and receptors
CO2	Learners will understand the relevance of negative regulation.
CO3	Students will demonstrate the steps in various signal transduction pathways
CO4	Learners will be able to compare & analyze about role of regulatory proteins in complement pathways
CO5	Students will assess role and action of cytokines in hematopoiesis and cross regulation
CO6	Learners will be capable of designing a comprehensive summary of biological response modifiers

Syllabus		
Credit I	**Cell surface molecules and receptors**	15 hours
	A. Definition, General structure and mechanism (dimerization and rotation), components of signal transduction (extracellular signaling molecule, receptor proteins, intracellular signaling proteins and target proteins) B. Adhesion molecules in immune activation, structure and function of B Cell Receptor, TCR- CD3 complex, Toll- like receptors, Cytokine receptors, G- protein coupled receptors C. Signal transduction pathways: IL- 2 pathways (JAK/STAT, Ras/MAP Kinase Pathways)	
Credit II	**Regulation of Immune response**	15 hours
	A. Negative regulation - Immunological tolerance, Mechanisms of tolerance induction (related experimentation using transgenic animals), T cell mediated suppression of immune response. B. Regulation of immune responses by antigen, antigen-antibody complexes, Network theory and its experimental evidence. C. Cytokines involved in hematopoiesis, Cytokine mediated cross regulation of TH subsets (TH1- TH2) D. Regulation of complement system – Classical and alternative pathway E. Biological Response Modifiers for cancer therapy and autoimmune disorders	

Suggested Readings:

1. Austyn J. M. and Wood K. J. (1993) Principles of Molecular and Cellular Immunology. First edition Oxford University Press, New York.

2. Barret J. T. (1983) Text Book of Immunology. Fourth edition. Saint Louis, Mosby, London.

3. Boyd W. C. (1966) Fundamentals of Immunology, Interscience Publishers, New York.

4. Gangal S. and Sontakke S. (2013) Textbook of Basic and Clinical Immunology. University Press, India.

5. Garcia K. C. and Adams (2005) How the T cell Receptor Sees Antigen -A Structural View. Cell. 122(3): 333–336.

6. Hafler D. A. (2007) Cytokines and interventional immunology, Nature Reviews, Immunology. 7(6): 423-423.

7. Kindt T. J., Osborne B. A. and Goldsby R. A. (2006) Kuby Immunology, Sixth edition, W. H. Freeman & Co.

8. Yoshimura A., Naka T. and Kubo M. (2007). SOCS proteins, cytokine signaling and immune regulation. Nature Reviews, Immunology, 7(6):454- 465.

9. Abbas A. K. and Lichtman A. H. (2004) Basic Immunology. Functions and Disorders of the Immune System. Second edition. Elsevier Inc.

10. Carroll M. C. (2004) The complement system in regulation of adaptive immunity. Nature Immunology. 5(10): 981- 986.

11.Patwardhan B., Gautam M. and Diwanay S. (2006) Botanical Immunomodulators and Chemoprotectants in Cancer Therapy. In Drug discovery and development Volume I: Drug Discovery.Ed. Chorghade Mukund S. Wiley- Interscience, John Wiley and Sons Inc. USA. 405-424.

12. Roitt I. M. (1984) Essentials of Immunology. P. G. Publishers Pvt. Ltd., New Delhi.

13. Roitt I. M. 1988.Essentials of Immunology. ELBS, London.

M.Sc. Sem I (NEP – Autonomy 2026 Pattern)

Course Title	Experimental Design	
Course Code: 26SMMB11MEB		**No. of Credits: 2**
Course Type: E2		**Total Teaching Hours: 30**

Course Objectives	
1.	To familiarize students with the relevance of mathematical models in biological study.
2.	To develop knowledge and skills for effective use of epidemiological studies.
3.	To enable students to understand clinical trials and their applications.
4.	To extend knowledge about the optimization of nutrient medium.

Course Outcome	
CO1	Students will be able to define the meaning and need of data analysis.
CO2	Learners will understand the relevance of epidemiological studies.
CO3	Students will demonstrate the steps in Clinical trials.
CO4	Learners will be able to compare & analyze various combinations of parameters in optimizing nutrient medium.
CO5	Students will assess experimental and observational studies.
CO6	Learners will be capable of designing a complete mathematical model.

Syllabus		
Credit I	**Designing of Experiments**	15 hours
	A. Factorial design (Full, Fractional and Plackett Burman) i. Two-factor and multi-factor designs ii. Main effects and interaction effects iii. 2^k factorial designs iv. Fractional factorial designs v. Confounding B. Types of variables (independent, dependent, control, nuisance) C. Experimental vs observational studies D. Validity: internal vs external E. Randomization, replication, and local control F. Clinical/field trials-Randomization, Bias removal (Blinding – single & double), controlled and uncontrolled trials G. Nested designs H. Longitudinal and time-course experiments I. Dose–response studies	
Credit II	**Mathematical approach for Biologists**	15 hours
	A. **Data Analysis** : Trends, Testing mathematical models, Goodness of fit: Least Square Analysis, Linear and Non-linear models **B. Concept of mathematical model** : Need, modeling the system of interest, modeling the data Deterministic Vs Stochastic model, Cyclic processes of model construction, verification and Applications **C. Mathematical Modeling in Biology** • Model formulation and assumptions • Parameter estimation • Model validation and limitations	

Suggested Readings:

1. David Brown & Peter Rothery. Models in biology: Mathematics, statistics, and computing JohnWiley &Sons,USA
2. Irfan Ali Khan and Atiya Khanum, Fundamentals of Biostatistics. 3rd Ed. Ukaaz, Publications, Hyderabad
3. Norman T.J.Bailey Statistical methods in biology, 3rd Ed. Cambridge University Press
4. Montgomery D.C. Design and analysis of experiments, John Wiley &Sons
5. Stephen Newman, Biostatistical methods in Epidemiology. Wiley Interscience Publication
6. Aviva Petrie and Carolene Sabin, 2005, Medical Statistics at a glance, 2nd Edition, Blackwell
7. Haefner James W. (1996) Modeling Biological Systems: Principles and Applications, Kluwer Academic Publications

Syllabus passed in BOS Microbiology and Biotechnology meeting held on 24th Jan 2026

M.Sc. Sem I (NEP – Autonomy 2026 Pattern)

Course Title	Industrial Waste Water Management		
Course Code: 26SMMB12MEA			**No. of Credits: 2**
Course Type: E3			**Total Teaching Hours: 30**

Course Objectives	
1.	To understand the concept of waste water generation and its treatment
2.	To impart knowledge on selection of treatment methods for industrial wastewater.
3.	To enable students to understand different techniques and methods of waste water treatment.
4.	To apply physicochemical and biological treatment methods for recovery, reuse and disposal of industrial wastewater.

Course Outcome	
CO1	Students will be able to identify environmental standards that apply to both direct and indirect industrial discharges.
CO2	Learners will understand the relevance of waste water treatment strategy.
CO3	Students will demonstrate the design criteria for physical, chemical, and biological unit operations and processes necessary to treat industrial wastewater.
CO4	Learners will be able to compare & analyze the design, conduct experiments and develop the ability to analyze the waste water quality.
CO5	Students will assess various methods of waste water treatment.
CO6	Learners will be capable of designing the layouts of waste water treatment methods.

Syllabus		
Credit I	**Principles and Unit Processes of Wastewater Treatment**	15 hours
	A. **Principles of Wastewater Treatment** i. The need for Wastewater Treatment ii. Measuring Pollution Load of wastewaters iii. Methods for estimating parameters used for determining treatment efficacy iv.Layout of typical wastewater treatment plants **B. Pretreatment & Primary treatment process (Unit Processes)** i. Flow equalization ii. Screening iii. Flocculation iv. Flotation v. Granular medium filtration	
Credit II	**Secondary and Tertiary Treatment Processes**	15 hours
	A. **Secondary Treatment process** (Unit Processes) i. Biological Processes (Aerobic) ii.Biological Processes (Anaerobic) iii. Biological processes (Combined) B. **Tertiary Treatment process** (Unit Processes) i. Sedimentation and clarification ii. Disinfection iii. Adsorption C.Emerging & Future Technologies **1.Advanced Biological Treatment Technologies** Membrane Bioreactor (MBR) and Moving Bed Biofilm Reactor (MBBR) 2. **Advanced Oxidation Processes (AOPs)** Ozonation (O_3) **3.Membrane-Based Separation Technologies** Nanofiltration (NF) **4.Smart & Digital Technologies** AI & Machine Learning **D. Sludge treatment and disposal**. i.Wastewater Disposal Methods ii.Standards of Dilution for Characteristics Current industrial wastewater treatment processes in Dairy, Pulp and Paper, Textile industries	

Syllabus passed in BOS Microbiology and Biotechnology meeting held on 24th Jan 2026

Suggested Readings:

1. Metcalf & Eddy, "Wastewater engineering Treatment disposal reuse", Tata McGraw Hill.
2. Eckenfelder, W.W., "Industrial Water Pollution Control", McGraw-Hill.
3. Mark J. Hammer, Mark J. Hammer, Jr., "Water & Wastewater Technology", Prentice Hall of India.
4. N.L. Nemerow –Theories and practices of Industrial Waste Engineering.
5. C.G. Gurnham –Principles of Industrial Waste Engineering
6. Advanced Treatment Technologies for Urban Wastewater Reuse Despo C. Fatta-Kassinos (Handbook of Environmental Chemistry).
7. Advanced Biological Processes for Wastewater Treatment Márcia Dezotti, Geraldo Lippel, João Paulo Bassin.
8.Advanced Materials and Technologies for Wastewater Treatment .First Edition Edited By Sreedevi Upadhyayula, Amita Chaudhary.
9.Advances in Water and Wastewater Treatment: Theoretical and Experimental Approaches. Edited By Pranav Deepak Pathak, Himanshu J. Patel, Anuja R. Jadhav
10.Wastewater to Water: Principles, Technologies and Engineering Design — Makarand M. Ghangrekar

M.Sc. Sem I (NEP – Autonomy 2026 Pattern)

Course Title	Cell Biology and Membrane Transport	
Course Code: 26SMMB12MEB		**No. of Credits: 2**
Course Type: E4		**Total Teaching Hours: 30**

Course Objectives	
1.	To familiarize students with the concepts of cell biology
2.	To develop knowledge about cell cycle regulation and apoptosis
3.	To enable students to understand protein trafficking among various cellular compartments
4.	To extend knowledge about concepts of membrane transport and signal transduction

Course Outcome	
CO1	Students will be able to define the meaning and role of various cell organelles
CO2	Learners will understand the relevance of protein trafficking among various cellular compartments
CO3	Students will demonstrate the steps in cell cycle
CO4	Learners will be able to compare & analyze about primary and secondary active transport
CO5	Students will assess role and action of signal transduction pathways in bacteria
CO6	Learners will be capable of designing a comprehensive summary of intrinsic and extrinsic pathway of apoptosis.

Syllabus		
Credit I	**Cell Biology**	15 hours
	A. Structural organization and functions of i. Endoplasmic Reticulum ii. Golgi Apparatus iii. Nucleus iv. Mitochondrion v. Lysosomes vi. Peroxisomes B. **Protein trafficking among various cellular compartments** (by secretory and cytosolic pathway: targeting to secretory vesicles, cell membrane, lysosomes, nucleus, mitochondria and peroxisomes) **C. Events in cell cycle and Regulation of cell cycle** D. **Apoptosis:** Intrinsic and Extrinsic pathway	
Credit II	**Membrane Transport**	15 hours
	A. The composition and architecture of membranes, membrane dynamics B. Solute transport across membranes: Passive diffusion, facilitated transport, primary and secondary active transport using P, V and F type ATPases, Ionophores, Ion mediated transport, transport of ions across membranes (ion pumps), ligand and voltage gated ion channels. C. Liposomes and model membranes, D. Signal transduction pathways in bacteria, second messengers, regulation of signaling pathways, bacterial two-component systems ,chemotaxis	

Suggested Readings:

1. Nelson D. L. and Cox M. M. (2002) Lehninger's Principles of Biochemistry, 4th edition, Mac Millan Worth Pub. Co. New Delhi.
2. Molecular Biology of the Cell, Bruce Albert et. al., 6th Ed., Garland Sciences.
3. Molecular Cell Biology-Lodish, Berk, 5th Edn. Freeman 2003
4. Cells-Levin, 1st Ed. Jones & Bartlett Publisher 2006
5. The cell – A molecular Approach 4th Edu. Geoffrey M. Cooper, Robert E. Hausman
6. Genes IX - Lewin B. 2004, Prentice Hall

M.Sc. Sem I (NEP – Autonomy 2026Pattern)

Course Title	Research Methodology	
Course Code: 26SMMB11RM		**No. of Credits: 4**
Course Type: RM		**Total Teaching Hours: 60**

Course Objectives	
1.	To familiarize students with technical and scientific writing skills
2.	To develop knowledge about how to make a research proposal
3.	To enable students to understand data mining, management and analysis
4.	To extend knowledge about research communication and presentation skills

Course Outcome	
CO1	Students will be able to define the meaning and role of technical and scientific writing skills
CO2	Learners will understand the relevance of interactive and collaborative activities
CO3	Students will demonstrate the steps while making scientific oral and poster presentations
CO4	Learners will be able to compare & analyze about data mining, management and analysis
CO5	Students will assess role and action of ethical issues in scientific writing and research
CO6	Learners will be capable of designing a comprehensive research proposal

Syllabus		
Credit I	**Technical writing skills**	15 hours
	1. Types and Formats of Scientific and Technical Reports 2. Fundamentals of Scientific Writing: Clarity, precision, coherence, and scientific style 3. Significance of Scientific Communication: Role in academics, industry and society 4. Ethical Issues in Scientific Writing and Research: Copyright, Plagiarism, and Academic Integrity 5. Structure and Components of a Research Paper 6. Scientific Publishing Practices: Peer review process, editorial workflow, and common challenges 7. Use of Search Engines and Digital Tools for Scientific Data Mining: Literature search strategies using SCOPUS, Google Scholar, PUBMED, Web of Science, science direct, Indian Citation Index, Research Gate and scifinder.	
Credit II	**Scientific Writing and Research Proposal Development**	15 hours
	1. Identification of Research Problem and Formulation of Title 2. Establishing Research Objectives and Hypothesis 3. Review of Literature: Data collection from research papers, dissertations, and peer-reviewed journals 4. Selection of Research Design and Methodology: Study design and specification of statistical methods 5. Data Collection Methods 6. Data Analysis and Statistical Interpretation: Possible outcomes and interpretation of results 7. Data Presentation: Tables, graphs, and figures 8. Conclusion and Preparation of Research Report 9. Referencing and Bibliography Preparation	
Credit III	**Data mining, management and analysis**	15 hours
	1. **Scientific Data Mining** i. Effective use of search engines and databases for literature search ii. Strategies for keyword selection and data collection 2. **Reference Management** i. Use of reference management tools (e.g., Zotero, Mendeley) ii. Organizing, citing, and formatting References 3. **Scientific Writing Exercises** i. Writing abstracts for research papers ii. Preparing a concept note for a research project iii. Writing a scientific news article or science blog 4. **Statistical Data Analysis** i. Hands-on exercises using statistical software for research data ii. Interpretation and visualization of results	

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Credit IV	**Research Communication and Presentation Skills**	15 hours
	1. Graphical Communication i. Preparing graphical abstracts using software ii. Designing figures, tables, and visuals for clarity and effective communication **2. Scientific Poster Preparation & Presentation** i. Planning and designing poster layout and content ii. Applying visual storytelling techniques iii. Delivering oral explanation and defense of poster content **3. Presentation of Scientific Work** i. Preparing and delivering PowerPoint presentations **ii.** Reading, analyzing, and presenting a published research article iii. Designing slides with clarity, visuals, and conciseness iv. Critically discussing methodology, results and conclusions v. Handling questions and feedback during presentations **4. Interactive and Collaborative Activities** i. Participation in group discussions ii. Providing and receiving peer feedback on presentations, posters and other exercises	

Suggested Readings:

1. Day, R. A., & Gastel, B. (2012). How to Write and Publish a Scientific Paper (7th Ed.). Cambridge University Press.
2. J. Ellis, T., Levy, Y. (2009). Towards a guide for novice researchers on research methodology: Review and proposed methods. Issues in Informing Science and Information Technology, 6, 323-337. https://doi.org/10.28945/1062
3. Alley, M. (2018). The Craft of Scientific Writing (4th Ed.). Springer.
4. Gopen, G. D., & Swan, J. A. (1990). The science of scientific writing. American Scientist, 78(6), 550–558.
5. Burns, T. W., O'Connor, D. J., & Stocklmayer, S. M. (2003). Science communication: A contemporary definition. Public Understanding of Science, 12(2), 183–202.
6. Roig, M. (2015). Avoiding Plagiarism, Self-Plagiarism, and Other Questionable Writing Practices.
7. Resnik, D. B. (2020). The Ethics of Science: An Introduction. Routledge.
8. Swales, J. M., & Feak, C. B. (2012). Academic Writing for Graduate Students (3rd Ed.). University of Michigan Press.
9. Ware, M., & Mabe, M. (2015). The STM Report. International Association of Scientific, Technical and Medical Publishers.
10. Falagas, M. E., et al. (2008). Comparison of PubMed, Scopus, Web of Science, and Google Scholar. FASEB Journal, 22(2), 338–342.
11. Locke, L. F., Spirduso, W. W., & Silverman, S. J. (2013). Proposals That Work (6th Ed.). SAGE.
12. Creswell, J. W., & Creswell, J. D. (2018). Research Design (5th Ed.). SAGE.
13. Booth, W. C., Colomb, G. G., & Williams, J. M. (2016). The Craft of Research (4th Ed.). University of Chicago Press.
14. Kothari, C. R. (2004). Research Methodology: Methods and Techniques. New Delhi, India: New Age International. Google Books