M.Sc.Sem I (NEP – Autonomy 2023 Pattern)

Course Title	Microbial Taxonomy
Course Code: 23SMMB111	**No. of Credits: 2**
Course Type: M1	**Total Teaching Hours: 30**

Course Objectives	
1.	To enrich students' knowledge related to basic concepts in Microbial systematics
2.	To inculcate the concepts of culturable and unculturable bacteria
3.	To make students acquainted with the concepts of microbial diversity

Course Outcome	
1.	Students will understand the concepts of Microbial systematics
2.	Students will be able to study the diversity and unculturable bacteria and bacterial systematics
3.	Students will understand the concept and applications of concepts of microbial diversity

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 Un-culturable 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.	

Suggested References:

1. Microbial Diversity:FormandFunctioninProkaryotes,PublishedOnline:30NOV2007.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. JacquelynG.Black(2013)Microbiology:PrinciplesandExplorations,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. PaceN.(1997)AMolecularViewofMicrobialDiversityandtheBiosphere,Science,276,734- 740.

M.Sc.Sem I (NEP – Autonomy 2023 Pattern)

Course Title	**Quantitative Biology**		
Course Code: 23SMMB112			**No. of Credits: 2**
Course Type: M2			**Total Teaching Hours: 30**

Course Objectives	
1.	To enrich students' knowledge related to basic concepts in Biostatistics
2.	To inculcate the concepts of testing hypothesis using parametric and non-parametric tests
3.	To make students acquainted with the concepts of significance tests

Course Outcome	
1.	Students will understand the concepts of descriptive statistics
2.	Students will be able to test the hypothesis and draw the conclusion from the present data that will help them in research
3.	Students will understand the concept and applications of parametric and non-parametric tests

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 ii. Measures of central tendency – Mean Mode,median iii. Measures of dispersion – Mean deviation, Standard deviation and Variance iv. Simple linear Regression and correlation (significance testing not necessary)	
Credit II	**Inferential Statistics-I**	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	

Suggested References:

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 UniversityPress
3. Goon,Gupta and DasguptaFundamentalsofstatistics,WorldPress,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 InterscienceP ublication
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 2023 Pattern)

Course Title	Molecular Biology I
Course Code: 23SMMB113	**No. of Credits: 2**
Course Type: M3	**Total Teaching Hours: 30**

Course Objectives	
1.	To make students aware about genomics
2.	To teach them applications of genomics
3.	To give them the knowledge of mobile DNA elements

Course Outcome	
1.	Students will learn about genomics and its applications
2.	Students will be acquainted with the concepts of mobile DNA elements
3.	Students will learn significance of transposons

Syllabus		
Credit 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 prokaryoticSNPs iv. Role of genomic variation in aging, Recognition of trades offs associated with genomic variation	
Credit II	**Mobile DNA elements**	15 hours
	i. Transposable elements in bacteria, IS elements, composite transposons, Integrons. ii. Replicative, nonreplicative transposons, and Mu transposition Controlling elements in Tn A, Tn 5 and Tn 10 transposition Transposons in maize and Drosophila iii. Retroviruses and retrotransposon, Ty elements in yeasts SINES, LINES and Alu elements **iv.** Significance of transposons and Integrons	

Suggested References:

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 9, 51000 Rijeka, Croatia (online book)

M.Sc.Sem I (NEP – Autonomy 2023 Pattern)

Course Title	Enzymology & Protein Biochemistry
Course Code: 23SMMB114	**No. of Credits: 2**
Course Type: M4	**Total Teaching Hours: 30**

Course Objectives	
1.	To make students learn the concepts of Enzymology
2.	To give students the knowledge of protein biochemistry including the concepts of protein structure
3.	To make students understand protein sequencing and significance of proteins

Course Outcome	
1.	Students will learn the concepts of Enzymology
2.	They will get the knowledge of protein biochemistry including the concepts of protein structure
3.	Students will understand protein sequencing and significance of proteins

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. Problems based on this topic iv. Tertiary, Quaternary and Super-secondary structure of proteins v. Ramachandran plot vi. Significance of Metalloprotein, motor proteins and membrane proteins	
Credit II	**Inhibitors and allosteric enzymes**	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. Models of allosteric enzymes (Monad, Wyman and Changeux and Koshland, Nemethy and Filmer model) iii. Kinetics of allosteric enzyme iv. Hill plot v. Examples of allosteric enzymes and their significance in regulation	

Suggested References:

1. Nelson D. L. and Cox M. M. (2002) Lehninger's Principles of Biochemistry, 4th edition, Mac MillanWorth Pub. Co. NewDelhi.
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. Chakrapani5th edition
6. ENZYMES: Biochemistry, Biotechnology, Clinical Chemistry by TrevorPalmer
7. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis, 2nd Edition by Robert A. Copeland

M.Sc.Sem I (NEP – Autonomy 2023 Pattern)

Course Title	Microbial Taxonomy and Molecular Biology
Course Code: 23SMMB 115	**No. of Credits: 2**
Course Type: P1	**Total Teaching Hours: 60**

Course Objectives	
1.	To make students aware about isolation of extremophiles
2.	To make them familiar with the technique of PCR
3.	To teach them latest molecular biology techniques and their applications

Course Outcome	
1.	Students will learn about extremophiles
2.	Students will learn about PCR
3.	Students will be acquainted with the latest molecular biology techniques and their applications

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 Manuals. 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 References:

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 BenjaminCummings 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 in to Microbial Diversity. Nature Reviews
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 2023 Pattern)

Course Title	Quantitative Biology and Enzymology
Course Code: 23SMMB116	**No. of Credits: 2**
Course Type: P2	**Total Teaching Hours: 60**

Course Objectives	
1.	To make students familiar with the applications of computer in Biostatistics
2.	To provide the students the knowledge of protein purification techniques
3.	To extend the knowledge of students to effect of parameters on enzyme activity

Course Outcome	
1.	Students will become familiar with the applications of computer in Biostatistics
2.	Students will get the knowledge of protein purification techniques
3.	Students will understand effect of parameters on enzyme activity

Syllabus		
Credit I	**Quantitative Biology**	30 hours
	A. Computer applications: 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 References:

1. RodneyF.Boyer(2000*)ModernExperimentalBiochemistry*3dedition.,BenjaminCummings

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, 2ndEdition by Robert A.Copeland

5. Richard Levin & David S.Rubin (2012): Statistics for Management,7thEdition,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

M.Sc.Sem I (NEP – Autonomy 2023 Pattern)

Course Title	Experimental Design and Molecular biology tools and applications
Course Code: 23SMMB117	**No. of Credits: 2**
Course Type: P3	**Total Teaching Hours: 60**

Course Objectives	
1.	To make them understand the concepts of statistical survey.
2.	To teach students FTIR analysis.
3.	To teach students about production and estimation of Biopolymers.

Course Outcome	
1.	Students will understand the concepts of statistical survey.
2.	Students will learn about FTIR analysis.
3.	Students will learn about production and estimation of Biopolymers.

Syllabus		
Credit I	**Experimental Design**	30 hours
	A. Statistical Survey i. Identification of Problem and Establishing Hypothesis ii.Survey Design (Questionnaire based) iii. Preparation of Questionnaire iv.Data Collection v. Data Analysis vi. Data Presentation vii.Conclusion of Survey B.Optimization of Media conditions	
Credit II	**Molecular biology tools and applications**	30 hours
	A. PCR Primer Design B. FTIR analysis of a biomolecule / recombinant molecule. C. Production and estimation of Biopolymers: Gum / Polyhydroxyalkanoates (PHB) D. Activity staining analysis (Zymograms)	

Suggested References:

1.Irfan Ali Khan and Atiya Khanum, Fundamentals of Biostatistics. 3rd Ed. Ukaaz, Publications,Hyderabad
2. Norman T.J.Bailey Statistical methods in biology, 3rd Ed. Cambridge University Press
3. Montgomery D.C. Design and analysis of experiments, John Wiley &Sons
4. Stephen Newman, Biostatistical methods in Epidemiology. Wiley IntersciencePublication
5. Molecular Cell Biology-Lodish ,Berk, 5th Edn. Freeman 2003
6.Molecular Biology of the Cell, 5th edn, Alberts 2008, Grandland science
7.Enzymology primer for Recombinant DNA technology Eun HM, Elservier, 1996

M.Sc.Sem I (NEP – Autonomy 2023 Pattern)

Course Title	Experimental Design
Course Code: 23SMMB118A	**No. of Credits: 2**
Course Type: E1	**Total Teaching Hours: 30**

Course Objectives	
1.	To make students learn the concepts of mathematical models and their applications.
2.	To make them understand the concepts of epidemiological study.
3.	To make them understand about clinical trials.

Course Outcome	
1.	Students will understand the use of mathematical models in biological study
2.	Students will understand the concepts and use of epidemiological studies.
3.	Students will understand about clinical trials and their applications.

Syllabus		
Credit I	**Designing of Experiments**	15 hours
	A. Sampling methods, sampling errors B. Survey design, DOE in Agriculture (randomization, replication and local control), designs-CRD, RCBD and LSD C. Factorial design (Full, Fractional and PlackettBurman) D. Epidemiological Study designs: i. Case control ii. Cohort, iii. Concurrent, iv. Cross-sectional, v. Retrospective/prospective E. Clinical/field trials-Randomization, Bias removal (Blinding – single & double), controlled and uncontrolled trials	
Credit II	**Mathematical approach for Biologists**	15 hours
	A. Presentation of experimental data (Tables, graphs and equations) B. Data Analysis (Trends, Testing mathematical models, Goodness of fit: Least Square Analysis, Linear and Non-linear models)	

	C. 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	

Suggested References:

1. David Brown & Peter Rothery. Modelsinbiology: Mathematics, statistics,andcomputingJohn Wiley &Sons,USA
2. Irfan Ali Khan and AtiyaKhanum, Fundamentals of Biostatistics. 3rd Ed. Ukaaz, Publications,Hyderabad
3. Norman T.J.Bailey Statistical methods in biology, 3rd Ed. Cambridge UniversityPress
4. Montgomery D.C. Design and analysis of experiments, John Wiley &Sons
5. Stephen Newman, Biostatistical methods in Epidemiology. Wiley InterscienceePublication
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 AcademicPublications

M.Sc Sem I (NEP – Autonomy 2023 Pattern)

Course Title	Fungal Systematics
Course Code: 23SMMB118B	**No. of Credits: 2**
Course Type: E2	**Total Teaching Hours: 30**

Course Objectives	
1.	To make students aware about the classification of fungi, along with their morphological characteristics.
2.	To make them understand the importance and applications of extremophiles.
3.	To teach them applications of Fungi in various Industries.

Course Outcome	
1.	Students will learn the methods of identification of fungi and to classify them.
2.	They will understand the techniques used for the isolation of extremophiles.
3.	Students will become capable for exploring fungi for industrial use

Syllabus		
Credit I	**Fungal Systematics:**	15 hours
	1. Six Classes of Fungi 2. Differentiating characters among different Classes of fungi 3. Importance of morphological characters in fungal differentiation and classification	
Credit II	**Extremophiles**	15 hours
	1. Enrichment, isolation, classification, properties and application of extremophiles: Thermophiles, Psychrophiles, Halophiles, Acidophiles,Methanogens 2. Adaptation mechanisms of extremophiles	

Suggested References:

1. Fungal Biology, 4th ed Blackwell. by Jim Deacon
2. Alexopoulos& Blackwell, Introductory Mycology, John Willey & Sons
3. B.C.Suman&V.P.Sharma, Mushroom Cultivation in India, Daya Publishing House
4. Carlos Albortobrusso, Mohamed Hijri, Mycorrhizal Biotechnology, Capital Publishing
5. D.P.Tripathi, Mushroom Cultivation. Oxford & IBH Publication Company Pvt.ltd
6. Poonam Singh & Ashok Pandey, Biotechnology for agro-Industrial residues utilisation. (2009),Springer.
7. Satyanarayana T. and Johri B.N. (2005). Microbial diversity, Current Perspectives and Potential Applications ,IK international
8. Nair, L. N. (2007). Topics in Mycology and Pathology, New Central Book agency, Kolkat

M.Sc. Sem I (NEP – Autonomy 2023 Pattern)

Course Title	Molecular Biology Tools and Applications
Course Code: 23SMMB119A	**No. of Credits: 2**
Course Type: E2	**Total Teaching Hours: 30**

Course Objectives	
1.	To make students aware about recombinant DNA technology and its applications.
2.	To make them familiar with various techniques used for molecular diagnostics.
3.	To teach them the latest molecular biology techniques and its applications.

Course Outcome	
1.	Students will learn about recombinant DNA technology and its applications.
2.	Students will become familiar with various techniques used for molecular diagnostics.
3.	Students will be acquainted with the latest molecular biology techniques and its applications

Syllabus		
Credit I	**Tools and techniques in Molecular Biology**	15 ours
	A. Study of protein-DNA interactions: electrophoretic mobility shift assay; DMS foot printing, DNase foot printing; methyl interference assay and its modifications, nested PCR, Hot start PCR, RT –PCR and Real time PCR (Q –PCR) Applications of PCR. B. DNA microarray, Construction of microarrays– genomic arrays, cDNA arrays and oligo arrays. Applications of microarray C. Super shift assay, Sequence tagged sites, Filter binding assay, Protein foot printing, finding the replicon, DNA fingerprinting, Measuring transcription rates D. Hybridization techniques: Free Solution, membrane based (DOT blot, SLOT blot). E. CRISPR-Cas system: Technology and Applications	

Credit II	**Applications of recombinant DNA technology**	15 hours
	A. Application of RDT in Production of Secondary Metabolites i. Synthesis of commercial products: Amino acids (L- Valine and L-cysteine), ascorbic acid, Polyketide antibiotics. ii. Hybrid Human-Mouse monoclonal antibodies, Human monoclonal antibodies, anticancer antibodies. iii. Biopolymers: gum, rubber, polyhydroxyalkanoates. B. Un-conventional microbial systems for production of high-quality protein drugs.	

Suggested References:

1. Molecular Cell Biology-Lodish ,Berk, 5th Edn. Freeman 2003
2. Molecular Biology of the Cell, 5th edn, Alberts 2008, Grandland science
3. Genes IX - Lewin B. 2004, Prentice Hall
4. Cell & Molecular & William & Wilkins 2006
5. DNA repair mutagenesis: Friedberg E. C. ASM press 1995.
6. Enzymology primer for Recombinant DNA technology Eun HM, Elservier, 1996
7. B.R.Glick,J.J Pasternak J. J. (1998) Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington D C, ASM Press. 3rd Ed

M.Sc. Sem I (NEP – Autonomy 2023 Pattern)

Course Title	Cell Biology and Membrane Transport
Course Code: 23SMMB119B	**No. of Credits: 2**
Course Type: E4	**Total Teaching Hours: 30**

Course Objectives	
1.	To acquaint students with the concepts of cell biology
2.	To make students understand cell cycle regulation and apoptosis
3.	To make students acquainted with the concept of Membrane transport and signal Transduction

Course Outcome	
1.	Students will learn the concepts of cell biology
2.	Students will understand cell cycle regulation and apoptosis
3.	Students understand the concepts of membrane transport and signal transduction with reference to signaling molecules and machinery

Syllabus		
Credit I	**Cell Biology**	15 hours
	A. Structural organization and function 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 References:

1. Nelson D. L. and Cox M. M. (2002) Lehninger's Principles of Biochemistry, 4th edition, Mac MillanWorth Pub. Co. NewDelhi.
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 2023 Pattern)

Course Title	Research methodology
Course Code: 23SMMB11RM	**No. of Credits: 4**
Course Type: RM	**Total Teaching Hours: 60**

Course Objectives	
1.	To make students learn technical writing skills
2.	To acquaint the students about Scientific Communication and Research Methodology
3.	To teach students to make a research proposal

Course Outcome	
1.	Students will learn technical writing skills
2.	Students will learn about Scientific Communication and Research Methodology
3.	Students will learn to make a research proposal

Syllabus		
Credit I	**Technical writing skills**	15 hours
	i. Types, Formats of scientific reports ii. Scientific writing skills iii. Significance of communicating science iv. Ethical issues v. Copyrights and plagiarism vi. Components of a research paper vii. Publishing scientific papers - peer review process and problems. (Assignment/activity-based teaching method may be used) viii. Use of search engines for scientific data mining, use of references	
Credit II	**Scientific writing for Research proposal-I** **Designing of Mock Research Proposal (Mini Project)**	15 hours
	i. Identification of Problem ii. Establishing Hypothesis iii. Review of Literature (Data collection from Research Papers/ Dissertations /Journals) iv. Use of reference management tools (e.g. Zotero) v. Title vi. Selection of Design	

Credit III	**Scientific writing for Research proposal-II** **Designing of Mock Research Proposal (Mini Project)**	15 hours
	i. Data Collection ii. Methodology (Specify Statistical Methods) iii. Possible outcomes (Statistical Interpretations) Data Analysis iv. Data Presentation v. Conclusion vi. References	
Credit IV	**Scientific Communication**	15 hours
	i. Concept of effective communication ii. Presentation skills iii. Formal scientific presentation skills iv. Preparing power point presentation v. Presenting the work vi. Scientific poster preparation & oral presentation vii. Participating in group discussions	

Suggested References:

1. 8th Day, Robert Adams, Gastel, Barbara: how to write and publish a scientific paper,Green wood and imprint of ABC-CLIO (2016)

2. Ahmed, V., Opoku, A., & Aziz, Z. (2016). Research Methodology in the Built Environment: A Selection of Case Studies (pp. 32-49). Abingdon-on-Thames, England: Routledge. Research Gate.

3. Brannen, J., & Moss, G. (2012). Critical issues in designing mixed methods policy research. American Behavioral Scientist, 56 (6), 789- 801. https://doi.org/10.1177/0002764211433796

4. Buchanan, D., & Bryman, A. (2007, July). Contextualizing methods choice in organizational research. Organizational Research Methods, 10 (3), 483- 501. https://doi.org/10.1177/1094428106295046

5. Choy, L. T. (2014). The strengths and weaknesses of research methodology: Comparison and complimentary between qualitative and quantitative approaches. IOSR Journal of Humanities and Social Science, 19 (4), 99- 104. https://doi.org/10.9790/0837-194399104

6. Collis, J., & Hussey, R. (2013). Business Research: A Practical Guide for Undergraduate and Postgraduate Students (4th ed.). London: Macmillan International Higher Education. Research Gate

7. Dumay, J. C. (2008). 2 Research Methods and Research Sites Employed. Sydney, Australia: SeS Library, USYD.

8. ESOMAR (2019). Global Market Research 2019. Amsterdam, The Netherlands: Esomar .

9. Goddard, W., & Melville, S. (2001). Research Methodology: An Introduction (2nd ed.). Johannesburg, 2196, South Africa: Juta and Company. Google Books

10. Goulding, C. (2002). Grounded Theory: A Practical Guide for Management, Business and Market Researchers. Thousand Oaks, CA: Sage.

11. Haq, M. (2014). A comparative analysis of qualitative and quantitative research methods and a justification for adopting mixed methods in social research. Bradford Scholars. https://hdl.handle.net/10454/7389

12. Harrison, H., Birks, M., Franklin, R., & Mills, J. (2017, January). Case study research: Foundations and methodological orientations. Forum Qualitative Sozialforschung / Forum: Qualitative Social Research, 18 (1). FQS

13. Holden, M. T., & Lynch, P. (2004). Choosing the appropriate methodology: Understanding research philosophy. The Marketing Review, 4 (4), 2-

14. https://doi.org/10.1362/1469347042772428

15. 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

16. Kirsch, G., & Sullivan, P. A. (1992). Methods and Methodology in Composition Research. Carbondale, IL: SIU Press. Google Books

17. Kothari, C. R. (2004). Research Methodology: Methods and Techniques. New Delhi, India: New Age International. Google Books

18. Macdonald, S., & Headlam, N. (2008). Research Methods Handbook: Introductory Guide to Research Methods for Social Research. Manchester, London: CLES.

19. Mills, J., & Birks, M. (2014). Qualitative Methodology: A Practical Guide. Thousand Oaks, CA: Sage. ResearchOnline

20. Murthy, S. N., & Bhojanna, U. (2009). Business Research Methods (2nd ed.). New Delhi, India: Excel Books India. Google Books

21. Neville, C. (2007, July). Effective Learning Service: Introduction to Research and Research Methods. Amman, Jordan: Credited Nations Relief and Works Agency for Palestine Refugees. UNRWA

22. Resnik, D. B. (2015, December 1). What is ethics in research & why is it important? NIEHS Research. Durham, NC: National Institute of Environmental Health Sciences. NIEHS

23. Saunders, M., Lewis, P., & Thornhill, A. (2007). Research Methods for Business Students. Upper Saddle River, NJ: Pearson Education. Google Books

24. SHU Library (2020, January 28). Research guides: Organizing academic research papers: 6. The methodology. SHU Library Research Guides Fairfield, CT: Sacred Heart University.

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26. Walker, D. H. (2006). Choosing an appropriate research methodology. Construction Management and Economics, 15 (2), 149- 159. https://doi.org/10.1080/01446199700000003

27. Zyphur, M. J., & Pierides, D. C. (2017). Is quantitative research ethical? Tools for ethically practicing, evaluating, and using quantitative research. Journal of Business Ethics, 143 (1), 1-16. https://doi.org/10.1007/s10551-017-3549-8

M.Sc. Sem II (NEP – Autonomy 2023 Pattern)

Course Title	**Instrumentation and Molecular Biophysics**
Course Code: 23SMMB121	**No. of Credits: 2**
Course Type: M1	**Total Teaching Hours: 30**

Course Objectives	
1.	To enrich students' knowledge related to basic concepts in Instrumentation and Molecular Biophysics
2.	To inculcate the concepts of instrumentation including FTIR, NMR and X-Rays
3.	To make students acquainted with the concepts of biophysics and instrumentation

Course Outcome	
1.	Students will understand the concepts of Instrumentation and Molecular Biophysics
2.	Students will be able to understand both fundamentals and applications of the instruments that are routinely used for the characterization of biomolecules.
3.	Students will understand the concept and applications of instruments

Syllabus		
Credit I	**Separation and analysis of biomolecules & Spectroscopy**	15 hours
	A. Techniques for sample preparation: Dialysis, ultra-filtration, centrifugal vacuum concentration **B. Chromatography**- Partition Coefficient, Resolution, Column Efficiency, Van Deemter equation, Interpretation of chromatograms. Principle, instrumentation and applications of High- Performance Liquid Chromatography (HPLC), Fast Protein Liquid Chromatography (FPLC), Supercritical Fluid Chromatography, Reversed Phase Chromatography and Gas chromatography. C. **Spectroscopy**: i. UV/Visible Spectroscopy-Instrumentation, Molar Absorptivities, Beer and Lamberts Law, Bathochromic and hypochromic shifts. ii. Fluorescence spectroscopy- Instrumentation, Quenching,	

	FRET. iii. Infrared spectroscopy- Principle, Instrumentation, FTIR and its applications. iv. Mass spectroscopy- Principles of operation, Ionization, Ion fragmentation, Mass Analysers, GC-MS,MALDI-TOF	
Credit II	**Biophysical Techniques**	15 hours
	A.NMR spectroscopy: Basic Principles of NMR, Chemical shift, Relaxation parameters, Spin coupling, Nuclear overhauser Effect Spectroscopy, Correlation Spectroscopy, Approach to structure determination by2D-NMR **B.X-ray crystallography**: Purification of proteins, Crystallization of proteins, Instrumentation, basic principles of x-ray diffraction, Crystal Structures (Bravais Lattices), Miller Indices, Fourier Transform and Inverse Fourier, Direct Lattice.	

Suggested References:

1.Wilson Keith and Walker John (2005) *Principles and Techniques of Biochemistry and Molecular Biology*, 6th Ed.Cambridge University Press, NewYork.

2. Rolf Ekman, Jerzy Silberring, Ann Westman-Brinkmalm, Agnieszka Kraj (2009) *Mass spectrometry: instrumentation, interpretation, and applications*, John Wiley &Sons, Inc., Canada.

3. Irwin H. Segel (1976) *Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry,* 2nd Edition.John Wiley &Sons.

4. Mount, D. W. (2001) *Bioinformatics: sequence and genome analysis.* Cold Spring Harbor Laboratory Press, NewYork.

5. David M Webster (2000) *Protein Structure Prediction-Methods and Protocols*, Methods in Molecular Biology Vol143 Humana Press.

6. Narayanan, P.(2000)EssentialsofBiophysics.NewAgeInternationalPublication,NewDelhi.

7.Clive Dennison (2002) *A guide to protein isolation*, Kluwer Academic Publishers

8. Pattabhi, V. and Gautham, N. (2002) *Biophysics.* Kluwer Academic Publishers, New York and Narosa Publishing House, Delhi.

9. David J Holme, Hazel Peck (1998) *Analytical Biochemistry*, 3rd Ed. Prentice Hall, Pearson Education Limited, Harlow England.

10. Rodney F. Boyer (2000*) Modern ExperimentalBiochemistry*3dedition., Benjamin Cummings

M.Sc. Sem II (NEP – Autonomy 2023 Pattern)

Course Title	**Molecular Biology II**
Course Code: 23SMMB122	**No. of Credits: 2**
Course Type: M1	**Total Teaching Hours: 30**

Course Objectives	
1.	To make students aware about genomics and proteomics
2.	To make them familiar with various techniques used for molecular diagnostics
3.	To teach them applications of molecular techniques

Course Outcome	
1.	Students will learn about proteomics and its applications
2.	Students will learn about genomics and its applications
3.	Students will be acquainted with the latest molecular biology techniques and their applications

Syllabus		
Credit I	**Cell and Molecular Biology of Cancer**	15 hours
	A. The genetics of normal and malignant cells **i.** Normal chromosomal structure/function. ii. Gene transcription, DNA repair mechanisms. iii. Gene polymorphisms, mini and microsatellites. iv.Genome instability, gene amplification and deletion. **B. Normal and aberrant mechanisms of cell growth control** Control of normal cell growth and behaviour; Altered expression, function and control of these mechanisms in malignancy; Role of mitotic kinases; Gene promoters and their activity in normal and malignant cells. **C. Using gene therapy and immunotherapy to treat cancer** Biomarkers of response to therapy: using circulating cells and DNA, biopsies, surrogate tissues, body fluids, non-invasive imaging.	

Credit II	**RNA splicing and RNA interference**	15 hours
	Nuclear splicing, spliceosome and small nuclear RNAs, group I and group II introns, Cis- and Trans-splicing reactions, tRNA splicing, alternate splicing. Regulation of translation, co-and post-translational modifications of proteins, Dipeptide assay, Tripeptide assay, In vitro translation **RNA interference**: The concept of RNAi (RNA interference) and discovery, Gene silencing, Gene activation, Biogenesis and Regulatory roles of non-coding RNAs - miRNA, siRNA, piRNA, lncRNA. RNAi-mediated gene silencing - Components and Mechanism, RISC and Proteins.	

Suggested References:

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. B.R. Glick, J.J Pasternak J. J. (1998) Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington D C, ASM Press. 3rd Ed
9. Genomes. 2nd edition, Brown TA, Oxford: Wiley-Liss; 2002
10. Gene Therapy Tools and Potential Applications-Francisco Martin Molina (2013) Janeza Trdine 9, 51000 Rijeka, Croatia (onlinebook)
11. Worgall S. and R. G. (2014) Gene Therapy In: Principles of Tissue Engineering (Fourth Edition). Academic Press: Credited States. Chapter 34.657-686.
12. Maghari B. M. and Ardekani A.M. (2011) Genetically modified foods and social concerns. Avicenna J Med Biotechnol.3(3):109-17.

M.Sc.Sem II (NEP – Autonomy 2023 Pattern)

Course Title	**Antibiotic Resistance and its prevention**		
Course Code: 23SMMB123			**No. of Credits: 2**
Course Type: M3			**Total Teaching Hours: 30**

Course Objectives	
1.	To acquaint students with the concepts of resistance developed in bacteria
2.	To make students understand the prevention from the resistant bacteria
3.	To make students learn different strategies to combat antibiotic resistance

Course Outcome	
1.	Students will learn the concepts of resistance developed in bacteria
2.	Students will understand the prevention from the resistant bacteria
3.	Students will learn different strategies to combat antibiotic resistance

Syllabus		
Credit I	**Antimicrobial resistance mechanisms in Bacteria**	15 hours
	Antimicrobial resistance mechanisms in Bacteria with respect to: 1. Biofilm 2. Efflux Pump 3. Alteration in target site 4. Inactivation of enzyme 5. Alternative pathway or enzyme 6. Formation of persister cells Special emphasis on ESKAPE group of pathogens and *Mycobacterium tuberculosis*	
Credit II	**Strategies to tackle Antimicrobial resistance**	15 hours
	1. Efflux pump inhibitors 2. Bacteriophages 3. Probiotics, Prebiotics and Synbiotics 4. Drug repurposing 5. Antibiofilm agents 6. Nanotechnology 7. Photodynamic light therapy 8. Phytochemicals 9. Antimicrobial peptides 10 Antibiotics in combinations	

Suggested References:

1. Toole ‘O’ George, H. B. Kaplan, R. Kolter, (2000) Biofilm formation microbial development Annual Review of Microbiology, Vol. 54, 49-794.
2. Melissa B. Miller and Bonnie L. Bassler (2001) Quorum sensing inbacteria. Annual Rev. Microbiol. Vol. 55,165–99.
3. Christopher M. Waters and Bonnie L. Bassler (2005) Quorum sensing: cell-to-cell communication in bacteria. Annu. Rev. Cell Dev. Biol. Vol. 21,319–346.
4. https://www.frontiersin.org/articles/10.3389/fmicb.2019.00539/full
5. https://jabonline.in/abstract.php?article_id=762&sts=2
6. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8472480/
7. https://pubs.rsc.org/en/content/articlelanding/2022/nr/d1nr08157h/unauth
8. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7904027/
9. https://link.springer.com/article/10.1007/s12275-017-7274-x
10. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7978324/

M.Sc.Sem II (NEP – Autonomy 2023 Pattern)

Course Title	**Immunology**
Course Code: 23SMMB124	**No. of Credits: 2**
Course Type: M4	**Total Teaching Hours: 30**

Course Objectives	
1.	To enrich students' knowledge related to basic concepts of Immunology.
2.	To give the students' knowledge about host immune response
3.	To make students acquainted with the cell surface receptors present on various cells for signal transduction pathways

Course Outcome	
1.	Students will understand the concepts of Immunology
2.	Students will be able to study the different effector mechanisms of host immune response
3.	Students will understand the concepts of signal transduction pathways

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 haematopoiesis, 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 References:

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 E. J. (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 II (NEP – Autonomy 2023 Pattern)

Course Title	**Molecular Biophysics and Molecular Biology**		
Course Code: 23SMMB125			**No. of Credits: 2**
Course Type: P1			**Total Teaching Hours: 60**

Course Objectives	
1.	To make students aware of molecular biophysics
2.	To make students aware of molecular biology and its applications

Course Outcome	
1.	Students get the complete knowledge of biophysics.
2.	Students get the knowledge of tools and applications of molecular biology.

Syllabus		
Credit I	**Molecular Biophysics**	30 hours
	1. Calibration of analytical instruments – Colorimeter and Spectrophotometer by estimation of biomolecules and statistical analysis of data generated. 2. Analysis of secondary metabolites by HPLC. 3.Separation of biological samples by ultracentrifugation 4. Separation of biomolecules by Gel filtration chromatography	
Credit II	**Molecular Biology**	30 hours
	1. Study of the process of bacterial conjugation and transfer of the gene of interest 2. Bacterial Transduction 3. Gene annonation 4. Curing of bacterial Plasmid	

Suggested References:

1. Green, M. R. and Sambrook, J. (2012) Molecular Cloning: A Laboratory Manual. 4th edition. CSHL Press.
2. Nadeau, J. L. (2015) Introduction to Experimental Biophysics. CRC Press

M.Sc. Sem II (NEP – Autonomy 2023 Pattern)

Course Title	**Antibiotic Resistance & Immunology**		
Course Code: 23SMMB126			**No. of Credits: 2**
Course Type: P2			**Total Teaching Hours: 60**

Course Objectives	
1.	To acquaint students with the concepts of resistance developed in bacteria.
2.	To make students understand the prevention from the resistant bacteria.
3.	To acquaint students with the strategies other than antibiotics.

Course Outcome	
1.	Students will learn the concepts of resistance.
2.	Students will understand the strategies to tackle antibiotic resistance.
3.	Students understand the concepts of novel strategies to combat resistance.

Syllabus		
Credit I	**Antibiotic Resistance**	30 hours
	A. Isolation of biofilm producing microorganisms and study of their antibiotic susceptibility profile B. Estimating biofilm forming ability of isolated organisms (Crystal violet assay) C. In-vitro efficacy testing of following with respect to their antimicrobial activity and biofilm inhibition and disruption ability: i. Nanoparticles. ii. Antibiotics in combination. iii. Phytochemicals. D. Efflux pump inhibition assay.	
Credit II	**Immunology**	30 hours
	1. Precipitation reactions of Antigen - Antibody: Single radial immunodiffusion. 2. Rocket Immunoelectrophoresis. 3.Agglutination techniques: Determination of iso- antibodies titre to human blood group antigens. 4. Western Blotting.	

Suggested References:

1.Reference Group Choice and Antibiotic Resistance Outcomes - PMC
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3323179/
2.https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance
3.https://apps.who.int/iris/bitstream/handle/10665/112642/9789241564748_eng.pdf
4.https://en.wikipedia.org/wiki/Antimicrobial_resistance
5. 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
6. Galvão de França N.D., CristovãoPoli 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
7. 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.
8. Laurell C. B. (1966) Quantitative estimation of proteins by electrophoresis in agarose gel containing antibodies. Anal.Biochem. 15:45–52
9. 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 II (NEP – Autonomy 2023 Pattern)

Course Title	**Bioinformatics & Omics in biology**
Course Code: 23SMMB127	**No. of Credits: 2**
Course Type: P3	**Total Teaching Hours: 60**

Course Objectives	
1.	Students should understand the concept of bioinformatics
2.	To provide detailed understanding and applications of major Omics technologies such as genomics, transcriptomics, proteomics and metabolomics etc.
3.	To provide knowledge about the data analysis of next generation sequencing.

Course Outcome	
1.	To make students aware of bioinformatics and its applications
2.	Understanding of modern Omics technologies in the field of biotechnology.
3.	Better understanding of the applications of the Omics technologies in different industries

Syllabus		
Credit I	**Bioinformatics**	30 hours
	i. Search methods viz. Basic, Advanced and LIMITS w.r.t NCBI, EBI, Swiss Prot, PDB etc. ii.Submission of Biological Sequences Biological Databases: Study of different Biological databases (esp. the ones given below), Format, their distinguishing features, Uses and Applications iii. Sequence databases: EMBL, DDBJ, GenBank, UniProt, PIR, TrEMBL iv Domain database: Prosite, PRINT, Pfam, BLOCK v.Structure database: PDB, protein explorer vi.Specialized database: KEGG, PUBMED, OMIM	
Credit II	**Proteomics**	30 hours
	i. NCBI - Sequence Databases & Tools ii. ISU Centers, Databases, Servers, Software iii. Sequence Alignment & Analysis iv. (BLAST, FASTA, Gene Prediction) v. Structure Databases & Visualization	

Suggested References:

1. Bioinformatics for omics data: methods and protocols (2011), Mayer, B., New York: Humana Press. ISBN 978-1617790270
2. Omics: Applications in Biomedical, Agricultural, and Environmental Sciences (2013), Barh D., Zambare V., Azevedo V. CRC Press. Taylor and Francis Group. ISBN 9781138074750
3. Applications of Advances Omics Technologies: from Genes to Metabolites (2014), Wilson and Wilsons. Elsevier. ISBN: 9780444626509
4. Genomics, Proteomics and Metabolomics in Nutraceuticals and Functional Foods (2015), Bagchi D., Swaroop A., Bagchi M. Wiley Blackwell. ISBN:9781118930427
5. Principles of Proteomics (2013), Twyman, R., Garland Science, ISBN: 978- 0815344728

M.Sc. Sem II (NEP – Autonomy 2023 Pattern)

Course Title	**Bioinformatics**
Course Code: 23SMMB128A	**No. of Credits: 2**
Course Type: E1	**Total Teaching Hours: 30**

Course Objectives	
1.	To make students understand the Bioinformatics
2.	To inculcate the concepts of Bioinformatics
3.	To give students the knowledge of Bioinformatics

Course Outcome	
1.	Students will possess the knowledge of Bioinformatics
2.	Students will understand Bioinformatics
3.	Students will be acquainted with the concepts of Bioinformatics

Syllabus		
Credit I	**Introduction**	15 hours
	A. Introduction and biological databases Nucleic acid, proteins, genomes— structure data bases, search engines, sequence data forms and submission tools, scoring matrices for sequence alignments, algorithms pairwise sequence alignments, database similarity searches- BLAST, FASTA B. Gene bank sequence database; submitting DNA sequences to databases and database searching; sequence alignment; pairwise alignment techniques, Multiple sequence alignment, phylogenetic analysis and tree building methods, motif searches, epitope prediction, data mining tools and applications, promoter and gene prediction, comparative analysis C. Demonstration of databases (GENBANK, PDB, OMIM) and software (RASMOL, Ligand Explorer)	

Credit II	**Structural Databases**	15 hours
	A. Structural biology and structural databases Nucleic acid structures, RNA folding, RNA loops, conformational study. various ribose ring conformations, ribose-ring puckering. protein-protein interactions, protein ligand interactions. DNA-binding proteins, RNA-binding proteins. B. Ramachandran plot, 3-dimensional structures of membrane proteins, importance of 310 helix and loops, biophysical aspects of proteins and nucleic acids. C. Structural databases: - Protein Data bank (PDB), Nucleic Acid Data Bank (NDB), Molecular modeling Data Bank (MMDB). Secondary structure, three-dimensional structure prediction, protein folding and functional sites, protein folding classes.	

Suggested References:

1. C.A.Orango, D.T. Jones and J.M. Thornton-Bio informatics –Genes Proteins and computers
2. Andreas D. Baxevaris Bioinformatics A Laboratory Guide to the Analysis of genes and proteins
3. Zhumur Ghosh &Mallick Bioinformatics Principles and Applications
4. Jeremy J. Ramsden –Bioinformatics: An Introduction
5. D.Maunt Bioinformatics sequence & Genome Analysis
6. James D Tisdall- Mastering Perl for Bioinformatics
7. Wall, Christian &Orwant- Programming Perl
8. HarshawardhanP.Bal - Perl Programming for Bioinformatics
9. Ingvar Eidhammer, Inge Jonassen and William R Taylor - Protein Bioinformatics: An Algorithmic Approach to sequence and structure Analysis.
10. Mount, D. W. (2001) *Bioinformatics: sequence and genome analysis.* Cold Spring Harbor Laboratory Press, New York.
11.David M Webster (2000) *Protein Structure Prediction-Methods and Protocols*, Methods in Molecular Biology Vol143 Humana Press.
12. Narayanan, P. (2000) Essentials of Biophysics. New Age International Publication, New Delhi.

M.Sc. Sem II (NEP – Autonomy 2023 Pattern)

Course Title	**Cell culture techniques**
Course Code: 23SMMB128B	**No. of Credits: 2**
Course Type: E2	**Total Teaching Hours: 30**

Course Objectives	
1.	To make students aware about the different methods of animal cell culture techniques
2.	To make them understand the applications of Cell Culture Techniques
3.	To teach them know commonly used cell culture systems and cell lines in immunological studies.

Course Outcome	
1.	Students will understand the methods of animal cell culture Techniques
2.	Students will understand the applications of Cell Culture Techniques
3.	Students will learn about commonly used cell culture systems and cell lines in immunological studies.

Syllabus		
Credit I	**Animal Cell Culture Techniques:**	15 hours
	A. Definition of terms: Primary cell cultures and cell lines, established cell lines, suspension and anchorage dependent cell cultures. B. Transformation of cells in culture, culture media, factors affecting cells in culture.	
Credit II	**Commonly used cell culture systems and cell lines in immunological studies:**	15 hours
	A. Cell culture systems and their applications: primary lymphoid cell culture cloned lymphoid cell lines, hybrid lymphoid cell lines. B. Immuno-modulation	

Suggested References:

1. Freshney R. I. (2005) Culture of Animal Cells: A Manual of Basic Technique.5th Ed. John Wiley and Sons, Inc.
2. Masters J. R. W. (2000). Animal Cell Culture – A Practical Approach. 3rd Ed. Oxford University Press.
3. Mather J. P. and Penelope E. R. (1998) Introduction to Cell and Tissue Culture Theory and Technique. Plenum Press, New York
4. Kindt T. J., Goldsby R. A., Osborne B. A. and Kuby J. (2007) Kuby Immunology. 6th Ed. W. H. Freeman and Co.
5. Patwardhan B., Diwanay S.and Gautam M. (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- 42

M.Sc. Sem II (NEP – Autonomy 2023 Pattern)

Course Title	**Concept of Omics in Biology**		
Course Code: 23SMMB129A			**No. of Credits: 2**
Course Type: E3			**Total Teaching Hours: 30**

Course Objectives	
1.	To provide detailed understanding and applications of major Omics technologies such as genomics, transcriptomics, proteomics and metabolomics etc.
2.	To provide knowledge about the data analysis of next generation sequencing.

Course Outcome	
1.	Understanding of modern Omics technologies in the field of biotechnology
2.	Understanding of data analysis generated through next generation sequencing
3.	Better understanding of the applications of the Omics technologies in different industries.

Syllabus		
Credit I	**Proteomics**	15 hours
	a) Basic concept of proteomics b) Expression, Analysis and Characterization of proteins c) Analysis of protein structure d) Protein interaction	
Credit II	**Metabolomics**	15 hours
	A. Introduction to metabolomics: Metabolome, Metabonomics, Metabolite profiling, Metabolome fingerprinting, Role of Biomarker in metabolomics, Tools of metabolome studies: NMR, MS, GC, LC, IR and its applications. Metabolome projects of plant and human, Future perspective of metabolomics	

Suggested References:

1. Bioinformatics for omics data: methods and protocols (2011), Mayer, B., New York: Humana Press. ISBN 978-1617790270
2. Omics: Applications in Biomedical, Agricultural, and Environmental Sciences (2013), Barh D., Zambare V., Azevedo V. CRC Press. Taylor and Francis Group. ISBN 9781138074750
3. Applications of Advances Omics Technologies: from Genes to Metabolites (2014), Wilson and Wilsons. Elsevier. ISBN: 9780444626509
4. Genomics, Proteomics and Metabolomics in Nutraceuticals and Functional Foods (2015), Bagchi D., Swaroop A., Bagchi M. Wiley Blackwell. ISBN:9781118930427
5. Principles of Proteomics (2013), Twyman, R., Garland Science, ISBN: 978- 0815344728

M.Sc. Sem II (NEP – Autonomy 2023 Pattern)

Course Title	**Respiration and Photosynthesis**
Course Code: 23SMMB129B	**No. of Credits: 2**
Course Type: E4	**Total Teaching Hours: 30**

Course Objectives	
1.	To make students understand the concept of respiration
2.	To make students learn the concept of bacterial photosynthesis
3.	To teach students biochemistry of methanogens

Course Outcome	
1.	Students will understand the concept of respiration
2.	Students will learn the concept of bacterial photosynthesis
3.	Students will learn biochemistry of methanogens

Syllabus		
Credit I	**Photosynthesis:**	15 hours
	i. Types of photosynthetic pigments ii. Photosynthetic apparatus in bacteria and algae iii. Oxic and anoxic photosynthesis iv. Light reaction & electron flow in photosynthesis v. Photophosphorylation and bioenergetics vi. Dark reaction and carbon assimilation, Calvin cycle, RUBISCO-structure and molecular regulation vii. Regulation and energetics of hexose and pentose metabolism.	
Credit II	**Respiration**	15 hours
	Anaerobic respiration- i. Concept of anaerobic respiration ii. Electron transport & bioenergetics importance (NO3 respiration, SO4 respiration, Iron respiration) iii. Fermentation (ethanol, lactic acid, butyric acid mixed acid fermentation) iv. Biochemistry of methanogens.	

Suggested References:

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 5thedition

M.Sc. Sem II (NEP – Autonomy 2023 Pattern)

Course Title	OJT/ Field Project
Course Code: 23SMMB12FP	**No. of Credits: 4**
Course Type: Int	**Total Teaching Hours: 60**