ఆంధ్రప్రదేశ్ కేంద్రీయ విశ్వవిద్యాలయం आंध्रप्रदेश केंद्रीय विश्वविद्यालय

CENTRAL UNIVERSITY OF ANDHRA PRADESH

Jnana Seema, Ananthapuramu, India - 515701

DEPARTMENT OF MOLECULAR BIOLOGY
SCHOOL OF INTERDISCIPLINARY AND APPLIED SCIENCES

Masters Programme
(as per the National Credit Framework 2023)

Vidya Dadati Vinayam
(Education Gives Humility)

M.Sc. MOLECULAR BIOLOGY

Programme Structure
(Effect from Academic Year 2026-27)

M.Sc. Molecular Biology

Department of Molecular Biology

School of Interdisciplinary and Applied Sciences

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M.Sc. Molecular Biology
Department of Molecular Biology
School of Interdisciplinary and Applied Sciences

1. Introduction to the Programme

The programme has been designed to provide students with strong academic foundations, advanced laboratory exposure, analytical abilities, and research-oriented training in various domains of molecular biology and allied biological sciences. The curriculum emphasizes both theoretical understanding and practical applications, thereby creating excellent opportunities for employment, higher education, entrepreneurship, and interdisciplinary research. The programme also aims to develop scientifically skilled graduates who can contribute effectively to academia, industry, healthcare, agriculture, biotechnology, and other emerging sectors of life sciences at national and international levels. While designing the syllabus of the core and elective courses, special attention has been given to meet the present and future demands of biological sciences and research. The core courses are structured in such a way that students can confidently prepare for competitive examinations such as CSIR-UGC NET, SET, GATE, and other national-level examinations required for higher studies and research careers.

The curriculum integrates conceptual knowledge with applied and analytical aspects of molecular biology, enabling students to understand biological systems through experimental, computational, and problem-solving approaches. The elective courses are designed to provide flexibility and interdisciplinary exposure so that students can explore diverse career opportunities in biotechnology, healthcare, bioinformatics, environmental sciences, pharmaceutical sciences, and related industries if they choose not to continue in core molecular biology research. The programme follows a student-centric and outcome-based educational approach aimed at developing scientific temperament, ethical values, leadership qualities, communication skills, and lifelong learning abilities among students. The curriculum encourages interdisciplinary learning and promotes innovation, creativity, teamwork, and professional responsibility. Students are trained to plan, organize, and execute scientific tasks independently as well as collaboratively, thereby preparing them to meet academic, industrial, and societal challenges.

2. Programme Vision

The vision of the M.Sc. Molecular Biology programme is to achieve excellence in teaching, research, and innovation in molecular biology and allied life sciences. The programme aims to provide quality education that integrates fundamental biological sciences with modern molecular and computational approaches. It strives to develop skilled, ethical, and socially responsible professionals capable of addressing challenges in healthcare, agriculture, biotechnology, and environmental sustainability. The programme encourages critical thinking, scientific inquiry, innovation, and interdisciplinary learning among students. It seeks to equip learners with advanced laboratory skills, analytical abilities, and modern biological techniques required for research and industry. The curriculum is designed to prepare students for higher education, competitive examinations, and research careers at national and international levels. The programme also promotes teamwork, leadership qualities, communication skills, and lifelong learning. It emphasizes the application of scientific knowledge for societal development and sustainable progress. The programme aspires to strengthen research culture and industry–academia collaboration in emerging areas of life sciences. Ultimately, it aims to produce globally competent molecular biologists capable of contributing to scientific advancement and national development.

3. Programme Educational Objectives (PEOs)

PEO1: Fundamental Knowledge in Life Sciences: To provide students with strong foundational and advanced knowledge in molecular biology, genetics, biochemistry, microbiology, biotechnology, and related life science disciplines for higher education and research

PEO2: Technical and Laboratory Competency: To develop technical competency in modern molecular biology techniques such as PCR, electrophoresis, recombinant DNA technology, cell culture, sequencing, bioinformatics tools, microscopy, chromatography, and computational biology applications.

PEO3: Research and Competitive Examination Readiness: To prepare students for competitive examinations such as CSIR-UGC NET, SET, GATE, DBT, ICMR, and other national and international examinations for research and professional careers.

PEO4: Professional & Ethical Competence Graduates will demonstrate ethical responsibility, critical thinking, and professional readiness to work effectively in diverse teams and multidisciplinary environments.

PEO5: Innovation and Interdisciplinary Applications: To encourage interdisciplinary learning, innovation, and application-oriented research for contributing to advancements in healthcare, agriculture, environmental sustainability, biotechnology, and allied sectors.

4. Programme Outcomes (POs)

The purpose of this programme is to equip students with advanced knowledge and practical skills in Molecular Biology. After successful completion of the programme, students will be able to:

PO1 Knowledge of Molecular Biology: Demonstrate comprehensive knowledge and understanding of molecular biology, genetics, biochemistry, microbiology, biotechnology, and allied biological sciences.

PO2 Application of Biological Concepts: Apply molecular biology concepts and modern biological techniques to analyse and solve complex biological problems.

PO3 Laboratory and Technical Skills: Perform laboratory experiments using advanced molecular biology tools and techniques such as PCR, electrophoresis, blotting, cloning, sequencing, microscopy, chromatography, and cell culture methods.

PO4 Computational and Bioinformatics Skills: Utilize computational and bioinformatics tools for biological data analysis, interpretation, and scientific research applications.

PO5 Research and Experimental Design Design and conduct experiments, analyze experimental data, interpret results, and draw scientifically valid conclusions.

PO6 Critical Thinking and Problem Solving Develop critical thinking, analytical reasoning, creativity, and problem-solving abilities in multidisciplinary biological sciences.

PO7 Scientific Communication Skills Communicate scientific ideas effectively through technical writing, project reports, research publications, oral presentations, and seminar discussions.

PO8 Ethics and Social Responsibility Demonstrate professional ethics, scientific integrity, social responsibility, and awareness of biosafety and environmental sustainability issues.

PO9 Teamwork and Leadership Work effectively as an individual as well as a member or leader in multidisciplinary teams and research environments.

PO10 Interdisciplinary and Industrial Applications: Apply interdisciplinary approaches and modern biological knowledge for innovations in healthcare, agriculture, biotechnology, pharmaceuticals, and environmental sciences.

PO11 Higher Education and Career Readiness: Develop confidence and competency to pursue higher education, research careers, entrepreneurship, and competitive examinations such as NET, SET, GATE, and related fields.

PO12 Lifelong Learning and Professional Development: Engage in lifelong learning and continuously upgrade professional, technical, and research skills to meet emerging trends and global challenges in life sciences.

5. Programme-Specific Outcomes (PSOs):

The learning outcomes are designed to equip students with the knowledge, skills, and abilities necessary to succeed in careers related to Molecular Biology.

PSO1 Molecular and Cellular Analysis: Apply advanced knowledge of molecular biology, cell biology, genetics, and biochemistry to understand cellular processes, gene expression, signal transduction, and molecular mechanisms involved in biological systems.

PSO2 Molecular Biology Techniques and Laboratory Skills: Demonstrate proficiency in modern molecular biology and biotechnology techniques such as PCR, RT-PCR, gel electrophoresis, DNA/RNA isolation, recombinant DNA technology, cloning, sequencing, blotting techniques, ELISA, chromatography, microscopy, and cell culture methods.

PSO3 Bioinformatics and Computational Biology Applications: Utilize bioinformatics databases, computational tools, sequence analysis software, molecular docking, phylogenetic analysis, and biological data interpretation methods for research and scientific problem-solving.

PSO4 Research Methodology and Scientific Communication: Design and perform biological experiments, analyze and interpret experimental data, prepare scientific reports, research articles, and presentations, and effectively communicate scientific findings using appropriate technical and scientific terminology.

PSO5 Industrial, Clinical, and Interdisciplinary Applications: Apply molecular biology knowledge and laboratory techniques in healthcare, diagnostics, pharmaceuticals, agriculture, environmental biotechnology, forensic science, and industrial research while maintaining professional ethics and biosafety standards.

5. Pedagogy of the Programme

The pedagogy of the M.Sc. Molecular Biology programme is designed to provide an effective blend of theoretical knowledge, practical exposure, research training, and skill-based learning in the field of molecular biology and allied life sciences. The programme follows a student-centric and outcome-based teaching approach aimed at developing scientific understanding, technical competency, analytical thinking, and professional skills among students. Teaching methodologies include classroom lectures, interactive learning sessions, tutorials, seminars, group discussions, assignments, and self-directed learning activities to strengthen conceptual understanding of biological sciences. Special emphasis is given to laboratory-based experiential learning to ensure hands-on training in modern molecular biology techniques and instrumentation. The programme provides intensive practical training in techniques such as PCR, RT-PCR,

gel electrophoresis, DNA and RNA isolation, recombinant DNA technology, cloning, sequencing, blotting techniques, chromatography, spectroscopy, microscopy, ELISA, microbial culture methods, and animal and plant cell culture techniques. Students are also trained in computational biology and bioinformatics tools for sequence analysis, database searching, phylogenetic analysis, and biological data interpretation. The curriculum integrates research-oriented learning through mini-projects, dissertation work, experimental design, data analysis, and interpretation of scientific results. Students are encouraged to critically analyze scientific literature, participate in journal clubs, prepare scientific reports, and deliver seminar presentations to improve scientific communication and technical writing skills.

Modern teaching aids, audiovisual tools, digital resources, virtual learning platforms, and biological databases are incorporated into the teaching-learning process to enhance conceptual clarity and technical proficiency. The programme also promotes interdisciplinary learning through elective courses, workshops, internships, industrial visits, and invited lectures by experts from academia, research institutes, and industry. Continuous Internal Assessment methods such as assignments, quizzes, laboratory records, viva-voce examinations, presentations, and internal tests are adopted to evaluate academic performance, laboratory skills, and research aptitude. Collaborative learning, teamwork, leadership qualities, professional ethics, biosafety awareness, and problem-solving abilities are also emphasized throughout the programme. Overall, the pedagogy is designed to prepare students for higher education, scientific research, entrepreneurship, industry, healthcare, biotechnology sectors, and national-level competitive examinations such as NET, SET, GATE, DBT, and related fields in life sciences.

6. Programme Structure

- The Master of Science in Molecular Biology is a two-year postgraduate programme divided into four semesters, comprising a total of 90 credits.
- The curriculum integrates Core Courses, Discipline-Specific Electives, Multidisciplinary Courses, MOOCs, Skill/Internship Components, and Dissertation Work, ensuring a balanced and comprehensive learning journey.
- **Semester-wise Structure:**
  - **Semester I:** Foundational courses in biomolecules, biochemistry, cell biology, microbiology, and microscopy provide basic knowledge in molecular and cellular sciences. The semester includes discipline-specific electives, a MOOC course, and academic writing to improve scientific communication. Lab-I offers practical training in biochemical, microbiological, and microscopy techniques essential for molecular biology studies and research.
  - **Semester II:** Advanced courses in immunology, molecular biology, genetic engineering, and genome editing provide in-depth understanding of modern biological concepts and applications. Electives in cancer biology, bioinformatics, and AI&ML strengthen interdisciplinary and computational skills. Lab-II provides hands-on training in molecular biology and immunological techniques for research and industrial applications.
  - **Semester III**: Courses in plant physiology, animal physiology, genomics, and proteomics provide advanced knowledge in functional and systems biology. Electives, internship opportunities, MOOCs, and skill enhancement courses support interdisciplinary learning and research exposure. Lab-III strengthens practical skills in genomics, proteomics, physiology, and advanced biological techniques.

- **Semester IV:** The final semester focuses on research techniques and project work/dissertation in molecular biology. Students apply laboratory, analytical, and bioinformatics skills to solve biological problems and conduct independent research. The semester enhances scientific writing, data analysis, dissertation preparation, and presentation skills for higher education and research careers.

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Semester and Course wise Credits Distribution

Semester	Core Course Crdits				DSE Credits		IDE Credits		CCC Credits				SIP Credits		Dissertation Credits		Total Credits
	Code	T	L	Total	Code	Total	Code	Total	Code	T	L/P	Total	Code	Total	Code	Total	
1	MMB101	1	3	4	MMB104 MMB105	4	MMB112 MOOC-I	3	-	-	-	-	-	-	-	-	23
	MMB102	1	3	4													
	MMB103	1	3	4													
	MMB106	2	-	2													
	MMB125	1	1	2													
	Total	**6**	**10**	**16**	-	**4**	-	**3**	-	-	-	-	-	-	-	-	
II	MMB201	1	3	4	MMB204 MMB205	4	MMB212 MOOC-II	3	MMB213	2	2	4	-	-	-	-	25
	MMB202	1	3	4													
	MMB203	1	3	4													
	MMB225	1	1	2													
	Total	**4**	**10**	**14**		**4**	-	**3**	-	**2**	**2**	**4**	-	-	-	-	
III	MMB301	1	3	4	MMB304 MMB305	4	MMB312 MOOC-III	3	MMB313	2	0	2	MMB306	2	-	-	25
	MMB302	1	3	4													
	MMB303	1	3	4													
	MMB325	1	1	2													
	Total	**4**	**10**	**14**		**4**	-	**3**	-	**2**	**0**	**2**	-	**2**	-	-	
IV	MMB401	1	2	3	-	-	-	-	-	-	-	-	-	-	MMB402	**12**	**15**
	Total	**1**	**2**	**3**	-	-	-	-	-	-	-	-	-	-	-	**12**	
Total Courses	**15**	-	-	-	**6**	-	**3**	-	**2**	-	-	-	**1**	-	**1**	-	
Total Credits	-	**15**	**32**	**46**	-	**12**	-	**9**	-	**4**	**2**	**6**	-	**2**	-	**15**	**88**
Percentage	-	**17.05**	**36.36**	**52.27**	-	**13.6**	-	**10.23**	-	**4.55**	**2.27**	**6.82**	-	**2.27**	-	**17.05**	**100**

Note: **T:** Tutorial **L: Lecture** **P:** Practicals **DSE:** Discipline Specific Elective
IDE: Inter-disciplinary Electives **CCC:** Common Compulsory Course **SIP:** Summer Internship Project

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Programme Structure

Semester I						
Sl. No.	**Course Code**	**Title of the Course**	**Credit Points**	**Credit Distribution**		
				L*	**T***	**P***
1	MMB101	Biomolecules and Biochemistry	4	3	1	0
2	MMB102	Cell Biology	4	3	1	0
3	MMB103	Microbiology and Microscopy	4	3	1	0
4	Any one of the following electives					
	MMB104	Biophysics and Structural Biology	4	3	1	0
	MMB105	Biodiversity and Evolutionary Biology				
5	MMB106	Academic Writing	2	1	1	-
6	MMB112	MOOC-I	3	3	0	-
7	MMB125	Lab-I	2	1	-	1
Total			**23**	**17**	**5**	**1**

Semester II						
Sl. No.	**Course Code**	**Title of the Course**	**Credit Points**	**Credit Distribution**		
				L*	**T***	**P***
1	MMB201	Immunology	4	3	1	0
2	MMB202	Molecular Biology	4	3	1	0
3	MMB203	Genetic Engineering and Genome Editing	4	3	1	0
4	Any one of the following electives					
	MMB204	Signal Transduction and Cancer Biology	4	3	1	0
	MMB205	Biostatistics and Bioinformatics				
5	MMB213 CCC	Introduction to Artificial Intelligence and Machine Learning (AI&ML)	4	2	-	2
6	MMB212	MOOC-II	3	2	1	-
7	MMB225	Lab-II	2	1	-	1
Total			**25**	**17**	**5**	**3**

Semester III						
Sl. No.	**Course Code**	**Title of the Course**	**Credit Points**	**Credit Distribution**		
				L*	**T***	**P***
1	MMB301	Plant Physiology	4	3	1	0
2	MMB302	Animal Physiology	4	3	1	0
3	MMB303	Genomics and Proteomics	4	3	1	0
4	Any one of the following electives					
	MMB304	Developmental Biology	4	3	1	0
	MMB305	Metabolomics and Metabolic Engineering				
5	MMB313 CCC	Building Mathematical Ability and Financial Literacy	2	1	1	-
6	MMB312	MOOC-III	3	2	1	-
7	MMB306	Internship	2	1	-	1
8	MMB325	Lab-III	2	1	-	1
Total			**25**	**17**	**6**	**2**

Semester IV						
Sl. No.	**Course Code**	**Title of the Course**	**Credit Points**	**Credit Distribution**		
				L*	**T***	**P***
1	MMB401	Research Techniques in Molecular Biology	3	2	1	0
2	MMB402	Project Work/Dissertation	12	-	2	10
Total			**15**	**2**	**3**	**10**

Note: **L:** Lectures**; P:** Practicals **; T:** Tutorials

Semester-wise Credit Distribution

Semester	Total Credits	Cumulative credit at the end of the semester
1	**23**	**23**
II	**25**	**48**
III	**25**	**73**
IV	**15**	**88**

I. Credit Requirement

- The minimum number of credits required to be earned by a student for the award of the degree is **88**
- Students may earn credits in excess of 88 by opting for additional courses; however, the upper limit shall not exceed 89 credits.

II. Assessment Pattern

- **Theory Courses**:
  - **Internal (40%)** – Formative evaluation comprising two best out of three tests (each test carrying a maximum of 15 marks, totalling 30 marks), along with seminar/assignments/attendance (10 marks).
  - **External (60%)** – Summative evaluation through the semester-end examination.

III. Laboratory Components:

- **Internal (40%)** – Continuous assessment through lab work and internal examination.
- **External (60%)** – Summative evaluation through the semester-end practical examination.

IV. End-Semester Examination:

- Maximum Marks: **60**
- Duration: **3 Hours**

Important Information to Students

i. Eligibility: Candidates with a Bachelor's degree in Life Sciences (Biotechnology, Microbiology, Zoology, Botany, Bioinformatics, Genetics, or an equivalent discipline), Medical Sciences, Veterinary Sciences, Pharmaceutical Sciences, or Agricultural Sciences from a recognized University, with a minimum aggregate of 50% marks or above (or an equivalent grade), are eligible to apply.

ii. The minimum duration for completion of the programme is four semesters (two academic years) and the maximum duration is eight semesters (four academic years) or as per amendments made by the regulatory bodies from time to time.

iii.A student should attend at least 75% of the classes, and practicals in each course of study.

iv. All theory courses in the programme carry a Continuous Internal Assessment (CIA) component to a maximum of 40 marks and for End Semester Examination (ESE) for a maximum of 60 marks. The minimum pass marks for a course is 50% for each Continuous Internal Assessment (CIA) and End Semester Examination (ESE).

v. A student should pass separately in both CIA and the SEE, i.e., a student should secure 20 marks (50%) out of 40 marks and 30 (50%) out of 60 marks in the lab components in CIA. A student should secure 20 (50%) out of 40 marks for CIA and 30 (50%) out of 60 marks for lab component.

vi. There are 3 CIA tests for each course per semester from which the best 2 performances are considered for the purpose of calculating the marks in CIA. A record of the continuous assessment is maintained by the academic unit. A record of the continuous assessment is maintained by the academic unit.

vii. Each CIA contains 15 marks, out of the best 2 tests scores are considered for 30 marks. Remaining 10 marks awarded for assignments, class presentations and class participation and punctuality of the student.

viii. A student failing to secure the minimum pass marks in the CIA is not allowed to take the semester end examination of that course. S/he has to redo the course by attending special classes for that course and get the pass percentage in the internal tests to become eligible to take the end semester examination.

ix. Semester-end examination shall consist of objective type questions, descriptive type questions, short answer questions and case studies or any other recommended by the Board of Studies (BoS).

x. Students failing a course due to lack of attendance should redo the course.

xi. Re-evaluation is applicable only for SEE papers and shall not be entertained for other components such as lab/practical /thesis/ dissertation/ internship etc.

viii. An on-campus elective course is offered only if 10 or 50% of the students registered, whichever is higher.

SEMESTER WISE
DETAILED SYLLABUS

SEMESTER-I

Course Code : **MMB101** Course Type: **Core** No. of Credits: **4.00** No. of Hours : **60**	**Course Title** **Biomolecules and Biochemistry**

Course Objectives:

- To understand the structure, classification, and functions of biomolecules.
- To study proteins, enzymes, nucleic acids, and metabolic pathways.
- To learn biochemical techniques and analytical methods used in molecular biology.

Course Outcomes (COs):

- CO1: Explain the structure, biological functions of carbohydrates, lipids, proteins, and nucleic acids.
- CO2: Interpret enzyme kinetics and mechanisms of enzyme regulation.
- CO3: Analyze thermodynamic principles involved in biological systems.
- CO4: Apply chromatography, centrifugation, and spectroscopy techniques in biochemical analysis.
- CO5: Demonstrate understanding of biomolecular interactions and metabolic energy utilization.

COs /POs Mapping:

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1 Recall & define	3	2	2	–	–	–	–	–	–	–	–	2
CO2 Explain & interpret	3	3	2	2	2	–	–	–	–	–	3	2
CO3 Apply Models	3	3	3	2	2	–	–	–	–	–	–	2
CO4 Analyse & evaluate	3	2	2	3	3	2	3	3	–	–	3	2
CO5 Research & create	3	3	-	2	2	–	–	–	2	2	-	2

Course Outline:

Unit-I: [12 Hours]

Carbohydrates: Classification, configurational and conformational aspects of carbohydrates. Structure, properties, and functions of homo and hetero- polysaccharides. Blood groups and bacterial polysaccharides. Glycoproteins, Cardio glycosides. Lipids: Classification and types of lipids. Structure and properties of fatty acids, acyl glycerols, phospholipids, glycolipids. Structure and function of steroids, and leukotrienes. Composition and biological role of lipoproteins.

Unit-II: [12 Hours]

Amino acids and Proteins: Classification and properties of amino acids. Non- protein amino acids. Primary structure of proteins. Secondary structure-α-helix, β-sheet, triple helical structure. Tertiary structure of protein-Insulin, keratin, and chymotrypsin. Quaternary structure - Hemoglobin. Structure-function relationship: Hair, silk. Enzymology: Enzyme classification, characterization and Enzyme kinetics; Relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification; Single substrate enzymes, Allosteric enzymes. Nucleic acids: Introduction to RNA and DNA.

Unit-III: **[14 Hours]**

Energy Utilization: I, II and III laws of thermodynamics. Enthalpy, entropy, free energy and chemical equilibrium. High energy compounds: Energy currency, ATP, ADP, Creatine phosphate, phosphorenol pyruvate as energy rich compound. ATP synthesis, ATP synthase complex, binding change mechanism, proton motive force, Mitchell's hypothesis. Substrate level phosphorylation, futile cycles and their application.

Unit-IV: **[10 Hours]**

Chromatography: Principle, procedure and applications of - Thin Layer Chromatography, Ion exchange Chromatography, Molecular exclusion Chromatography, Gas-Liquid Chromatography, High Performance Liquid Chromatography, and Affinity Chromatography.

Unit-V: **[12 Hours]**

Centrifugation: Principle and types. Ultracentrifugation - Preparative and Analytical, Differential and Density gradient centrifugation. Spectrophotometry: Principles and biochemical applications of UV-Vis spectrophotometry.

Suggested Readings:

Berg, Jeremy M, John L.Tymoczko, Lubert Stryer, and Lubert Stryer.
Biochemistry, New York: W.H. Freeman, 2007.
Glaser, Roland. Biophysics: An Introduction, 2012.
Internet resource. Lindon, John C, George E. Tranter, and JohnL. Holmes. Encyclopedia of Spectroscopy and Spectrometry: [volume2]. San Diego, CA: Academic Press, 2000.
Nelson, David L, Michael M. Cox, AaronA. Hoskins, and Albert L.
Lehninger. Lehninger Principles of Biochemistry, 2021.

References:

Elliott, William H, and Daphne C.Elliot. Biochemistry and Molecular Biology, Oxford: Oxford University Press, 2009.
Mainwaring, WI.P. Nucleic Acid Biochemistry and Molecular Biology, Oxford: Blackwell Scientific Publications, 1982.
Miller, James M. Chromatography: Concepts and Contrasts,2ndEd,
Wiley, 2009. Harlow: Pearson Education UK, 2013. Internet resource.
Moran, Laurence A, Robert A. Horton, Gray Scrimgeour, Marc Perry, and David Rawn. Principles of Biochemistry, Harlow: Pearson Education UK, 2013. Internet resource.
Voet, Donald, and Judith G.Voet. Biochemistry, Singapore: J.Wiley & Sons, 2021.
Wilson, Keith. Principles and Techniques of Biochemistry and Molecular Biology, Cambridge: Cambridge Univ. Press, 2010.
Zubay, Geoffrey L, William W. Parson, and Dennis E.Vance.
Principles of Biochemistry, Dubuque, Iowa: Wm. C. Brown, 1995. Internet resource.

Course Code : **MMB102** Course Type : **Core** No. of Credits : **4.00** No. of Hours : **60**	**Course Title** **Cell Biology**

Course Objectives:

- To provide comprehensive knowledge of cell structure, organization, and functions of cellular organelles in prokaryotic and eukaryotic systems.
- To develop understanding of cellular processes including membrane transport, cell signaling, cell cycle regulation, apoptosis, and cellular communication.
- To equip students with practical and analytical skills in modern cell biology techniques, microscopy, cell culture, and molecular approaches used in biological research.

Course Outcomes (COs):

- Explain the structural and functional significance of cellular components and organelles.
- Describe mechanisms of membrane transport and signal transduction pathways.
- Analyze the regulation of cell cycle, division, apoptosis, and its importance.
- Apply cell biology lab techniques such as microscopy, staining, and cell culture for experimental analysis.
- Interpret and evaluate current research findings related to cellular processes and molecular mechanisms.

COs /POs Mapping:

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1 **Recall & define**	3	2	2	-	-	-	-	-	-	-	-	2
CO2 **Explain & interpret**	3	3	2	2	2	–	–	–	–	–	3	2
CO3 **Apply Models**	3	3	3	2	2	-	-	-	-	-	-	2
CO4 **Analyse & evaluate**	3	2	2	3	3	2	3	-	-	-	-	2
CO5 **Research & create**	3	3	-	2	2	–	–	–	2	2	-	2

Course Outline:

Unit-I: **[12 Hours]**

Dynamic organization of the cell: Cell theory, Ultra-structure of prokaryotic and eukaryotic cells; chemical organization of the cell; cell membranes-structure models; internal organization of the cell; intracellular organelles: endoplasmic reticulum and Golgi apparatus; Mitochondria, Chloroplast, Lysosomes. Nucleus- Internal organization, Nucleosomes, Chromatin- structure and function, cellular cytoskeleton

Unit-II: **[12 Hours]**

Cell-cell communications: Cell-environment communications. Role of different adhesion molecules: Desmosomes, Hemi-desmosomes, Gap junctions, Tight Junctions, Plasmodesmata. Organelle Interconnectivity and communications

Unit-III: **[14 Hours]**

Cellular processes: cell division: mitosis, meiosis and cytokinesis, cell differentiation: Introduction to stem cells, Molecular mechanisms of membrane transport active, passive, facilitated. Cellular responses to environmental signals in plants, animals, and microorganisms.

Unit-IV: **[10 Hours]**

Regulation of cell cycle: Discovery of MPF, cyclins and cyclin dependent kinases, Check points - role of Rb and p53, apoptosis. Neurotrophic factors, caspases, pathways of apoptosis. Cell Cycle mis regulation

Unit-V: **[12 Hours]**

Cancer: Cancer – Classification, Types and Stages. Tumor suppressor genes and proto-oncogenes. Molecular basis of cancer, cell senescence.

Suggested Readings:

Lodish, Harvey F, Arnold Berk, Chris Kaiser, Monty Krieger, Matthew, P.Scott, Anthony Bretscher, Hidde L. Ploegh, and Paul, T.Matsuda Molecular Cell Biology, New York: W.H. Freeman, 2008.

Karp, Gerald, and Nancy L. Pruitt. Cell and Molecular Biology: Concepts and Experiments, Hoboken, N.J: John Wiley & Sons, 2008.

References:

Pecorino, Lauren. Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics, 2021.
Wilson, John H, and Tim Hunt. Molecular Biology of the Cell, 5thEdition, New York: Garland Science,2008

Course Code : **MMB103** Course Type : **Core** No. of Credits : **4.00** No. of Hours : **60**	**Course Title** **Microbiology and Microscopy**

Course Objectives:

- To study microbial diversity, classification, and growth characteristics.
- To understand microbial control methods, host-pathogen interactions, and virology.
- To gain knowledge of microscopy principles and specimen preparation techniques

Course Outcomes (COs):

- CO1: Classify microorganisms based on morphology and taxonomy.
- CO2: Explain microbial growth, culture methods, and antimicrobial resistance.
- CO3: Analyze virus structure, replication, and host interactions.
- CO4: Apply sterilization and microbial control techniques in laboratory practices.
- CO5: Demonstrate the use of different microscopic techniques for microbial observation.

COs /POs Mapping:

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1 Recall & define	3	2	2	–	–	–	–	–	–	–	–	2
CO2 Explain & interpret	3	3	2	2	–	–	–	–	–	–	–	2
CO3 Apply Models	3	3	3	2	2	–	–	–	–	–	–	2
CO4 Analyse & evaluate	3	2	2	3	3	2	3	3	–	–	–	2
CO5 Research & create	3	3	-	3	2	–	–	–	2	2	-	2

Course Outline:

Unit-I: **[12 Hours]**

Introduction to microbiology and microbes, history and scope of microbiology, morphology, structure, growth, and nutrition of bacteria, bacterial growth curve, bacterial culture methods; Antimicrobial resistance. Microbial diversity, microbial taxonomy, criteria for classification of bacteria. Cyanobacteria, acetic acid bacteria, Pseudomonads, lactic and propionic acid bacteria, endospore forming bacteria, Mycobacteria. Archaea: Halophiles, Methanogens, Hyper thermophilic Archaea. Eukarya: Algae, fungi, slime molds and protozoa

Unit-II: **[12 Hours]**

Control of microorganisms: Sterilization, disinfection, and antisepsis: Physical and chemical methods for control of microorganisms, antibiotics, antiviral, and antifungal drugs, biological control of microorganisms.

Unit-III: **[14 Hours]**

Virology: Virus and bacteriophages, general properties of viruses, viral structure, taxonomy of virus, viral replication, cultivation and identification of viruses; sub-viral particles-Satellite virus, virusoids, viroids and prions.

Unit-IV: **[10 Hours]**

Host-microbes interaction Host-pathogen interaction; Symbiosis (Nitrogen fixation and ruminant symbiosis); Microbial communication system; Bacterial quorum sensing; Microbial biofilm; Prebiotics and probiotics, microbiome. Environmental microbiology, Ecological impact of microbes; Microbes, and nutrient cycles; Microbial fuel cells.

Unit-V: **[12 Hours]**

Microscopy and Specimen preparation; Lenses and the Bending of Light, Magnification, Resolution, Numerical aperture, Working principle of types of Microscopes: Bright-Field, Dark-Field, Phase-Contrast, Electron Microscope: Transmission Electron Microscope (TEM), Cryogenic electron microscopy.

Suggested Readings:

Pelczar, Michael J.EC.S. Chan, Noel R. Krieg, Microbiology, New York: Mc Graw-Hill, 1986
Willey, J.M., Sherwood, L. and Woolverton, C.J. Prescott's Microbiology, 11th Edition, McGraw-Hill, 2020.
Madigan, M.T.,Bender, K.S., Buckley,D.H. et al. Brock Biology of Microorganisms, 16th Edition, Pearson, 2021.
Pelczar, M.J., Chan,E.C.S. and Krieg, N.R. Microbiology, 5th Edition, McGraw-Hill, 1986.
Tortora, G.J., Funke,B.R. and Case, C.L. Microbiology: An Introduction, 13th Edition, Pearson, 2019.
Atlas, R.M. Principles of Microbiology, 2nd Edition, McGraw-Hill, 1997.

References:

Matthai, William C, Jacquelyn G. Black, and Christina Y. Berg. Study Guide [to] Microbiology, Principles and Explorations, Fourth Edition, Jacquelyn G. Black, New York: J. Wiley, 1999.
Willey, Joanne M, Linda Sherwood, Christopher J. Woolverton, Lansing M. Prescott, and Joanne M.Willey. Prescott's Microbiology, New York: McGraw Hill,2011

Course Code : **MMB104** Course Type : **Elective** No. of Credits : **4.00** No. of Hours : **60**	**Course Title** **Biophysics and Structural Biology**

Course Objectives:

- To understand the physical principles underlying biological systems.
- To study spectroscopic and structural biology techniques.
- To understand peptide synthesis and biomolecular interactions.
-

Course Outcomes (COs):

- CO1: Explain structural aspects of proteins, nucleic acids, and carbohydrates.
- CO2: Interpret spectroscopic data for biomolecular analysis.
- CO3: Analyze X-ray crystallography and thermodynamic principles.
- CO4: Describe peptide synthesis and purification methods.
- CO5: Apply biophysical techniques in structural biology research.

COs /POs Mapping:

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1 Recall & define	3	2	2	–	–	–	–	–	–	–	–	2
CO2 Explain & interpret	3	3	2	2	2	–	–	–	–	–	3	2
CO3 Apply Models	3	3	3	2	2	–	–	–	–	–	–	2
CO4 Analyse & evaluate	3	2	2	3	3	2	3	3	–	–	3	2
CO5 Research & create	3	3	-	2	2	–	–	–	2	2	-	2

Course Outline:

Unit-I: **[12 Hours]**

Conformational and Structural aspects of biopolymers: Basic ideas on structure and conformation of simple molecules structural features of proteins, nucleic acids and carbohydrates, aspects of biomolecular forces.

Unit-II: **[12 Hours]**

Molecular Spectroscopy: Principles and biological applications of UV-Vis, fluorescence, vibrational and circular dichroism spectroscopy. Mass spectrometry and NMR spectroscopy with applications to peptide and protein structure determination and Ramachandran Plot. Raman Effect, Isothermal titration calorimetry, ESR.

Unit-III: **[14 Hours]**

X-ray Crystallography: Elements of X-ray crystallography. Production and properties of X-rays, diffraction of X-rays by crystals, Laue equations, Bragg's Law, Fourier transformation

Unit-IV: **[10 Hours]**

Thermodynamics: Basics of thermodynamics, ligand binding and co-operativity in biological systems, kinetics, diffusion and sedimentation. Kinetics of conformational transition of proteins.

Unit-V: **[12 Hours]**

Peptide design, synthesis of peptides (solution phase and solid phase), protection and deprotection of amino and carboxyl group, unnatural amino acids, conformation of peptides, purification and crystallization of peptides, determination of structure of small molecules, application of peptides.

Suggested Readings:

Tinoco, Ignacio, Kenneth Sauer, and James C. Wang. Physical Chemistry:Principles and Applications in Biological Sciences, Engle wood Cliffs: Prentice- Hall, 1978.
Leach, Andrew R. Molecular Modelling : Principles and Applications, Harlow, England: Prentice Hall, 2001.
Cavanagh, John,Wayne J. Fairbrother, IIIA. G. Palmer, and Nicholas J. Skelton. Protein Nmr Spectroscopy: Principles and Practice, Burlington: Elsevier Science, 1995. Internet resource.

References:

Van, Holde K. E, Pui S. Ho, and W C. Johnson. Principles of Physical Biochemistry, Upper Saddle River, N.J: Pearson Education International, 2006.
Cantor, Charles R, and Paul R. Schimmel. Biophysical Chemistry:1, New York: W.H.Freeman,1980.
Kurt Wüthrich. NMR of Proteins and NucleicAcids, 1986.
Schulz, GE, and RH. Schirmer. Principles of Protein Structure, NewYork: Springer-Verlag, 1979.
Upadhyay, Avinash, Kakoli Upadhyay, and Nirmalendu Nath. Biophysical Chemistry:(Principles and Techniques),Himalaya PublishingHouse,2009.

Course Code : **MMB105** Course Type : **Elective** No. of Credits : **4.00** No. of Hours : **60**	**Course Title** **Biodiversity and Evolutionary Biology**

Course Objectives:

- To introduce the concept, levels of biodiversity and its importance in sustaining life on Earth and to understand the distribution of biodiversity at global, national, and local levels, with emphasis on India and to explain the principles and mechanisms of evolution, including classical theories such as Lamarckism and Darwinism.
- To study ecological principles from organismal to ecosystem level, including population dynamics and community interactions.
- To introduce the play of species in their contribution of ecological niche

Course Outcomes (COs):

- CO1: Define and differentiate genetic, species, and ecosystem diversity.
- CO2: Describe India's biodiversity richness and identify major biogeographic regions.
- CO3: Explain evolutionary theories and evidence supporting evolution.
- CO4: Apply conservation strategies such as in-situ and ex-situ conservation.
- CO5: Assess environmental issues like global climate change and biodiversity conservation.

COs /POs Mapping:

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1 Recall & define	3	2	2	–	–	–	–	–	–	–	–	2
CO2 Explain & interpret	3	3	2	2	2	–	–	–	–	–	3	2
CO3 Apply Models	3	3	3	2	2	–	–	–	–	–	-	2
CO4 Analyse & evaluate	3	2	2	3	–	2	3	3	–	–	3	2
CO5 Research & create	3	3	-	2	2	–	–	–	2	2	-	2

Course Outline:

Unit-I: [12 Hours]

Biodiversity: Introduction - Definition: Genetic diversity, species diversity, ecosystem diversity, biogeographic regions of India, value of biodiversity: Consumptive, productive use, social, ethical, aesthetic and option values.

Unit-II: [12 Hours]

Magnitude of biodiversity at global, national and local levels, India as a mega diversity country, hotspots of biodiversity, threats to biodiversity: Habitat loss, poaching, human-wildlife conflicts, RET (Rare, Endangered and Threatened) species of India, strategies for conservation of biodiversity: In-situ and ex-situ conservation and their types.

Unit-III: [14 Hours]

Evolutionary Biology: Introduction-History of Evolutionary Thoughts- Lamarckism and Darwinism; Evidence for Evolution, Phylogeny and the Tree of Life, Species Concept and Speciation; Origin of

Earth and Early Life, The evolutionary time scale; Eras, periods and epoch; Origin of unicellular and multi cellular organisms; Mechanisms of Evolution, Major groups of plants and animals; Stages in primate evolution including Homo.

Unit-IV: **[10 Hours]**

Macro evolution and Molecular Evolution; Plant and Animal Diversity, Extinctions and Adaptive Radiations; Introduction to ecology; Behavioral ecology, Organismal Ecology: Plants and animal adaptations. Population Ecology: Characterization of populations., Ecological Genetics -Molecular divergence and molecular clocks.

Unit-V: **[12 Hours]**

Ecology: Population growth and life history traits; Community Ecology: Characterizing communities, Community Ecology: Disturbance and succession; Ecosystem ecology: Energy flow and nutrient cycles; Climate patterns and Biomes, Conservation Biology, Global Climate Change.

Suggested Readings:

Wilson, E. O. – Biodiversity (1st ed., 1988).
Wilson, E. O. – The Diversity of Life (2nd ed., 2010).
Begon, M., Townsend, C. R., & Harper, J. L. – Ecology: From Individuals to Ecosystems (2006).
Odum, E. P., & Barrett, G. W. – Principles of Ecology (5th ed., 2004).
Futuyma, D. J., & Kirkpatrick, M. – Evolution (5th ed., 2023).
Li, W. H. – Molecular Evolution (1st ed., 1997).
Sharma, P. D. – Ecology and Environment / Environmental Biology (13th ed., 2018).

References:

Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., & Orr, R. B. – Campbell Biology(2020).
Groom, M. J., Meffe, G. K., & Carroll, C. R. – Principles of Conservation Biology (3rd ed., 2006).
Darwin, C. – The Origin of Species (1st ed., 1859 / Landmark 150th Anniversary Edition, 2009).
Herron, J. C., & Freeman, S. – Mechanisms of Evolutionary Analysis (5th ed., 2013).
IUCN Red List – IUCN Red List of Threatened Species (Version 2024-2 / ongoing dynamic database updates for RET species data).
WWF International – Living Planet Report / Biodiversity Reports (Biennial Publications; most recent flagship editions 2022, 2024).
NCERT- Biology Textbooks for Class XI & XII (Revised National Curriculum Framework Editions).

Course Code : **MMB106** Course Type : **SEC/DEC** No. of Credits: **2.00** No. of Hours : **30**	**Course Title** **Academic Writing**

Course Objectives:

- To develop students' ability to critically read and analyse scientific and research-oriented texts using effective reading strategies and note-making techniques.
- To train students in academic and scientific writing practices, including literature reviews, abstracts, conference papers, and research discussions.
- To familiarise students with research ethics, referencing styles, plagiarism awareness, authorship guidelines, and the peer-review publication process.
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Course Outcomes (COs):

By the end of the course, students will be able to;

CO1: Identify the structure, arguments, evidence, methods, and results in scientific and academic texts through analytical reading practices.
CO2: Apply effective note-making and synthesis techniques to identify research gaps and prepare literature reviews.
CO3: Draft academic research components such as introductions, abstracts, discussions, keywords, and conference papers using appropriate scholarly conventions.
CO4: Use standard referencing and citation styles accurately while maintaining academic integrity and avoiding plagiarism.
CO5: Revise, edit, and respond to peer-review feedback effectively while demonstrating awareness of publication ethics and authorship practices.

COs /POs Mapping:

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	–	✓	✓	✓	✓	–	–	–	✓	✓	–	✓
CO2	–	✓	✓	✓	✓	–	–	–	✓	✓	✓	✓
CO3	–	✓	✓	✓	✓	–	–	–	✓	✓	✓	✓
CO4	–	–	–	✓	✓	–	–	–	✓	✓	✓	✓
CO5	–	✓	✓	✓	✓	–	–	–	✓	✓	✓	✓

Course Outline:

Unit-I: [6 Hours]

Types of Scientific Writing, Reading Strategies for Dense Scientific Texts, Identifying Arguments

Unit-II: [6 Hours]

Evidence, Methods, and Results, and Effective note-making for Literature Reviews and Research Gaps

Unit-III: [6 Hours]

Writing Literature Reviews, Referencing Styles, Drafting Introductions and Literature Reviews

Unit-IV: [6 Hours]

Writing Discussions: Interpreting Findings, Acknowledging Limitations, Writing Effective Research Abstracts and Keywords

Unit-V: **[6 Hours]**

Preparing Conference Papers**,** Revising, Editing, Responding to Peer Reviews**,** Ethics in Publishing, Plagiarism, and Authorship Guidelines

Suggested Readings:

Stephen Bailey Academic Writing: A Handbook for International Students
Rowena Murray Writing for Academic Journals
Adrian Wallwork English for Writing Research Papers

References:

Cargill, Margaret, and Patrick O'Connor. Writing Scientific Research Articles: Strategy and Steps. 3rd ed.,
Wiley-Blackwell, 2013.
Day, Robert A., and Barbara Gastel. How to Write and Publish a Scientific Paper. 9th ed., Greenwood, 2022.
Hart, Chris. Doing a Literature Review: Releasing the Research Imagination. 2nd ed., Sage Publications, 2018.
Hofmann, Angelika H. Scientific Writing and Communication: Papers, Proposals, and Presentations. 4th ed.,
Oxford UP, 2019.
Turabian, Kate L. A Manual for Writers of Research Papers, Theses, and Dissertations. 9th ed., University of
Chicago Press, 2018.

Course Code : **MMB125** Course Type : **Core** No. of Credits : **2.00** No. of Hours : **60**	**Course Title** **Practicals: Biomolecules Biochemistry, Cell Biology, Microbiology and Microscopy** **Lab-I (Based on MMB-101,102,103)**

1.Introduction to molarity and normality.

2.Preparation of buffers and pH measurement.

3.Chromatography

4.Estimation and analysis of nucleic acid and proteins (Agarose and SDS-PAGE analysis).

5.Estimation of sugar by DNS and Anthrone methods.

6.Sterilization techniques, hot air oven, autoclave/pressure cooker, filtration unit.

7.Media preparation; Nutrient broth, nutrient agar.

8.Study of pure culture techniques:Serial dilution, pour plate, spread plate, streak plate.

9.Measurement of growth using- Turbidometer /Photo colorimeter/ spectrometer and Haemo cytometer (Yeast cells).

10.Staining: Simple staining and negative staining, Differential (Gram's staining).

11. Antibiotic sensitivity tests.

12. Microscopic observation of cells undergoing Mitosis & Meiosis.

Suggested readings:

Wilson, Keith, John M. Walker, Andreas Hofmann, and Samuel Clokie.
Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology.2018.
Cappuccino, James G. and Natalie Sherman. Microbiology: ALaboratory Manual, 2014.
Benson, Harold J.Benson's Microbiological Applications: Laboratory Manualin General Microbiology, 2015.

SEMESTER-II

Course Code : **MMB201** Course Type : **Core** No. of Credits : **4.00** No. of Hours : **60**	**Course Title** **Immunology**

Course Objectives:

- To understand the organization and functioning of the immune system.
- To study antigen-antibody interactions and immune response mechanisms.
- To gain knowledge of immunological techniques and vaccine development.

Course Outcomes (COs):

- CO1: Explain innate and adaptive immune responses.
- CO2: Describe the structure and functions of antibodies and immune cells.
- CO3: Analyze antigen presentation and immunological memory.
- CO4: Apply immunological techniques such as ELISA and Western blotting.
- CO5: Demonstrate understanding of hypersensitivity, autoimmunity, and transplantation.

COs /POs Mapping:

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1 Recall & define	3	2	2	–	–	–	–	–	–	–	–	2
CO2 Explain & interpret	3	3	2	2	2	–	–	–	–	–	3	2
CO3 Apply Models	3	3	3	2	2	–	–	–	–	–	–	2
CO4 Analyse & evaluate	3	2	2	3	3	2	3	3	–	–	3	2
CO5 Research & create	3	3	-	2	2	–	–	–	2	2	-	2

Course Outline:

Unit-I: **[12 Hours]**

Fundamental concepts and overview of the immune system: Organs of immune system - Primary and secondary lymphoid organs. Hematopoiesis and the importance of bone marrow and the thymus in the immune system. Components of innate and acquired immunity; Innate immune response, phagocytosis; Pathogen recognition receptors (PRR) and pathogen associated molecular pattern (PAMP); Antigens and antigenicity, antibodies, their structure and function, major histocompatibility complex.

Unit-II: **[12 Hours]**

B and T lymphocytes: Positive and negative selection - The central dogma of immune system, immune responses generated by B and T lymphocytes. Structure of TCR and BCR, RAG genes and generation of TCR and BCR - antibody diversity. Complement system, basics of antigen processing and presentation - importance of MHC. Immunological memory and immunodeficiency.

Unit-III: **[14 Hours]**

Antigen-antibody interactions and Vaccinology: Precipitation and agglutination. RIA, ELISA, Western blotting, ELISPOT assay, flow cytometry and immune electron microscopy; bone marrow chimera generation, lympho proliferation assay, mixed lymphocyte reaction. Monoclonal, polyclonal

antibody, humanized antibodies and catalytic antibodies.

Unit-IV: **[10 Hours]**

Vaccinology: Active and passive immunization; Live, killed, attenuated, subunit vaccines; Role and properties of adjuvants, recombinant DNA vaccines, RNA vaccines, conjugate vaccines, viral-like particles (VLPs),

Unit-V: **[12 Hours]**

Hypersensitivity and autoimmunity: Types of hypersensitivity, autoimmunity and autoimmune diseases, peripheral tolerance and T regulatory cells, Transplantation: Immunological basis of graft rejection, auto immune disorder.

Suggested Readings:

Roitt, Ivan M, Jonathan Brostoff, and David K. Male.
Immunology, Edinburgh: Mosby, 2001.
Kindt, Thomas J, Richard A. Golds by, Barbara A. Osborne, and Janis Kuby. Kuby Immunology, New York: W.H. Freeman,2007.
Parham, Peter. The Immune System, New York: Garland Science,2005

References:

Goding, James W. Monoclonal Antibodies: Principles and Practice: Production and Application of Monoclonal Antibodies in Cell Biology, Biochemistry and Immunology, London: Academic Press, 1996.
Murphy, Kenneth, Paul Travers, Mark Walport, and Charles Janeway.
Janeway's Immunobiology, New York: Garl and Science,2012.
Owen, Judith A, Jenni Punt, Sharon A. Stranford, Patricia P.Jones and Janis Kuby. Kuby Immunology, New York: W.H. Freeman, 2013.

Course Code : **MMB202** Course Type : **Core** No. of Credits : **4.00** No. of Hours : **60**	**Course Title** **Molecular Biology**

Course Objectives:

- To understand the structure, organization, and replication of genetic material.
- To study transcription, translation, and regulation of gene expression.
- To learn DNA repair, recombination, and molecular regulatory mechanisms

Course Outcomes (COs):

- CO1: Explain DNA replication, transcription, and translation processes.
- CO2: Analyze genome organization and chromatin structure.
- CO3: Interpret mechanisms of DNA repair and recombination.
- CO4: Describe regulatory mechanisms controlling gene expression.
- CO5: Apply molecular biology concepts to biological and biomedical problems.

COs /POs Mapping:

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1 Recall & define	3	2	2	–	–	–	–	–	–	–	–	2
CO2 Explain & interpret	3	3	2	2	2	–	–	–	–	–	3	2
CO3 Apply Models	3	3	3	2	2	–	–	–	–	–	–	2
CO4 Analyse & evaluate	3	2	2	3	3	2	3	3	–	–	3	2
CO5 Research & create	3	3	-	-	2	–	–	–	2	2	-	2

Course Outline:

Unit-I: **[10 Hours]**

Nucleic acid structure and function: DNA super coiling: super helical density, Lk, Wr and Tw, topo isomerases, Genome complexity: DNA re-association kinetics, Cot curve, C-value paradox, repetitive and unique sequences.

Unit-II: **[10 Hours]**

DNA to Chromosome: Genomes of bacteria, eukaryotes, organelle and viruses: linear and circular chromosomes, single stranded and doubles stranded DNA / RNA viral genome, Organization of DNA in to chromosomes: DNase I sensitive regions, hetero chromatin and euchromatin, DNA methylation (X chromosome inactivation).

Unit-III: **[10 Hours]**

DNA replication: DNA polymerases, synthesis of leading and lagging strands DNA replication in prokaryotes and eukaryotes: Initiation, elongation and termination; Regulation of replication, segregation of chromosomes to daughter cells.

Transcription and RNA processing: Prokaryotic and Eukaryotic transcription; RNA modification: Splicing, alternative splicing, capping, polyA addition, editing, rRNA processing, base modification, tRNA processing and modifications.

Unit-IV: **[20 Hours]**

Translation: Genetic code, Translation initiation, elongation, termination, Codon, anticodon interaction, ribosome profiling, co-translational protein folding. DNA repair and recombination:

Pyrimidine dimer, nick and gap in DNA, AP sites, base mispairing; Mismatch, base excision and nucleotide-excision repair mechanisms, SOS response. Translation DNA synthesis, regulation of Y-family of polymerases in bacteria and eukaryotes, Non-homologous end joining (NHEJ), Homologous recombination, Holliday model, double strand break repair model, gene conversion, mating type switching in yeast, site specific recombination, FLP/FRT and Cre-Lox recombination, transposition - DNA transposons and retroposons mechanism

Unit-V: **[10 Hours]**

Regulation of gene expression: Promoters and enhancers. Transcriptional regulation in D : Regulation of lac and trp operons in bacteria, regulation by sigma factors, anti-sigma factors, anti-sense RNA, two component regulatory system in bacteria, Concept of eukaryotic gene regulation, RNA in gene regulation: RNA binding proteins, RNA stability, UTR mediated gene regulation, Riboswitch, RNA interference, nonsense and nonstop mediated decay, Post translational gene regulation: Covalent modification of proteins: Phosphorylation, methylation, acetylation, adenylation, arginylation.

Suggested Readings:

Krebs, Jocelyn E, Benjamin Lewin, Stephen T. Kilpatrick, and Elliott S. Goldstein. Lewin's Genes Xi, Burlington, Mass: Jones & Bartlett Learning, 2014.
Cooper, Geoffrey M, and Robert E. Hausman. The Cell: A Molecular Approach, Sunderland, MA: Sinauer Associates, 2013.
Lodish, Harvey F, Arnold Berk, Chris Kaiser, Monty Krieger, Anthony Bretscher, Hidde L. Ploegh, Angelika Amon, and Kelsey C. Martin. Molecular Cell Biology, 2016.

References:

Alberts, Bruce, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. Molecular Biology of the Cell, New York: Garl and Science,2002.
Maniatis,Tom, Edward F.Fritsch, andJ oseph Sambrook. Molecular Cloning: A Laboratory Manual, Cold Spring Harbor: Cold Spring Harbor Laboratory, 1982.

Course Code : **MMB203** Course Type : **Core** No. of Credits : **4.00** No. of Hours : **60**	**Course Title** **Genetic Engineering and Genome Editing**

Course Objectives:

- To understand the principles and tools of genetic engineering.
- To study PCR, cloning vectors, and recombinant DNA technology.
- To gain knowledge of genome editing technologies and their applications

Course Outcomes (COs):

- CO1: Explain recombinant DNA techniques and cloning strategies.
- CO2: Perform PCR amplification and nucleic acid hybridization methods.
- CO3: Analyze the use of vectors in gene cloning and expression.
- CO4: Demonstrate understanding of CRISPR and genome editing technologies.
- CO5: Evaluate ethical issues and applications of genetic engineering.

COs /POs Mapping:

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1 Recall & define	3	2	2	–	–	–	–	–	–	–	–	2
CO2 Explain & interpret	3	3	2	2	2	–	–	–	–	–	3	2
CO3 Apply Models	3	3	3	2	2	–	–	–	–	–	–	2
CO4 Analyse & evaluate	3	2	2	3	3	2	3	3	–	–	3	2
CO5 Research & create	3	3	-	2	2	–	–	–	2	2	-	2

Course Outline:

Unit-I: **[12 Hours]**

Introduction and tools for genetic engineering, Overall impact of genetic engineering; Tools required for genetic engineering experiments- Host strains; Restriction endonucleases, restriction mapping, restriction-modification methylases; DNA and RNA ligase, DNA ligation using - Cohesive-ended and blunt-ended DNA fragments; Linkers, adaptors; Homo polymeric tailing, nucleic acids modifying enzymes.

Unit-II: **[12 Hours]**

Nucleic acid hybridization methods: Radioactive and non-radioactive labelling of nucleic acids and proteins, southern, northern, western, fluorescence in situ hybridization (FISH) and detection of chromosomal abnormalities.Polymerase chain reaction and its applications. Principles of PCR: Primer design;Types of PCR - Inverse PCR, multiplex, nested; Reverse-transcription PCR, real time PCR, touchdown PCR, hotstart PCR, colony PCR, Site-specific mutagenesis invitro and invivo; PCR in molecular diagnostics (viral and bacterial detection).

Unit-III: **[14 Hours]**

Molecular vectors and expression systems: Plasmids, Bacteriophages, cosmids, YACs, BACs, Ti plasmid and Ri plasmids and viral vectors. Construction of cDNA and genomic DNA libraries; Library screening methods; Transformation, transduction and transfection methods. Expression vectors (pET vectors). Overexpression of recombinant protein in bacteria, baculovirus, yeast and mammalian cells; Purification of recombinant proteins.

Unit-IV: **[10 Hours]**

Application of Genetic Engineering: Gene silencing techniques: siRNA and miRNA, construction of shRNA vectors; DNA and protein microarrays. Introduction to genome editing technologies: ZFNs, TALEN.

Unit-V: **[12 Hours]**

Origins of CRISPR, CRISPR Knockout basics (Experimental Design, Guide RNA design, Delivery into Cells, Genotyping, Validation), CRISPR Knockin (Inserting or Mutating DNA Sequences in the Genome), CRISPR Editing in Animal Models (Knockout and Knock in Strategies in Mice), CRISPR Interference (dCas9 Fusions Inhibition or Activation), CRISPR to target RNA and Other Cas Proteins, CRISPR-Based Gene Therapy (Gene editing, Clinical Applications). Ethical principles and IPR.

Suggested Readings:

Roitt, Ivan M, Jonathan Brostoff, and David K. Male.Immunology, Edinburgh: Mosby, 2001.
Kindt, Thomas J, Richard A. Golds by, Barbara A. Osborne, and Janis Kuby. Kuby Immunology, New York: W.H. Freeman,2007.
Parham, Peter. The Immune System, New York: Garland Science,2005

References:

Goding, James W. Monoclonal Antibodies: Principles and Practice: Production and Application of Monoclonal Antibodies in Cell Biology, Biochemistry and Immunology, London: Academic Press, 1996.
Murphy, Kenneth, Paul Travers, Mark Walport, and Charles Janeway.
Janeway's Immunobiology, New York: Garl and Science,2012.
Owen, Judith A, Jenni Punt, Sharon A. Stranford, Patricia P.Jones and Janis Kuby. Kuby Immunology, New York: W.H. Freeman, 2013.

Course Code : **MMB204** Course Type : **Elective** No. of Credits : **4.00** No. of Hours : **60**	**Course Title** **Signal Transduction and Cancer Biology**

Course Objectives:

- To understand cell signaling pathways and molecular communication.
- To study the molecular basis and hallmarks of cancer.
- To gain knowledge of tumor immunology and anticancer therapies.

Course Outcomes (COs):

- CO1: Explain major signal transduction pathways in cells.
- CO2: Analyze oncogenes, tumor suppressor genes, and cancer progression.
- CO3: Interpret the molecular mechanisms of apoptosis and metastasis.
- CO4: Describe tumor immunology and immune evasion strategies.
- CO5: Evaluate different approaches in cancer diagnosis and therapy.

COs /POs Mapping:

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1 Recall & define	3	2	2	–	–	–	–	–	–	–	–	2
CO2 Explain & interpret	3	3	2	2	2	–	–	–	–	–	3	2
CO3 Apply Models	3	3	3	2	2	–	–	–	–	–	–	2
CO4 Analyse & evaluate	3	2	2	3	3	2	3	3	–	–	3	2
CO5 Research & create	3	3	-	2	2	–	–	–	2	2	-	2

Course Outline:

Unit-I: [12 Hours]

Cell signalling: Hormones and their receptors, cell surface receptors. Signal transduction pathways, second messengers, Oncogenic signalling: NF-kB signalling. Ras-MAPK signalling, G-protein mediated signalling, RTK signalling,Ca++signalling,signaling by growth factors and Wnt signalling.

Unit-II: [12 Hours]

Hallmarks of cancer: Basics of apoptosis and escape from apoptosis in cancer. Uncontrolled proliferation and anchorage independent growth signals. Mechanism of invasion and metastasis. Angiogenesis, inflammation. Tumor metabolism

Unit-III: [14 Hours]

Different types of cancers, mitogens, oncogenes and tumor suppressors. Genetic and epigenetic regulation of tumor suppressor and oncogenes in cancer progression

Unit-IV: [10 Hours]

Tumor immunology: An overview on tumor micro environment, tumor antigens; immune response to tumors and tumor evasion of the immune system.

Unit-V: [12 Hours]

Cancer immunotherapy. General anticancer therapeutics and future perspectives

Suggested Readings:

Alberts, B, D Bray, JL ewis, MRaff, KR oberts, and JD. Watson. Molecular Biology of the Cell, NY, Garl and Publishing Inc, n.d., 1994.
Klein smith, Lewis J. Principles of Cancer Biology, San Francisco: Pearson Benjamin Cummings, 2006.
Darnell, James E, Harvey F. Lodish, and David Baltimore. Molecular CellBiology, New York: Scientific American Books, 1990.

References:

Ettinger, David S, and Ross C. Done hower. Current Cancer Therapeutics, Philadelphia, Pa: Current Medicine, 2010.
Knowles, Margaret A,and P Selby. Introduction to the Cellular and Molecular Biology of Cancer, New York: Oxford University Press, 2005.
Mazurek, Sybille, and Maria Shoshan. Tumor Cell Metabolism:Pathways, Regulation and Biology, 2015.
Rees, Robert C, and Robert C. Rees. Tumor Immunology and Immunotherapy, 2014. Internet resource.
Weinberg, Robert A. The Biology of Cancer, New York,N.Y:Garland Science, 2014.

Course Code : **MMB205** Course Type : **Elective** No. of Credits : **4.00** No. of Hours : **60**	**Course Title** **Biostatistics and Bioinformatics**

Course Objectives:

- To introduce statistical concepts and computational tools used in biology.
- To study sequence analysis, molecular docking, and database applications.
- To develop analytical and data interpretation skills in biological research.

Course Outcomes (COs):

- CO1: Apply bioinformatics tools for sequence and database analysis.
- CO2: Perform sequence alignment and phylogenetic analysis.
- CO3: Analyze biological data using statistical methods.
- CO4: Interpret molecular docking and computational biology results.
- CO5: Demonstrate the use of statistical software and bioinformatics resources.

COs /POs Mapping:

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1 Recall & define	3	2	2	–	–	–	–	–	–	–	–	2
CO2 Explain & interpret	3	3	2	2	2	–	–	–	–	–	3	2
CO3 Apply Models	3	3	3	2	2	–	–	–	–	–	–	2
CO4 Analyse & evaluate	3	2	2	3	3	2	3	3	–	–	3	2
CO5 Research & create	3	3	-	2	2	–	–	–	2	2	-	2

Course Outline:

Unit-I: **[12 Hours]**

Bio informatics basics Computers in biology and medicine; Data base concepts; Protein and nucleic acid databases; Structural databases; Biological XML DTD's; Pattern matching algorithm basics; Databases and search tools: Biological back ground for sequence analysis; Identification of protein sequence from DNA sequence; Searching of data bases similar sequence; NCBI; Publicly available tools; Resources at EBI; Resources on web; Data base mining tools.

DNA sequence analysis gene bank sequence database; Submitting DNA sequences to data bases and data base searching.

Unit-II: **[12 Hours]**

Sequence alignment; Pair wise alignment techniques; Motif discovery and gene prediction. Multiple sequence alignment; Flexible sequence similarity searching with the FASTA3 program package; Use of CLUSTALW and CLUSTALX for multiple sequence alignment; Submitting DNA protein sequence to databases: SEQUIN, genome centres; Submitting aligned sets of sequences, updating submitted sequences, methods of phylogenetic analysis.

Unit-III: **[14 Hours]**

Molecular docking: Types and principles, Semi-flexible docking, Flexible docking; Ligand and protein preparation, Macromolecule and ligand optimization, Ligand conformations, Clustering, Analysis of docking results and validation with known information. Extra-precision docking platforms, Use of Small-molecule libraries, Natural compound libraries for virtual high through put screenings.

Unit-IV: **[10 Hours]**

Statistical concepts: Data structure, sampling methods, descriptive statistics - Data collection, tabulation, graphical representation - Histogram, frequency polygon, frequency curve, bar graphsetc. Measures of central tendency: Mean, median, mean deviation, standard deviation, standard error, coefficient of variation, confidence limits.

Unit-V: **[12 Hours]**

Types of distribution of data: Normal, Binomial, Poisson hypothesis testing:Z- test, t-test, ANOVA, multiple comparisons- LSD and DMRT, chi-square test; Regression and correlation; Non-parametric significance tests; Experimental designs - CRBD, RCBD, LSD, factorial; Data transformation - Arcsine, log, square-root.

Suggested Readings:

Aitken, Michael R.F, Bill Broad hurst, and SB. H ladky. Mathematics for Biological Scientists, New York, NY: Garland Science, 2010.
Lesk, Arthur M. Introduction to Bioinformatics, New York: Oxford University Press, 2002.
Stroud, K A, and Dexter J. Booth. Foundation Mathematics, New York: Palgrave Macmillan, 2009.

References:

Baxevanis, Andreas D, and BF.F. Ouellette. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, NewYork: Wiley- Inter science, 2001.
Gu, Jenny, and Philip E. Bourne. Structural Bioinformatics, Hoboken, N.J: Wiley- Blackwell, 2009.
Lesk, Arthur M. Introduction to Protein Science: Architecture, Function, and Genomics, Oxford: Oxford University Press, 2010. 4.Mount, David W. Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor, N.Y:Cold Spring Harbor Laboratory Press, 2006.
Pevsner, Jonathan. Bioinformatics and Functional Genomics, 2009.

Course Code : MMB213 Course Type : **CCC** No. of Credits : **4.00** No. of Hours : **30T + 60L**	**Course Title** **Introduction to Artificial Intelligence and Machine Learning**

Course Objectives:

- Provide To provide students with a strong foundation in the concepts, principles, and applications of Artificial Intelligence, including problem solving, knowledge representation, machine learning, and intelligent systems.
- To develop programming skills in Python, enabling students to write programs, apply control structures, functions, lists, and strings, and solve computational problems effectively.
- To enable students to understand and apply AI techniques such as machine learning, natural language processing, computer vision, and reasoning methods for solving real-world problems.

Course Outcomes (COs):

- By the end of the course, students can be able to;
- **CO1:** Explain the fundamental concepts, characteristics, and applications of Artificial Intelligence and intelligent agents.
- **CO2:** Apply problem-solving and searching techniques, including uninformed, informed, and constraint satisfaction approaches, to AI problems.
- **CO3:** Demonstrate knowledge representation, logical reasoning, probabilistic reasoning, and automated planning techniques in AI systems.
- **CO4:** Analyze basic machine learning models and AI applications such as NLP, speech recognition, and computer vision.
- **CO5:** Develop Python programs using functions, control structures, strings, and lists to solve computational and AI-related problems.

COs /POs Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	–	–	1	–	–	–	–	–	–	2
CO2	3	3	2	1	2	–	–	–	–	–	–	2
CO3	3	3	2	2	2	–	–	–	–	–	–	2
CO4	3	3	2	2	3	_	_	_	–	–	–	2
CO5	3	2	3	2	3	–	–	–	1	1	_	2

Course Outline:

Unit-I: **[12 Hours]**

Introduction To Artificial Intelligence: Definition – Future of Artificial Intelligence - Characteristic of Intelligent Agents – Typical Intelligent Agents –Problem Solving Approach to Typical AI problems. Problem solving by Searching: Uninformed and informed strategies and implementation; Path planning; Constraint Satisfaction Problems (CSP).

Unit-II: **[12 Hours]**

Knowledge Representation: Logical Agents– Propositional and first order Predicate logic - inference - Knowledge representation and Automated Planning– Uncertain Knowledge and Reasoning: Quantifying uncertainty– probabilistic reasoning**.**

Unit-III: **[14 Hours]**

Machine learning & AI Applications: Machine learning basics - Learning from examples - forms of learning (supervised, unsupervised, reinforcement learning) - simple models (linear & logistic regression) - Deep Learning AI applications: Natural Language Processing - Language Models - Machine Translation; Speech Recognition; Computer Vision - Image classification.

Unit-IV: **[10 Hours]**

Python Programming: Introduction-The Python Programming Language, History, features, Installing Python, Running Python program, Debugging: Syntax Errors, Runtime Errors, Semantic Errors – Experimental Debugging, Formal and Natural Languages, The Difference between Brackets, Braces, and Parentheses. Variables and Expressions: Values and Types - Variables, Variable & Keyword Type conversion - Operator and Operands – Expressions – Interactive – Mode and script Mode, Order of Operations. Conditional Statements: if, if- else, nested if –else -Looping: for, while, nested-loops. Control statements: Terminating loops, skipping specific conditions.

Unit-V: **[12 Hours]**

Functions: Function Calls, Type Conversion Functions, Math Functions, Adding New Functions, Definitions and Uses, Flow of Execution, Parameters and Arguments, Variables and Parameters. Strings: Strings, String Slices, Strings are immutable, and Searching–Looping–and counting String methods - the in operator–String Comparison – String operations Lists: Values and Accessing Elements, Lists are mutable, traversing a List, Deleting elements from List–, Built-in List Operators, Concatenation, In Operator, Built-in List functions and methods.

Suggested Readings:

M.Tim Jones, Artificial Intelligence: A Systems Approach (Computer Science), Jones and Bartlett Publishers, NC.; 1 st Edition, 2008.
Burkahard A Meier, Python GUI programming Cookbook, Packt Publication 2nd Edition.
S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, Prentice Hall, 4th Edition 2022.

References:

Barry, P., Head first Python: A brain-friendly guide, O'Reilly Media, Inc. Lutz, 2016.
Lavika Goel, Artificial Intelligence: Concept and Applications, Willy, 2021
Mark Lutz, Learning python: Powerful object-oriented programming, O'Reilly Media, Inc., 2013.
Nils J. Nilsson, The Quest for Artificial Intelligence, Cambridge University Press, 2009.

Course Code : **MMB225** Course Type : **Core** No. of Credits : **4.00** No. of Hours : **60**	**Course Title** **Practicals: Immunology, Molecular Biology, Genetic Engineering and Genome Editing Lab-II (Based on MMB-201,202,203)**

1.ELISA and its applications

2.Blood grouping

3.Immuno blotting

4. Genomic DNA isolation

5.DNA quantification and

6. Agarose gel electrophoresis

7.PCR amplification

8.Restriction digestion and gel extraction

9.Ligation

10.Preparation of competent cells

11.Transformation of bacterial cells and IPTG screening

12.Genotyping

Suggested Reading

Sambrook, Joseph, EF. Fritsch and Tom Maniatis. Molecular Cloning: A Laboratory Manual, Cold Spring Harbor: Cold Spring Harbor Laboratory, 1989

References

Green, Michael R, Joseph Sambrook, and Joseph Sambrook. Molecular Cloning: A Laboratory Manual, Cold Spring Harbor, N.Y: Cold Spring Harbor Laboratory Press, 2012

SEMESTER-III

Course Code : **MMB301** Course Type : **Core** No. of Credits : **4.00** No. of Hours : **60**	**Course Title** **Plant Physiology**

Course Objectives:

- To understand physiological and metabolic processes in plants.
- To study plant growth, transport, photosynthesis, and stress physiology.
- To gain knowledge of plant hormones and environmental responses.

Course Outcomes (COs):

- CO1: Explain water transport and nutrient uptake in plants.
- CO2: Analyze photosynthesis, respiration, and nitrogen metabolism.
- CO3: Describe the role of plant hormones in growth and development.
- CO4: Interpret plant responses to biotic and abiotic stresses.
- CO5: Apply plant physiology concepts in agricultural and environmental studies.

COs /POs Mapping:

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1 Recall & define	3	2	1	–	–	–	–	–	–	–	–	1
CO2 Explain & interpret	3	3	2	1	–	–	–	–	–	–	–	1
CO3 Apply Models	2	2	2	1	1	–	–	–	–	–	–	1
CO4 Analyse & evaluate	2	3	2	2	1	1	2	-	–	–	–	2
CO5 Research & create	3	3	2	2	2	2	3	1	1	1	2	3

Course Outline:

Unit-I: [12 Hours]

Introduction to physiology and homeostasis: Plant nutrition: Essential nutrients, deficiencies and plant disorders; Heavy metal stress and homeostasis; Mechanism of ion uptake by plants. Transport mechanism in plant: Osmosis, Active transport and Passive transport, Xylem transport, Phloem Transport; Loading and unloading mechanism of food.

Unit-II: [12 Hours]

Water relations in plants: Polarity; Water potential in plants; Movement of water in plants; Soil-plant-atmosphere continuum. Photo periodism: Photoperiodic response, Physiology of flowering, phytochrome chemistry and mechanism; Senescence and its molecular aspects; Dormancy and Vernalization mechanism. cryptochromes and phototropins; Stomatal movement and biological clocks

Unit-III: [14 Hours]

Photosynthesis: Photophosphorylation,Thylakoid membrane in photo phosphorylation, C3cycle, C4cycle, and CAM pathways. Respiration and photo respiration- Citric acid cycle; Plant mitochondrial electron transport and ATP synthesis; Alternate oxidase; Photo respiratory pathway. Nitrogen metabolism-Nitrate and ammonium assimilation; Amino acid biosynthesis.

Unit-IV: [10 Hours]

Plant hormones - Biosynthesis, storage, breakdown and transport; Physiological effects and

mechanisms of action. Plant growth regulators: Auxins, gibberellins, cytokinins, ethylene, abscisic acid, salicylic acid, Jasmonic acid, mode of senescence.

Unit-V: **[12 Hours]**

Rhizosphere physiology: Root respiration, Secondary metabolites- Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles. Stress physiology - Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses.

Suggested Readings:

Plant Physiology and Development – Plant Physiology and Development by Lincoln Taiz, Eduardo Zeiger, Ian M. Møller & Angus Murphy, 7th Edition, 2022, Oxford University Press.
Fundamentals of Plant Physiology – Fundamentals of Plant Physiology by Lincoln Taiz et al., 1st Edition, 2018, Oxford University Press/Sinauer Associates.
Introduction to Plant Physiology – Introduction to Plant Physiology by William G. Hopkins & Norman P. A. Hüner, 4th Edition, 2008, Wiley India.
Plant Physiology – Plant Physiology by Lincoln Taiz & Eduardo Zeiger, 5th Edition, 2010, Sinauer Associates/Oxford University Press.
Physiology and Biochemistry of Plants – Physiology and Biochemistry of Plants by S. N. Pandey & B. K. Sinha, 1st Edition, 2006, Vikas Publishing House

References:

Plant Physiological Ecology – Plant Physiological Ecology by Hans Lambers, F. Stuart Chapin III & Thijs L. Pons, 3rd Edition, 2008, Springer.
Physiology of Woody Plants – Physiology of Woody Plants by Stephen G. Pallardy, 3rd Edition, 2008, Academic Press.
Plant Biochemistry and Molecular Biology – Plant Biochemistry and Molecular Biology by Hans-Walter Heldt & Birgit Piechulla, 2nd Edition, 2010, Academic Press.
Plant Physiology – Plant Physiology by Lincoln Taiz & Eduardo Zeiger, 4th Edition, 2006, Sinauer Associates.
Plant Physiology – Plant Physiology by V. K. Jain, 1st Edition, 2017, S. Chand Publishing

Course Code : **MMB302** Course Type : **Core** No. of Credits : **4.00** No. of Hours : **60**	**Course Title** **Animal Physiology**

Course Objectives:

- To understand the structure and functions of animal organ systems.
- To study physiological mechanisms in circulation, respiration, digestion, and excretion.
- To gain knowledge of endocrine and reproductive physiology.

Course Outcomes (COs):

- CO1: Explain physiological processes in major animal organ systems.
- CO2: Analyze mechanisms of respiration, digestion, and circulation.
- CO3: Describe nervous and muscular system functions.
- CO4: Interpret endocrine regulation and reproductive physiology.
- CO5: Relate physiological disorders to organ system dysfunctions.

COs /POs Mapping:

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1 Recall & define	**3**	**2**	**1**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**1**
CO2 Explain & interpret	**3**	**3**	**2**	**1**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**1**
CO3 Apply Models	**2**	**2**	**2**	**1**	**1**	**–**	**–**	**–**	**–**	**–**	**–**	**1**
CO4 Analyse & evaluate	**2**	**3**	**2**	**2**	**1**	**1**	**1**	**-**	**–**	**–**	**–**	**2**
CO5 Research & create	**3**	**2**	**2**	**2**	**2**	**1**	**2**	**1**	**1**	**2**	**2**	**2**

Course Outline:

Unit-I: [12 Hours]

Introduction to Physiology: An overview of animal anatomy and body plan; Homeostasis,Organs and Organ systems. Circulatory system: Closed and Open circulatory system, Structure and function of heart in higher vertebrates (mammals); Blood as connective tissue- Components of blood; Blood groups; Blood clotting; Lymph and lymph nodes.

Unit-II: [12 Hours]

Respiratory system: Anatomy of lungs in mammals; Mechanism and regulation of breathing; Hemoglobin and Oxyhemoglobin dissociation curve, oxygenand carbon dioxide transport; Acid-Base balance of the blood. Digestive system: Anatomy of alimentary canal in mammals. Role of liver and pancreas in digestion. Mechanism of digestion and absorption in mammals.

Unit-III: [14 Hours]

Muscular system: Structure and type of muscles; neuromuscular junction, muscle contraction; Energy requirements of skeletal muscles and metabolism. Nervous system: Types of neurons and supporting cells. Nerve impulse and mechanism of impulse conduction, Neurotransmitters, Synaptic Integration, Synaptic Plasticity and inhibition.

Unit-IV: [10 Hours]

Excretory system: Structure and function of mammalian kidney, Nephron as a functional unit of kidney, Process of filtration and urine formation: Renal control of electrolyte and acid-base balance..

Unit-V: **[12 Hours]**

Reproductive and Endocrine system: Female reproduction system - reproductive cycle, Structure of Ovary. Male reproductive system: Structure of testis, mechanism of spermatogenesis, structure of sperm. Endocrine organs and hormones invertebrates (mammals); Mechanism of hormone action and signal transduction; Thyroid and pancreatic metabolic disorders

Suggested Readings:

Animal Physiology – Richard W. Hill, Gordon A. Wyse & Margaret Anderson, 5th Edition, 2021, Oxford University Press/Sinauer Associates.
Principles of Animal Physiology – Christopher D. Moyes & Patricia M. Schulte, 3rd Edition, 2016, Pearson Education.
Animal Physiology: Adaptation and Environment – Knut Schmidt-Nielsen, 5th Edition, 1997, Cambridge University Press.
Animal Physiology – P. S. Verma, B. S. Tyagi & V. K. Agarwal, 1st Edition, 2000, S. Chand Publishing.
Introduction to Animal Physiology – Ian Kay, 1st Edition, 1998, Bios Scientific Publishers.

References:

Animal Physiology – Richard W. Hill, Gordon A. Wyse & Margaret Anderson, 4th Edition, 2016, Sinauer Associates.
Principles of Animal Physiology – Christopher D. Moyes & Patricia M. Schulte, 2nd Edition, 2013, Pearson Education.
Comparative Animal Physiology – C. Ladd Prosser & Frank A. Brown Jr., 4th Edition, 1991, Wiley-Liss.
Environmental Physiology of Animals – Pat Willmer, Graham Stone & Ian Johnston, 2nd Edition, 2005, Blackwell Publishing.
Textbook of Medical Physiology – Arthur C. Guyton & John E. Hall, 14th Edition, 2020, Elsevier.

Course Code : **MMB303** Course Type : **Core** No. of Credits : **4.00** No. of Hours : **60**	**Course Title** **Genomics and Proteomics**

Course Objectives:

- To understand genome organization, mapping, and sequencing strategies.
- To study transcriptomics, comparative genomics, and proteomics.
- To gain knowledge of protein analysis and mass spectrometry techniques.

Course Outcomes (COs):

- CO1: Explain genome mapping and sequencing methodologies.
- CO2: Analyze transcriptome and comparative genomics data.
- CO3: Describe principles and applications of proteomics.
- CO4: Interpret mass spectrometry and protein identification results.
- CO5: Apply omics technologies in biological and biomedical research.

COs /POs Mapping:

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1 Recall & define	3	2	2	1	–	–	–	–	–	–	–	1
CO2 Explain & interpret	3	3	3	2	1	–	–	–	–	–	–	1
CO3 Apply Models	2	3	2	2	2	1	–	–	–	–	–	1
CO4 Analyse & evaluate	2	3	3	3	2	1	1	1	–	–	–	2
CO5 Research & create	3	3	3	3	2	2	2	2	1	1	2	3

Course Outline:

Unit-I: **[12 Hours]**

Genome: Genome mapping: Genetic and physical maps; markers for genetic mapping; methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques, somatic cell hybridization, comparative gene mapping. Genome sequencing strategies, Next generation sequencing, Human Genome Project, genome sequencing projects for microbes, plants and animals, accessing and retrieving genome project information from the web.

Unit-II: **[12 Hours]**

Comparative genomics: Identification and classification of organisms using molecular markers- 16S rRNA typing / sequencing, SNPs; use of genomes to understand evolution of eukaryotes, track emerging diseases; determining gene location in genome sequence. Functional genomics; Transcriptome analysis and identification and functional annotation of gene, microarrays, RNA-Seq, Rapid amplification of cDNA ends (RACE), Yeast two-hybrid systems, phage display gene function-forward and reverse genetics,

Unit-III: **[14 Hours]**

Introduction to proteomics: Proteome and nature of proteome, separation of proteins/peptides by HPLC forward and reverse, single and two- dimensional gel electrophoresis and detection - staining and immune blot. Expression proteomics -In vitro protein synthesis and in vivo protein expression and purification from bacteria, yeast, insect and human cells.

Unit-IV: **[10 Hours]**

Structural and functional proteomics: Mass sectrometry- fundamentals, mass spectrometry ionization techniques, mass analyzers - MALDI-TOF.

Unit-V: **[12 Hours]**

Mass spectra analysis - search engines: Mascot, Swiss-Prot, protein prospector, determination of peptide sequence, determination of post-translational modifications, peptide sequencing, functional annotation of proteins, protein chips and functional proteome.

Suggested Readings:

Brown, TA, and TA. Brown. Genomes 4, 2018.
Lesk, Arthur M. Introduction to Protein Science: Architecture, Function, and Genomics, 2016.
Hamdan, Mahmoud H. "Proteomics Today: Protein Assessment and Biomarkers Using Mass Spectrometry, 2d Electrophoresis, and Microarray Technol", 2005.

References:

Comai, Lucio, Jonathan E. Katz, and Parag Mallick. Proteomics: Methods and Protocols, 2017.
Posch, Anton. Proteomic Profiling: Methods and Protocols, 2015. 3.Tibayrenc, Michel. Genetics and Evolution of Infectious Diseases. Amsterdam: Elsevier, 2011.
Twyman, Richard M. Principles of Proteomics, New York: BIOS Scientific Publishers, 2004.
Wang, Xinkun. Next-generation Sequencing Data Analysis, 2016.

Course Code : **MMB304** Course Type : **Elective** No. of Credits : **4.00** No. of Hours : **60**	**Course Title** **Developmental Biology**

Course Objectives:

- To understand the principles and stages of embryonic development.
- To study mechanisms of differentiation, regeneration, and aging.
- To gain knowledge of reproductive technologies and developmental regulation.

Course Outcomes (COs):

- CO1: Explain fertilization, cleavage, gastrulation, and organogenesis.
- CO2: Analyze embryonic induction and developmental signaling mechanisms.
- CO3: Describe regeneration and metamorphosis processes.
- CO4: Interpret the role of genes and hormones in development.
- CO5 :Apply developmental biology concepts in reproductive technologies.

COs /POs Mapping:

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1 Recall & define	3	2	1	–	–	–	–	–	–	–	–	1
CO2 Explain & interpret	3	3	2	2	1	–	–	–	–	–	–	1
CO3 Apply Models	2	2	2	1	1	–	–	–	–	–	–	1
CO4 Analyse & evaluate	2	3	2	2	2	1	1	-	–	–	–	2
CO5 Research & create	3	3	2	2	2	1	2	1	1	-	2	2

Course Outline:

Unit-I: **[12 Hours]**

Phases of development Developmental patterns among Metazoans –Gameto genesis: Structure of Mammalian gametes. Fertilization: Biochemical events, Cleavage (Patterns & types), Gastrulation: Germ layer formation. Organo genesis. Growth and differentiation. Genetic regulations of early embryonic development- Gradient theory- Morpho genetic gradients- cellfate and cell lineage

Unit-II: **[12 Hours]**

Embryonic induction and organizers - Spemann and Mangold experiments. Molecular biology of the Nieuwkoop center- Functions of organizer-Induction Regional specification types - Nuclear transplantation - Growth and Post embryonic development - Sex determination - Genomic equivalence and cytoplasmic determinants - Imprinting- Cell aggregation and differentiation in Dictyostelium. Axis and pattern formation in Drosophila

Unit-III: **[14 Hours]**

Metamorphosis and regeneration Influence of hormones on growth and meta morphosis of Insects and Amphibians-Formation of limb budin Amphibia – Specification of limb fields- Induction of early limb bud- Eyelens induction- Cell death and the formation of digits and joints. Regenerative ability of various Inverte brates and Verte brates – Mechanism of regeneration- Blastema formation- Wolffian regeneration- Factors affecting regeneration.

Unit-IV: **[10 Hours]**

Differentiation and aging Teratogenesis: Teratogenic agents. Embryonic induction and differentiation. Embryonic induction in vertebrates: Types - exogenous and endogenous. Theories of organizer or

inductor.

Unit-V: **[12 Hours]**

Morphology – Chemical basis of neural induction. Differentiation- Characteristics and types of differentiation. Aging and Senescence- Apoptosis. Selective action of genes in differentiation. Advanced Techniques In Developmental Biology:

Assisted Reproductive Technology (ART), Super ovulation, ICSI, GIFT- Artificial insemination, Invitro fertilization.

Suggested Readings:

Berrill, N.J. Developmental Biology, New Delhi: Tata McGraw-Hill, 1979. Browder, Leon W. Developmental Biology, Philadelphia: Saunders College, 1980.
Balinsky, Boris I, and B.C Fabian. An Introduction to Embryology, Philadelphia: Saunders College Publishing, 1981.
Strick berger, Monroe W, Monroe W. Strick berger, Benedikt Hallgrimsson, and BrianK. Hall. Strickberger's Evolution: The Integration of Genes, Organisms and Populations, Sudbury, Mass. [etc.: Jones and Bartlett Publishers, 2008.

References:

Di, Castri F, and TY ounes. Biodiversity, Science and Development: to wardsa New Partnership, Wallingford, Oxon, UK: CAB
International in association with the International Union of Biological Sciences, 1996.
Gilbert, Scott F, and Michael J.F. Barresi. Developmental Biology, 2020.
Kaur, H. Environmental Chemistry, Meerut: Pragati Prakashan 2010
Oppenheimer, Steven B, and George Lefevre. Introduction to Embryonic Development, Englewood, Cliffs, NJ: Prentice Hall, 1989.

Course Code : **MMB305** Course Type : **Elective** No. of Credits : **4.00** No. of Hours : **60**	**Course Title** **Metabolomics and Metabolic Engineering**

Course Objectives:

- To understand metabolomics concepts and analytical techniques.
- To study metabolic pathways and metabolic engineering strategies.
- To gain knowledge of metabolic flux analysis and industrial applications.

Course Outcomes (COs):

- CO1:Explain metabolite analysis and metabolomics workflows.
- CO2:Analyze metabolic pathways and inborn metabolic disorders.
- CO3:Interpret metabolic engineering approaches for pathway optimization.
- CO4: Apply flux balance and metabolic flux analysis methods.
- CO5: Evaluate industrial and biomedical applications of metabolomics.

COs /POs Mapping:

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1 Recall & define	3	2	2	1	–	–	–	–	–	–	–	1
CO2 Explain & interpret	3	3	3	2	1	–	–	–	–	–	–	1
CO3 Apply Models	2	3	2	2	2	1	–	–	–	–	–	1
CO4 Analyse & evaluate	2	3	3	3	2	2	1	-	–	–	–	2
CO5 Research & create	3	3	3	3	3	2	2	1	1	1	2	3

Course Outline:

Unit-I: [12 Hours]

Introduction to metabolomics - Metabolites, and metabolism - Types of metabolism - Primary and secondary, Structural diversity of metabolites - Physical and chemical properties, metabolites in the biological system, metabolons. Metabolites isolation from the biological system - Separation methods for metabolomics - Gas chromatography (GC), HPLC, Capillary electrophoresis (CE); Detection methods-GC-MS, Secondary ion mass spectrometry (SIMS), NMR-1Dand2D.

Unit-II: [12 Hours]

Metabolomic Data Analysis & Integration, Peak detection, retention time alignment; Identification of molecular features and metabolites; Structural confirmation of metabolites. Software- Multiquant, MZ mine, XCMS, Marker View, Lipid Search. Metabolic pathways and inborn errors of metabolism; Metabolomics in drug discovery, Metabolic profiling, Metabolic finger printing, Metabolic foot-printing.

Unit-III: [14 Hours]

Introduction to Metabolic Engineering, basic concepts; Scopes and Applications; Metabolism (Cellular Transport processes, Fuelling Reactions) Cellular Metabolism (Biosynthetic reactions, Polymerization, Growth Energetics);

Unit-IV: [10 Hours]

Regulation of Metabolic Pathways, Reconstruction of Genome- scale metabolic network. Examples of pathway manipulations by metabolic engineering: Ethanol, Amino acids, antibiotics, vitamins, biopolymers, etc., Improvements of cellular properties, Biodegradation.

Unit-V: **[12 Hours]**

Metabolic Flux Analysis: Flux Balance Analysis (FBA), Flux Variability Analysis, Flux Map, Determination of Metabolic Fluxes: Isotope labelled substrate, Isotope mapping, Mapping Matrix, Isotope Distribution Vector, Application of metabolic flux analysis.

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Suggested Readings:

Nelson, David L, Michael M.Cox, and Albert L. Lehninger.
Lehninger Principles of Biochemistry,2017.
Devlin,ThomasM. Textbook of Biochemistry: With Clinical
Correlations, Hoboken, N.J: Wiley,- Liss,2006.
Jeevan,KP. Metabolomics- Fundamentals and Applications, 2016. 4.Nielsen, Jens H. Biotechnology for the Future, Berlin: Springer, 2011.

References:

Stephanopoulos, G, Aristos A. Aristidou, and Jens H. Nielsen. Metabolic Engineering: Principles and Methodologies, San Diego: Academic Press, 1998.
Sussulini, Alessandra. Metabolomics: from Fundamentals to Clinical Applications, 2017.
Voet, Donald, and Judith G.Voet. Biochemistry, Hoboken, NJ: John Wiley and Sons, 2011.

Course Code :MMB**313** Course Type : **CCC** No. of Credits : **2.00** No. of Hours : **30**	**Course Title** **Building Mathematical Ability and Financial Literacy**

Course Objectives:

- The main objectives of this course are to:
- Introduce the fundamental concepts of relations, functions, and propositional logic for mathematical and computational reasoning.
- Provide understanding of statistical measures for interpreting data.
- Develop analytical and problem-solving skills using logical reasoning, and truth tables.
- Provide learners with fundamental knowledge of personal finance, budgeting, savings, expenditure management, and financial discipline for effective day-to-day financial planning.
- Familiarize students with investment options, banking structures, financial institutions, taxation, insurance, and the roles of RBI and SEBI in the financial system.
- Enable students to make informed financial decisions through understanding of investment planning, risk management, digital payments, and awareness of financial frauds.

Course Learning Outcomes (COs):

By the end of the course, students can be able to;

- **CO1:** Explain and analyze sets, relations, and functions.
- **CO2:** Construct truth tables and apply logical operations and equivalence laws in mathematical reasoning.
- **CO3:** Compute measures of central tendency and dispersion.
- **CO4:** Prepare budgets, track expenses, manage savings, and set financial goals using basic money management principles.
- **CO5:** Evaluate financial risks, use digital payment systems securely, and adopt appropriate strategies for financial planning and risk reduction.

Course Outline:

Unit-I [7 Hours]

Functions: Review of set theory, cartesian product of sets, binary relation, types of relations, definition of function, types of functions including injective, surjective, bijective function, and inverse function.

Unit-II [5 Hours]

Propositional logic: Definition and examples of proposition, compound proposition. **Propositional/logical operations:** conjunction, disjunction, conditional and it's consequences (converse, inverse, contrapositive), and biconditional statements, truth tables of compound propositions.

Unit-III [6 Hours]

Descriptive Statistics: Representation of the data, mean, median, and mode for both ungrouped and grouped data, mean deviation, range, variance and standard deviation for ungrouped data.

Unit-IV [5 Hours]

Foundations of Financial Literacy: Introduction to financial literacy and its process and structure, personal finance, income, expenditure, savings, and budgeting, financial goals, financial discipline, money management skills, awareness of financial frauds, basic budgeting and expense tracking activities.

Unit-V [7 Hours]

Financial Institutions: Banking system and credit process, recent innovations in the banking system, Reserve Bank of India role and functions, monetary policy tools. Capital Market; Primary market, secondary market, financial decision-making,SEBI. Digital Finance: Digital payments System and digital currency.

Suggested Readings:

Rosen, K. H. (2019). *Discrete mathematics and its applications* (8th ed.). McGraw-Hill Education. (Chapters 1: 1.1–1.3; Chapter 2: 2.1–2.3; Chapter 6: 6.1–6.3)
Ross, S. M. (2017). *Introductory statistics* (4th ed.). Academic Press (an imprint of Elsevier). (Chapters 2–4)
Lewis, M. K. (2000). *Monetary economics*. Oxford University Press, New York.

References:

Brahmaiah, B., & Subbarao, P. (1998). *Financial futures and options*. Himalaya Publishing House, Mumbai.
C Rangarajan. (1991). *Indian economy: Essays in money and finance*. UBS Publishers' Distributors Ltd.
Devore, J. L., & Berk, K. N. (2012). *Modern mathematical statistics with applications* (2nd ed.). Springer.
Kolman, B., Busby, R. C., & Ross, S. C. (2009). *Discrete mathematical structures* (6th ed.). Pearson Prentice Hall.
Lewis, M. K. (2000). *Monetary economics*. Oxford University Press.
Rosen, K. H. (2019). *Discrete mathematics and its applications* (8th ed.). McGraw-Hill Education.
Ross, S. M. (2017). *Introductory statistics* (4th ed.). Academic Press.
Prof. Ashish Choudhury. (n.d). *Discrete Mathematics*. NPTEL, IIIT Bangalore, https://nptel.ac.in/courses/106108227

Course Code : **MMB325** Course Type : **Core** No. of Credits : **2.00** No. of Hours : **60**	**Course Title** **Practicals: Plant Physiology, Animal Physiology, Genomics and Proteomics Lab-III (Based on MMB301,302,303)**

1. To demonstrate the influence of light on growth and measurement of photosynthetic pigments.
2. To study the effects of nutrient deficiency on plant growth and development and estimate total anthocyanins content in leaves.
3. Estimation of alkaline phosphatase activity in roots
4. Effect of temperature on cell membrane permeability
5. Demonstration of opening and closing of stomata and stomatal index
6. Determination of Water potential in potato
7. Quantification of SOD and Catalase antioxidative enzymes in abiotic stress leaf material
8. Electrolyte leakage from the abiotic stress plant leaf material
9. Estimation of salivary amylase activity.
10. Estimation of lipase activity.
11. Experiments on urine analysis in human urine sample-Test for urea, blood cells, bile salts, albumin, and ketone bodies in human urine sample.
12. Determination of cell fragility by osmotic hemolysis experiment.
13. Sugar analysis from human urine sample
14. Applications of BLAST, FASTA, CLUSTALW, GENSCAN, RASMOL.
15. Chromosome banding, karyotyping and making ideogram of the banded chromosomes
16. Cell counting using hemocytometer

Suggested Reading

Malik C.P. and AK. Srivastava. Textbook of Plant Physiology, Ludhiana: Kalyani Publishers, 2005.

Comai, Lucio, Jonathan E. Katz, and Parag Mallick. Proteomics: Methods and Protocols, 2017.

Kuruwanshi,V.B. Guhey, A.Practical manual on principles of plant physiology (pp501).2016

References

Hall, John E, and Arthur C. Guyton. Guyton and Hall Textbook of Medical Physiology, 2011

SEMESTER-IV

Course Code : **MMB401** Course Type : **Core** No. of Credits : **3.00** No. of Hours **: 45**	**Course Title** **Research Techniques in Molecular Biology**

Course Objectives:

- To understand advanced research techniques used in molecular biology.
- To develop experimental design and analytical skills for research.
- To familiarize students with modern instrumentation and data interpretation.

Course Outcomes (COs):

- CO1: Explain and apply molecular biology techniques including primer design, PCR amplification, restriction digestion, cloning strategies, and development of transgenic organisms.
- CO2: Demonstrate knowledge of protein expression systems, fermentation technology, and analytical techniques such as MALDI-TOF and HPLC for industrial and research applications.
- CO3: Perform plant and animal tissue culture techniques, prepare culture media, maintain cell lines, and evaluate their applications in biotechnology industries.
- CO4: Analyze and interpret experimental data using statistical tools such as mean, ANOVA, t-test, standard deviation, correlation, and regression for scientific research.
- CO5: Prepare research proposals, dissertations, scientific manuscripts, references, and select appropriate indexed journals for publication of research findings.

COs /POs Mapping:

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1 Recall & define	3	3	3	2	2	1	1	–	–	–	–	1
CO2 Explain & interpret	3	3	3	3	3	2	1	–	–	–	1	2
CO3 Apply Models	3	3	2	3	3	2	2	1	–	–	1	2
CO4 Analyse & evaluate	2	3	3	3	2	2	2	2	1	–	2	2
CO5 Research & create	3	3	2	3	2	2	2	2	2	1	3	3

Course Outline:

Unit-I: [10 Hours]

Molecular Biology Techniques-Strain improvement and product enhancement strategies: Selection and screening of specific trait gene from the NCBI for development of research plan, Design and development of primers, Amplification of desired gene from the different sources (Plant, Bacteria and animals' cells) and them importance's. Selection of Restriction enzymes to prepare the gene cassette for cloning (Trouble shoots and precautions). Development of transgenic plants and animals, characterization of transgenic plants and animals by Molecular and Biochemical assays

Unit-II: [10 Hours]

Introduction of cloning and its scope, Protein expression and protein expression vectors, expression of protein in BL-21 cells, Principle and applications of MALDI-TOF, HPLC and its applications in industries, Fermentation technology: Types of different fomenters, Principle and applications of fermentation technology, Safety and Precautions to be taken in fermentation technology.

Unit-III: **[10 Hours]**

Plant tissue culture: Basic principles of Plant tissue culture, Preparation of MS media and their composition, Production of medicinal and ornamental plants by Micro propagation techniques.
Animal tissue culture: cell line culture techniques, Different pHs required for animal cell culture and their safety and precautions. Types of cultures and application of animal cell culture in industry.

Unit-IV: **[10 Hours]**

Preparation and development of research articles: Methods for the collection of research articles, How to write the dissertation: How to develop the objectives, review of articles, selection of best method to execute the experiment. How to interpretation the research data by using statistical tools (Mean, ANOVA, t- test, Standard deviation, S. Error, Corelation and Regression) and their importance's in research.

Unit-V: **[5 Hours]**

Collection and arrangement of references, Selection of appropriate journals based on their impact factor, SCI- indexing, Scopus, WoS, Pubmed of indexing, and H-index), How to upload the research articles in the research journals.

Suggested Readings:

Upadhyay, Avinash, Kakoli Upadhyay, and Nirmalendu Nath. Biophysical Chemistry: (Principles and Techniques), Himalaya PublishingHouse,2009.
Martin Clynes. Animal cell culture Techniques.Springer Lab Manual,1998.
Sambrook, Joseph, EF. Fritsch, and Tom Maniatis. Molecular Cloning: A Laboratory Manual, Cold Spring Harbor: Cold Spring Harbor Laboratory, 1989.
Sunghun Park. Plant tissue culture techniques and experiments.Fourth edition. Elsevier Science.
Kothari, C.R. Research Methadology, methods and techniques. New Age Publishers.

References:

Comai, Lucio, Jonathan E. Katz, and Parag Mallick. Proteomics: Methods and Protocols, 2017.
Ritu Khasa and Sushil Kumar. Techniques in plant tissue culture. Akinik Publications, 2022.
Mark Stephan Felix and Ian Smith, A Practical Guide to Dissertation and Thesis Writing. Cambridge Scholars Publications, 2019. ISBN (10): 1-5275-3681-5.

Course Code : **MMB402** Course Type : **Core** No. of Credits : **12** No.of Hours **:180**	**Course Title** **Project Work /Dissertation**

Each student will work on a project towards a dissertation by applying the knowledge acquired in molecular biology and biochemistry. The project maybe selected based on a literature survey and available resources as suggested by the respective supervisors.

The students may conduct the project work in any laboratory of their choice in India or abroad upon obtaining approvals from the competent authority. Student is required to submit a detailed project report on the selected topic for their project as per the guidelines decided by the department.
The project work is to be evaluated through presentation and viva-voce during the semester and the final evaluation will be done at the end of the semester as per the guidelines decided by the department from time to time.

Candidate may visit research labs/institutions with the due permission of the head on the recommendation of the supervisor concerned.

Dissertation / Project Report Evaluation: 60Marks

Presentation and Viva-Voce: 40 Marks.