ఆంధ్రప్రదేశ్ కేంద్రీయ విశ్వవిద్యాలయం आंध्रप्रदेश केंद्रीय विश्वविद्यालय

CENTRAL UNIVERSITY OF ANDHRA PRADESH

Jnana Seema, Ananthapuramu, India - 515701

DEPARTMENT OF GENOMIC SCIENCE

SCHOOL OF INTERDISCIPLINARY AND APPLIED SCIENCES

Masters Programme

(as per the National Credit Framework 2023)

Vidya Dadati Vinayam

(Education Gives Humility)

MSc. GENOMIC SCIENCE

Programme Structure

(Effect from Academic Year 2026 - 27)

M.Sc. Genomic Science

Department of Genomic Science

School of Interdisciplinary and Applied Sciences

CONTENTS

M.Sc. Genomic Science
Department of Genomic Science
School of Interdisciplinary and Applied Sciences

1. Introduction to the Programme

The M.Sc. in Genomic Science is a postgraduate programme is designed to prepare students for career and research in genomics and allied life sciences. This interdisciplinary programme integrates molecular biology, bioinformatics, computational biology, and biotechnology to provide a holistic understanding of genome organization and function. It focuses on theoretical knowledge as well as hands-on training in advanced laboratory and computational techniques. The curriculum is in alignment with NEP 2020 and designed to foster research aptitude, analytical thinking, and ethical responsibility. It emphasizes problem-solving, innovation, and application-based learning. Core courses and electives together prepare students for national-level competitive exams like CSIR NET, ICMR, GATE, UGC SET/SLET Exams. The programme also enables students to pursue research and careers in academic, pharmaceutical, and healthcare sectors. With an emphasis on in silico biology, molecular genetics, and systems biology, graduates develop the skill required to handle complex datasets. The interdisciplinary design ensures exposure to Artificial Intelligence, Machine Learning, and data-driven approaches in biology. The programme nurtures intellectual curiosity, professional competence, and lifelong learning skills.

2. Programme Vision

The vision of the M.Sc. Genomic Science programme is to cultivate globally competitive graduates equipped with cutting-edge knowledge in genomics, molecular biology, and computational sciences. It aims to advance scientific understanding of genomes and their role in health, disease, and evolution. The programme envisions fostering innovation through interdisciplinary learning and research that bridges biological and computational domains. It strives to empower students to contribute to sustainable solutions in healthcare, agriculture, and environmental sciences. The vision includes nurturing a new generation of scientists with strong ethical values, analytical thinking, and leadership qualities. By integrating traditional knowledge systems with modern science, the programme seeks to build a balanced and holistic scientific perspective. It aspires to create an ecosystem that supports creativity, entrepreneurship, and translational research. The ultimate goal is to enable societal advancement through genomic discoveries and biotechnological innovations, aligned with national and global scientific missions.

3. Programme Educational Objectives (PEOs)

PEO1: Fundamental Knowledge in Genomic Science: To provide students with strong foundational and advanced knowledge in genomics, molecular biology, genetics, biochemistry, bioinformatics, computational biology, biotechnology, and allied life science disciplines for higher education, research, and industrial applications.

PEO2: Technical and Computational Competency: To develop technical and computational competency in modern genomic and molecular biology techniques such as PCR, RT-PCR, sequencing technologies, recombinant DNA technology, genome editing, electrophoresis, cell culture, chromatography, microscopy, bioinformatics tools, computational modelling, and AI & ML applications in genomics.

PEO3: Research and Competitive Examination Readiness: To prepare students for higher education, scientific research, and competitive examinations such as CSIR-UGC NET, SET, GATE, DBT, ICMR, and other national and international examinations related to genomics, bioinformatics, biotechnology, and life sciences.

PEO4: Professional and Ethical Competence: Graduates will demonstrate ethical responsibility, scientific integrity, critical thinking, biosafety awareness, and professional readiness to work effectively in multidisciplinary teams, healthcare systems, research organizations, and industrial environments.

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

4. Programme Outcomes (POs)

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

PO1 Knowledge of Genomic Science: Demonstrate comprehensive knowledge and understanding of genomics, molecular biology, genetics, biotechnology, bioinformatics, computational biology, and allied life sciences.

PO2 Application of Genomic Concepts: Apply genomic science principles, molecular techniques, and computational approaches to analyze and solve complex biological and biomedical problems.

PO3 Laboratory and Technical Skills: Perform laboratory experiments using advanced genomic and molecular biology tools and techniques such as PCR, RT-PCR, sequencing, electrophoresis, blotting, recombinant DNA technology, genome editing, chromatography, microscopy, and cell culture methods.

PO4 Computational and Bioinformatics Skills: Utilize computational biology, bioinformatics databases, sequence analysis tools, molecular modelling, AI & ML applications, and statistical approaches for genomic data analysis and interpretation.

PO5 Research and Experimental Design: Design and conduct experiments, analyze genomic and biological datasets, interpret scientific results, and draw valid conclusions using interdisciplinary research methodologies.

PO6 Critical Thinking and Problem Solving: Develop analytical reasoning, computational thinking, creativity, and problem-solving abilities for addressing challenges in genomics and life sciences research.

PO7 Scientific Communication Skills: Communicate scientific concepts, research findings, and technical information effectively through scientific writing, project reports, publications, oral presentations, and seminars.

PO8 Ethics and Social Responsibility: Demonstrate professional ethics, scientific integrity, biosafety awareness, data privacy, and social responsibility in genomic research and biotechnological applications.

PO9 Teamwork and Leadership: Work effectively as an individual and as a member or leader of multidisciplinary teams in academic, industrial, healthcare, and research environments.

PO10 Interdisciplinary and Industrial Applications: Apply interdisciplinary approaches integrating genomics, biotechnology, computational biology, healthcare, agriculture, pharmaceuticals, and environmental sciences for innovation and sustainable development.

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

PO12 Lifelong Learning and Professional Development: Engage in lifelong learning and continuously upgrade technical, computational, and research skills to address emerging trends and global challenges in genomics and 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 Genomic Science.

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. Genomic Science programme is designed to provide an effective blend of theoretical knowledge, practical exposure, research training, and skill-based learning in the field of M.Sc. Genomic Science 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 genomic science 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 Genomic Science 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, microbiology, immunology, biophysical techniques, genetics, biodiversity, and academic writing provide fundamental knowledge in molecular and cellular sciences. The semester emphasizes core concepts of genomics, biomolecular interactions, microbial diversity, and analytical techniques. Elective courses broaden understanding in genetics, proteomics, biodiversity, and evolutionary biology, while Indian Knowledge System (IKS) and MOOC courses enhance interdisciplinary learning and scientific communication skills. Lab-I provides practical training in biochemistry, microbiology, microscopy, chromatography, electrophoresis, and molecular analysis techniques essential for genomic science research.

  Semester II: Advanced courses in in silico biology, computational modelling, cell and molecular biology, genetic engineering, and genome editing provide in-depth understanding of modern genomics and molecular technologies. Electives in cancer biology and cancer genomics strengthen interdisciplinary and translational research perspectives. AI & ML courses introduce computational approaches in biological data analysis, while MOOC learning supports flexible skill enhancement. Lab-II provides hands-on training in DNA isolation, PCR amplification, cloning, transformation, ELISA, and molecular diagnostic techniques for research and biotechnology applications.

Semester III: Courses in R and Python programming, omics technologies, drug discovery, metabolomics, and metabolic engineering provide advanced knowledge in systems biology and computational genomics. Students gain expertise in genomics, transcriptomics, proteomics, metabolomics, bioinformatics, and data interpretation. Electives in bioethics, biosafety, and intellectual property rights promote responsible scientific practices, while internships and MOOCs encourage interdisciplinary exposure and professional development. Lab-III strengthens practical skills in omics data analysis, programming, molecular modelling, metabolomics, and advanced genomic applications.

Semester IV: The final semester focuses on research methodology and dissertation/project work in genomic science. Students apply laboratory, computational, analytical, and bioinformatics skills to investigate biological problems and conduct independent research in genomics and allied areas. The semester enhances scientific writing, data analysis, interpretation of omics datasets, dissertation preparation, presentation skills, and research aptitude required for higher education, biotechnology industries, and research careers.

Semester and Course wise Credits Distribution

Semester	Core Course Credits				DSE Credits		IDE Credits		CCC Credits				SIP Credits		Dissertation Credits		Total Credits
	Code	T	L/P	Total	Code	Total	Code	Total	Code	T	L/P	Total	Code	Total	Code	Total	
1	MGS101	1	3	4	MGS104 MGS105	4	MGS112 MOOC-I	3	-	-	-	-	-	-	-	-	25
	MGS102	1	3	4													
	MGS103	1	3	4													
	MGS106	2	-	2													
	MGS107	1	1	2													
	MGS125	1	1	2													
	Total	**7**	**11**	**18**	**-**	**4**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
II	MGS201	1	3	4	MGS204 MGS205	4	MGS212 MOOC-II	3	CCC213	2	2	4	-	-	-	-	25
	MGS202	1	3	4													
	MGS203	1	3	4													
	MGS225	1	1	2													
	Total	**4**	**10**	**14**		**4**	**-**	**3**	**-**	**2**	**2**	**4**	**-**	**-**	**-**	**-**	
III	MGS301	1	3	4	MGS304 MGS305	4	MGS312 MOOC-III	3	CCC313	2	0	2	MGS306	2	-	-	25
	MGS302	1	3	4													
	MGS303	1	3	4													
	MGS325	1	1	2													
	Total	**4**	**10**	**14**		**4**	**-**	**3**	**-**	**0**	**0**	**2**	**-**	**2**	**-**	**-**	
IV	MGS401	1	2	3	-	-	-	-	-	-	-	-	-	-	MGS402	12	15
	Total	**1**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Total Courses	**15**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**
Total Credits	**-**	15	32	**49**	**-**	**12**	**-**	**9**	**-**	**4**	**2**	**6**	**-**	**2**	**-**	**12**	**90**
Percentage	**-**	**16.67**	**53.56**	**54.44**	**-**	**13.33**	**-**	**10**	**-**	**4.44**	**2.22**	**6.67**	**-**	**2.22**	**-**	**13.33**	**100**

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

M.Sc. Genomic Science

Department of Genomic Science
School of Interdisciplinary and Applied Sciences

Programme Structure

Semester I						
Sl. No.	**Course Code**	**Title of the Course**	**Credit Points**	**Credit Distribution**		
				L*	**T***	**P***
1	MGS101	Biomolecules and Biochemistry	4	3	1	0
2	MGS102	Microbiology and Immunology	4	3	1	0
3	MGS103	Biophysical Techniques and Biostatistics	4	3	1	0
4	Any one of the following electives					
	MGS104	Genetics and Proteomics	4	3	1	0
	MGS105	Biodiversity and Evolutionary Biology				
5	MGS106	Academic Writing	2	-	2	-
6	MGS107	Indian Knowledge System - Life Sciences	2	1	1	-
7	MGS112	MOOC-I	3	-	3	-
8	MGS125	Lab-I	2	-	1	1
Total			**25**	**13**	**11**	**1**

Semester II						
Sl. No.	**Course Code**	**Title of the Course**	**Credit Points**	**Credit Distribution**		
				L*	**T***	**P***
1	MGS-201	Insilco Biology and Computational Modelling	4	3	1	0
2	MGS-202	Cell and Molecular Biology	4	3	1	0
3	MGS-203	Genetic Engineering and Genome Editing	4	3	1	0
4	Any one of the following electives					
	MGS-204	Signal Transduction and Cancer Biology	4	3	1	0
	MGS-205	Cancer Genomics				
5	MGS212	MOOC-II	3	3	-	-
6	CCC213	Introduction to Artificial Intelligence and Machine Learning (AI&ML)	4	2	2	-
7	MGS225	Lab-II	2	-	1	1
Total			**25**	**17**	**7**	**1**

Semester III						
Sl. No.	**Course Code**	**Title of the Course**	**Credit Points**	**Credit Distribution**		
				L*	**T***	**P***
1	MGS-301	Introduction to R and Python Programming	4	3	1	0
2	MGS-302	Omics in Biology	4	3	1	0
3	MGS-303	Drug discovery Design and Development	4	3	1	0
4	Any one of the following electives					
	MGS-304	IPR, Biosafety and Bioethics	4	3	1	0
	MGS-305	Metabolomics and Metabolic Engineering				
5	MGS-306	Internship	2	-	2	-
6	MGS-312	MOOC-III	3	3	-	-
7	MGS313	Building Mathematical Ability and Financial Literacy	2	1	1	-
8	MGS-325	Lab-III	2	-	1	1
Total			**25**	**16**	**8**	**1**

Semester IV						
Sl. No.	**Course Code**	**Title of the Course**	**Credit Points**	**Credit Distribution**		
				L*	**T***	**P***
1	MGS-401	Research Techniques in Molecular Biology	3	2	1	0
2	MGS-402	Project / Dissertation	12	1	1	10
Total			**15**	**3**	**2**	**10**

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

Semester-wise Credit Distribution

Semester	Total Credits	Cumulative credit at the end of the semester
1	25	25
II	25	50
III	25	75
IV	15	90

I. Credit Requirement

- The minimum number of credits required to be earned by a student for the award of the degree is **90**
- Students may earn credits in excess of 95 by opting for additional courses; however, the upper limit shall not exceed **91 credits**.

II. Assessment Pattern

- **Theory Courses**:
    - **Internal (40%)** – Formative evaluation comprising two best out of three tests (each test carrying a maximum of 20 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: Candidate with a Bachelor's degree in any branch of Life Sciences Microbiology, Botany, Biotechnology, Zoology, Genetics, Agriculture, Medicine and Veterinary Science

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 (50%) out of 40 marks for theory 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 : **MGS101** 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 Genomic Science.

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 chymo trypsin. 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 : **MGS102** Course Type : **Core** No. of Credits : **4.00** No. of Hours : **60**	**Course Title** **Microbiology and Immunology**

Course Objectives:

- To introduce students to the fundamentals of microbiology, including microbial structure, growth, and microbial classification, taxonomy, and ecological diversity across Bacteria, Archaea, and Eukarya.
- To explain methods for control of microorganisms, including sterilization, antimicrobial agents, and resistance mechanisms and provide knowledge of virology, including virus structure, replication, and classification.
- To explain about immunity, types and antibodies, structure function, Immunological reactions.

Course Outcomes (COs):

- CO1: Demonstrate understanding of biomolecular interactions and metabolic energy utilization.
- CO2: Describe the history, scope, and importance of microbiology.
- CO3: Explain bacterial structure, growth curve, and nutritional requirements.
- CO4: Classify microorganisms using taxonomic criteria.
- CO5: To explain various kinds of Immunity, Cells and processes.

COs /POs Mapping:

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1 Recall & define	3	3	1	–	–	–	–	–	–	–	–	1
CO2 Explain & interpret	3	3	2	1	–	–	–	–	–	–	–	1
CO3 Apply Models	2	3	2	2	1	–	–	–	–	–	–	1
CO4 Analyse & evaluate	2	3	2	2	2	-	3	3	–	–	–	1
CO5 Research & create	2	3	3	2	2	1	–	–	2	2	1	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, 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. 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-III: **[14 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. Structure of TCR and BCR, RAG genes and generation of TCR and BCR - antibody diversity.

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

Complement system, basics of antigen processing and presentation - importance of MHC. RIA, ELISA, 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:

Prescott's Microbiology – Joanne M. Willey, Kathleen M. Sandman & Dorothy H. Wood, McGraw Hill, 2024.
Brock Biology of Microorganisms – Michael T. Madigan, Kelly S. Bender, Daniel H. Buckley, W. Matthew Sattley & David A. Stahl, Pearson, 2022/2024.
Microbiology – Michael J. Pelczar Jr., E.C.S. Chan & Noel R. Krieg, 5th Edition, McGraw Hill, 1993.
Kuby Immunology – Jenni Punt, Sharon A. Stranford, Patricia P. Jones & Judy A. Owen, W.H. Freeman, 2018.
Janeway's Immunobiology – Kenneth Murphy & Casey Weaver, Garland Science, 2022.
Fields Virology – David M. Knipe & Peter M. Howley, Wolters Kluwer, 2020.
Medical Virology – Fenner & White, Academic Press, 2016.

References:

Microbial Physiology – Albert G. Moat, John W. Foster & Michael P. Spector, Wiley-Liss, 2002.
General Microbiology – Roger Y. Stanier et al., Macmillan Education, 1986.
The Prokaryotes – Martin Dworkin et al., Springer, 2006.
Bacterial Pathogenesis – Abigail A. Salyers & Dixie D. Whitt, ASM Press, 2002.
Fundamental Immunology – William E. Paul, Lippincott Williams & Wilkins, 2012.
Immunology: A Short Course – Richard Coico & Geoffrey Sunshine, Wiley-Blackwell, 2021.
Jawetz, Melnick & Adelberg's Medical Microbiology – Brooks, Carroll, Butel, Morse & Mietzner, McGraw Hill, 2019.
Medical Microbiology – Patrick R. Murray, Ken S. Rosenthal & Michael A. Pfaller, Elsevier, 2020.
Principles and Techniques of Biochemistry and Molecular Biology – Keith Wilson & John Walker, Cambridge University Press, 2018.

Course Code : **MGS103** Course Type : **Core** No. of Credits : **4.00** No. of Hours : **60**	**Course Title** **Biophysical Techniques and Biostatistics**

Course Objectives:

- To provide a comprehensive understanding of biophysical principles governing biomolecular structure and interactions and familiarize students with advanced analytical and spectroscopic techniques used in biology.
- To develop a strong foundation in thermodynamics, kinetics, and structural biology.
- To introduce statistical tools and experimental design for biological research.

Course Outcomes (COs):

- CO1: Apply spectroscopic and biophysical techniques in biological research.
- CO2: Analyze protein and nucleic acid structures using modern tools.
- CO3: Explain thermodynamic and kinetic principles in biological systems.
- CO4: Perform statistical analysis and hypothesis testing on experimental data.
- CO5: Design and interpret biological experiments using proper statistical methods Critically evaluate scientific data and research findings.

COs /POs Mapping:

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1 **Recall & define**	3	2	2	1	2	–	–	–	–	–	–	1
CO2 **Explain & interpret**	2	3	3	2	2	–	1	–	–	1	–	1
CO3 **Apply Models**	2	3	2	3	2	1	–	–	1	–	–	1
CO4 **Analyse & evaluate**	2	3	3	3	2	1	2		–	2	–	1
CO5 **Research & create**	2	3	3	3	3	2	–	–			1	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. 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-II: **[12 Hours]**

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

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

Statistical concepts: Data structure, sampling methods, descriptive statistics - Data collection, tabulation, graphical representation - Histogram, frequency polygon, frequency curve, bar graphs etc.

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

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.

Suggested Readings:

Cantor, C. R., & Schimmel, P. R. – Biophysical Chemistry (1st ed., 1980, published in 3 parts).
Nelson, D. L., & Cox, M. M. – Lehninger Principles of Biochemistry (8th ed., 2021).
Voet, D., & Voet, J. G. – Biochemistry (4th ed., 2011).
Tinoco, I., Sauer, K., Wang, J. C., Puglisi, J. D., Harbison, G., & Rovnyak, D. – Physical Chemistry: Principles and Applications in Biological Sciences (5th ed., 2013).
Skoog, D. A., Holler, F. J., & Crouch, S. R. – Principles of Instrumental Analysis (7th ed., 2017).
Zar, J. H. – Biostatistical Analysis (5th ed., 2014).

References:

Branden, C., & Tooze, J. – Introduction to Protein Structure (2nd ed., 1999).
Atkins, P., & de Paula, J. – Physical Chemistry (11th ed., 2018).
Engel, T., & Reid, P. – Thermodynamics, Statistical Thermodynamics & Kinetics (4th ed., 2019).
Daniel, W. W., & Cross, C. L. – Biostatistics: A Foundation for Analysis in the Health Sciences
Rhodes, G. – Crystallography Made Crystal Clear: A Guide for Users of Macromolecular Models (3rd ed., 2006).

Course Code : **MGS104** Course Type : **Elective** No. of Credits : **4.00** No. of Hours : **60**	**Course Title** **Genetics and Proteomics**

Course Objectives:

- To develop a strong foundation in classical, molecular, and population genetics.
- To understand chromosomal structure, variation, and inheritance patterns.
- To explain gene expression regulation and developmental genetics.

Course Outcomes (COs):

- CO1: Explain Mendelian and non-Mendelian inheritance patterns.
- CO2: Analyze chromosomal structure, mutations, and genetic variations.
- CO3: Understand gene regulation during development and differentiation.
- CO4: Apply population genetics principles such as Hardy–Weinberg equilibrium.
- CO5: Perform and interpret protein separation and analysis techniques

COs /POs Mapping:

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

Course Outline:

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

Mendelian Genetics and analysis: Deviation to Mendelism, Chromosomal basis of Inheritance, Chromosome structure, function and classification, Euchromatin and heterochromatin, Coding and Non- coding sequences, transposons, Genetic Recombination in Eukaryotes, Linkage and Crossing Over, Chromosome mapping, Gene Mutations - Mutagenesis, detection, molecular basis and Applications, Chromosomal Changes, Number variation – Euploidy (auto and allopolyploidy), aneuploidy, Structural variations – Deficiencies, duplications, Inversions, translocations, Interaction of Genotype and Environment, non-genetic environment, penetrance and expressivity

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

Gene expression regulation during differentiation and growth, Hetero chromatization in humans, dosage compensation mechanism, sex chromatin, position effect, Quantitative inheritance, Continuous traits – multigenic variability, dominance – additivity, norms of reaction, Non-Mendelian Inheritance

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

Population Genetics Genotype and allelic frequencies, Hardy-Weinberg equilibrium, non-random mating, consequences of homozygosity, factors affecting gene frequencies, heterosis, mutation – effect on allele frequencies, migration and genetic drift. Developmental Genetics- model system of Drosophila, Genetic screen, Pattern formation, Maternal effect, Homeotic transformations.

Unit-IV: **[10 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-V: **[12 Hours]**

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

Snustad, D. P., & Simmons, M. J. – Principles of Genetics (7th ed., 2015).
Brooker, R. J. – Genetics: Analysis and Principles (7th ed., 2021).
Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. – Molecular Biology of the Gene (7th ed., 2013).
Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. – Lewin's GENES XII (12th ed., 2017).
Liebler, D. C. – Introduction to Proteomics: Tools for the New Biology (1st ed., 2002).
Pennington, S. R., & Dunn, M. J. – Proteomics: From Protein Sequence to Function (1st ed., 2001).

References:

Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., & Martin, K. C. – Molecular Cell Biology (9th ed., 2021).
Brown, T. A. – Genomes 5 (5th ed., 2023).
Hartl, D. L., & Ruvolo, M. – Essential Genetics and Genomics (7th ed., 2019).
Westermeier, R., Naven, T., & Höpker, H. R. – Proteomics in Practice: A Guide to Successful Experimental Design (2nd ed., 2008).
Siuzdak, G. – Mass Spectrometry for Biotechnology (1st ed., 1996).

Course Code : **MGS105** 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; Behavioural 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 : **106** 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.

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 : **MGS107** Course Type : **AEC** No. of Credits : 2.00 No. of Hours : 30	**Course Title** **Indian Knowledge System**

Course Objectives:

- To introduce students to the principles and concepts of Indian Knowledge Systems (IKS) and their relevance to modern life sciences.
- To understand traditional Indian practices related to health, agriculture, biodiversity, medicine, and environmental conservation through scientific perspectives.
- To develop analytical and research skills for integrating indigenous knowledge with contemporary biological sciences for sustainable development.

Course Outcomes (COs):

- CO1: After successful completion of the course, students will be able to:
- CO2: Explain the basic concepts and historical development of Indian Knowledge Systems in relation to life sciences.
- CO3: Describe traditional Indian practices in medicine, agriculture, biodiversity conservation, and environmental management.
- CO4: Analyze the scientific basis of indigenous biological knowledge and its applications in modern research and healthcare.
- CO5: Evaluate the role of IKS in promoting sustainable development, ecological balance, and public health.

COs /POs Mapping:

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

Course Outline:

Unit-I: [6 Hours]

Indian Knowledge System: Meaning and Nature, Varied Disciplines and Scope. Historicity of IKS. Ancient Indian contributions to life sciences.

Unit-II: [6 Hours]

Integration of traditional wisdom with modern biotechnology. Folk and classical streams of medical knowledge in India: folk and tribal medicine. Home remedies.

Unit-III: [6 Hours]

Traditional Indian fermented foods and beverages – Probiotic foods. Introduction and Indigenous microbial knowledge in food preservation

Unit-IV: [6 Hours]

Historical development and milestones of Ayurveda and Siddha. Foundational concepts – Tridoṣa. Pulse diagnosis. Yoga: Historical development and milestones, personalities, textual sources. Definition of yoga. yoga as therapy for health and wellness.

Unit-V: [6 Hours]

Agriculture in ancient India. Plant diseases and their management. Pest control, manures for plants, plant grafting techniques.Sacred groves. About social forestry –benefits from leaves, fruits from plantation.

Suggested Readings:

Kapil Kapoor & Avadhesh Kumar Singh (Eds.), Indian Knowledge Systems (2 Vols.), 2005. D.K. Printworld.

M.S. Valiathan, The Legacy of Caraka, 2003. Orient Longman.

B.K.S. Iyengar, Light on Yoga, 1966. George Allen & Unwin.

Course Code : **MGS125** 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 Microbial growth using- Turbidometer/Photo colorimeter/ spectrometer and Haemo cytometer

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 : **MGS201** Course Type : **Core** No. of Credits : **4.00** No. of Hours : **60**	**Course Title** **Insilco Biology and Computational Modelling**

Course Objectives:

- To introduce the fundamental concepts and scope of in silico biology, including its integration with bioinformatics and computational biology.
- To develop understanding of biological databases and sequence analysis tools for studying DNA, RNA, and proteins and to familiarize students with mathematical and computational models used in analyzing biological systems.
- To provide knowledge on gene regulation, enzyme kinetics, and biological network analysis using computational approaches.

Course Outcomes (COs):

- CO1: Explain key concepts of in silico biology
- CO2: Effectively use biological databases
- CO3: Sequence analysis tools such as BLAST and FASTA.
- CO4: Apply computational and mathematical models (deterministic and stochastic)
- CO5: Analyze biological systems, interpret gene regulatory mechanisms, enzyme kinetics, and population dynamics using modelling approaches.

COs /POs Mapping:

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

Course Outline:

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

Concept, scope, and significance of in silico biology and its relationship with bioinformatics and computational biology. Biological databases including DNA, RNA, and protein sequence repositories, along with genome and proteome resources. Sequence formats, motifs, homology, orthology, and scoring matrices like PAM and BLOSUM. Sequence search tools such as BLAST and FASTA and their applications in biological data analysis.

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

Mathematical and Computational approaches used to model biological systems. Biological models including deterministic and stochastic models. Application of ordinary differential equations.

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

Gene regulation, enzyme kinetics, and population dynamics. Concepts of stochastic modelling including simulation algorithms, Stability and steady-state analysis. Network and pathway modelling including gene regulatory networks and metabolic flux analysis. Properties of Biological networks.

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

Biomolecular structures and interactions. Protein structure and the use of structural databases and visualization tools. Homology modelling, including template identification, model building, and validation methods.

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

The principles of molecular docking and scoring functions, molecular dynamics simulations including energy minimization and conformational analysis. Applications of molecular modelling in drug discovery.

Suggested Readings:

Boinformatics: Sequence and Genome Analysis – David W. Mount, 2nd Edition, Cold Spring Harbor Laboratory Press, 2004.
Introduction to Bioinformatics – Arthur M. Lesk, 5th Edition, Oxford University Press, 2019.
Biological Sequence Analysis – Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison, 1st Edition, Cambridge University Press, 1998.
Molecular Modelling: Principles and Applications – Andrew R. Leach, 2nd Edition, Pearson Education, 2001.
Systems Biology: A Textbook – Edda Klipp et al., 2nd Edition, Wiley-Blackwell, 2016.

References:

Essential Bioinformatics – Jin Xiong, 1st Edition, Cambridge University Press, 2006.
Bioinformatics for Dummies – Jean-Michel Claverie & Cedric Notredame, 2nd Edition, Wiley Publishing, 2007.
Fundamentals of Bioinformatics and Computational Biology – S. C. Rastogi et al., 1st Edition, PHI Learning, 2009.
National Center for Biotechnology Information (NCBI) – Online databases and BLAST tools.
European Bioinformatics Institute (EBI) – Sequence databases and analysis tools.

Course Code : **MGS202** Course Type : **Core** No. of Credits : **4.00** No. of Hours : **60**	**Course Title** **Cell and Molecular Biology**

Course Objectives:

- To understand the structural and functional organization of prokaryotic and eukaryotic cells.
- To explain cellular communication, adhesion, and intracellular coordination mechanisms.
- To provide knowledge of nucleic acid structure, genome organization, and gene expression.

Course Outcomes (COs):

- CO1:Students will be able to differentiate between cellular structures and their functions.
- CO2: Students will interpret mechanisms of cell communication, transport, and division.
- CO3: Students will analyze genome complexity and nucleic acid behavior.
- CO4: Students will explain molecular processes like replication, transcription, translation, and repair.
- CO5: Students will evaluate gene regulation mechanisms in prokaryotes and eukaryotes.

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	2	2	1	1	–	–	–	–	–	–	1
CO3 **Apply Models**	2	3	3	2	2	–	–	–	–	–	–	1
CO4 **Analyse & evaluate**	2	3	3	3	2	1	3	3	–	–	–	1
CO5 **Research & create**	2	3	3	3	3	1	–	–	2	2	1	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, cellular cytoskeleton. Cell-cell communications: Cell-environment communications.

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

Role of different adhesion molecules: Desmosomes, Hemi-desmosomes, Gap junctions, Tight Junctions, Plasmodesmata. Organelle Interconnectivity and communications. Cellular processes: cell division: mitosis, meiosis and cytokinesis, cell differentiation: Introduction to stem cells, Molecular mechanisms of membrane transport active, passive, facilitated, Channels and Pumps. Cellular responses to environmental signals in plants, animals, and microorganisms.

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

Nucleic acid structure and function. DNA re-association kinetics, Cot curve, C-value paradox, repetitive and unique sequences.: Genomes of bacteria, eukaryotes, organelle and viruses: linear and circular chromosomes, hetero chromatin and euchromatin, DNA methylation (X chromosome inactivation). Central Dogma of Molecular Biology, DNA Replication, Transcription and Translation.

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

DNA repair and recombination: Pyrimidine dimer, nicks and gaps in DNA, AP sites, base mispairing; Mismatch, base excision and nucleotide-excision repair mechanisms, SOS response. Transposition - DNA transposons and retroposons mechanism. 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,

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

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.

Suggested Readings:

Molecular Biology of the Cell – Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter, 7th Edition, 2022.
Essential Cell Biology – Bruce Alberts, Rebecca Heald, Karen Hopkin, Alexander Johnson, David Morgan, Martin Raff, Keith Roberts, Peter Walter, 6th Edition, 2023.
Molecular Biology of the Gene – James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick, 7th Edition, 2014.
Cell and Molecular Biology: Concepts and Experiments – Gerald Karp, 8th Edition, 2015.
Lewin's Genes XII – Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick, 12th Edition, 2017.

References:

The Cell: A Molecular Approach – Geoffrey M. Cooper, Robert E. Hausman, 8th Edition, 2018.
Molecular Cell Biology – Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, Hidde Ploegh, Angelika Amon, 9th Edition, 2021.
Principles of Gene Manipulation and Genomics – Sandy B. Primrose, Richard Twyman, 7th Edition, 2006.
Genomes 4 – T. A. Brown, 4th Edition, 2017.
Genes IX – Benjamin Lewin, 9th Edition, 2008.

Course Code : **MGS203** 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 : **MGS204** 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 : **MGS205** Course Type : **Elective** No. of Credits : **4.00** No. of Hours : **60**	**Course Title** **Cancer Genomics**

Course Objectives:

- To understand the basic concepts of cancer biology and its genetic basis.
- To differentiate between normal and cancer cells at molecular and cellular levels.
- To study the role of oncogenes, tumour suppressor genes, and mutations in cancer

Course Outcomes (COs):

- CO1:Explain cancer as a genetic and molecular disease.
- CO2: Distinguish between benign and malignant tumours and various cancer types.
- CO3: Describe the role of oncogenes, tumour suppressor genes, and cell cycle regulation.
- CO4: Analyse genetic mutations, chromosomal abnormalities, and epigenetic changes in cancer.
- CO5: Interpret data from next-generation sequencing (NGS), microarrays, and transcriptomics.

COs /POs Mapping:

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

Course Outline:

Unit-I: [12 Hours]

Basic concepts of cancer and tumor biology, Cancer as a genetic disease. Differences between normal cells and cancer cells; Benign and malignant tumors. Hallmarks of cancer. Carcinogenesis, role of environmental, chemical, viral, and lifestyle factors in cancer development. Major types of cancer: carcinomas, sarcomas, leukemias, lymphomas, and melanomas.

Unit-II: [12 Hours]

Oncogenes and tumor suppressor genes. Cell cycle regulation and apoptosis in cancer DNA repair mechanisms and genomic instability, Germline and somatic mutations. Chromosomal abnormalities: translocations, deletions, duplications, and aneuploidy, Copy number variations and single nucleotide polymorphisms. Epigenetic changes in cancer.

Unit-III: [14 Hours]

Principles of cancer genomics, Next-generation sequencing technologies. Whole genome sequencing and whole exome sequencing. RNA sequencing and transcriptome analysis. Microarray technology in cancer research. Detection of mutations and gene expression profiling. Signs and symptoms of cancer, Cancer screening and early detection methods Diagnostic techniques: biopsy, histopathology, molecular diagnostics, and biomarker analysis.

Unit-IV: [10 Hours]

Imaging methods: CT scan, MRI, PET scan, and ultrasound. Tumor staging and grading systems. Tumor heterogeneity and cancer progression. Metastasis and tumor microenvironment. Conventional cancer treatments: surgery, chemotherapy, and radiation therapy. Targeted therapy and molecular drugs. Hormone therapy in cancer treatment.

Unit-V: [12 Hours]

Cancer immunotherapy and immune checkpoint inhibitors. Role of Genomics in personalized and precision medicine. Pharmacogenomics and targeted drug development. Emerging approaches: liquid biopsy, circulating tumor DNA, and single-cell genomics. Ethical issues and future perspectives in cancer genomics research.

Suggested Readings:

- Robert A. Weinberg – The Biology of Cancer, 2nd Edition, Garland Science (2013).
- Lauren Pecorino – Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics, 4th Edition, Oxford University Press (2016).
- Vinay Kumar, Abul K. Abbas, Jon C. Aster – Robbins & Cotran Pathologic Basis of Disease, 10th Edition, Elsevier (2020).
- Bruce Alberts et al. – Molecular Biology of the Cell, 6th Edition, Garland Science (2014).
- Charles Swanton, Samuel Aparicio (Editors) – Cancer Genomics, 1st Edition, Springer (2013).

References:

- Benjamin Lewin – Genes XII, 12th Edition, Jones & Bartlett Learning (2017).
- Roger J.B. King, Mike W. Robins – Cancer Biology, 4th Edition, Pearson (2018).
- J.F. Cairns – Cancer: Science and Society, Revised Edition, Freeman (2011).
- D.J. Sherr, J.M. Roberts – Cell Cycle Control in Cancer, 1st Edition, Cold Spring Harbor Laboratory Press.
- Richard Durbin et al. – Biological Sequence Analysis, 1st Edition, Cambridge University Press (1998).
- National Cancer Institute (NCI) – Cancer Genomics and Diagnostics Resources (latest online editions).
- WHO Classification of Tumours Series – Latest Editions, International Agency for Research on Cancer (IARC).

Course Code : **213** 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 : **MGS225** 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

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.EMSA

13.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 : **MGS301** Course Type : **Core** No. of Credits : **4.00** No. of Hours : **60**	**Course Title** **Introduction to R and Python Programming**

Course Objectives:

- To introduce fundamental concepts of computers and programming.
- To understand data structures and control flow in programming.
- To provide practical exposure to real-world data analysis applications.

Course Outcomes (COs):

- CO1:Understand basic programming concepts and logic building.
- CO2:Write simple programs in R and Python.
- CO3:Work with different data types and structures.
- CO4:Perform basic data manipulation and analysis.
- CO5:Use Python libraries for numerical computation and data handling.

COs /POs Mapping:

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

Course Outline:

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

Introduction to computers, programming languages, algorithms, and flowcharts. Concept of variables, data types, operators, and expressions. Decision-making statements, looping statements, and basic program structure.

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

Installation of R and overview of R environment. Data types, vectors, matrices, lists, and data frames in R. Writing simple programs, using functions, and basic data visualization.

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

Installation of Python and introduction to Python syntax. Variables, data types, strings, lists, tuples, and dictionaries. Conditional statements, loops, functions, and basic file handling.

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

Introduction to data analysis concepts, Working with Python libraries: NumPy (array operations and numerical computing). Pandas (data frames, data manipulation, data cleaning). Data input and output (CSV, Excel files).

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

Data visualization using Matplotlib and Seaborn: Line plots, bar charts, histograms, scatter plots. Basic statistical analysis: Mean, median, standard deviation. Introduction to simple data interpretation and reporting Applications of Python in scientific and real-world data analysis

Suggested Readings:

R for Data Science – Authors: Hadley Wickham & Garrett Grolemund (1st Edition)
Python for Data Analysis – Author: Wes McKinney (2nd Edition) Let Us C – Author: Yashavant Kanetkar (Latest Edition)
Introduction to Computing Using Python – Authors: Mark J. Guzdial & Barbara Ericson (Latest Edition)
The Art of R Programming – Author: Norman Matloff (1st Edition)
Data Structures and Algorithms in Python – Authors: Michael T. Goodrich, Roberto Tamassia & Michael H. Goldwasser (1st Edition)
Fundamentals of Computers – Author: V. Rajaraman (6th Edition)

References:

- Hands-On Programming with R – Author: Garrett Grolemund (1st Edition)
- Think Python – Author: Allen B. Downey (2nd Edition)
- Python Crash Course – Author: Eric Matthes (2nd Edition)
- R Cookbook – Author: Paul Teetor (2nd Edition)
- Advanced R – Author: Hadley Wickham (2nd Edition)
- Statistics for Beginners – Author: Victor Kane (Latest Edition)
- Elements of Statistical Learning – Authors: Trevor Hastie, Robert Tibshirani & Jerome Friedman (2nd Edition)

Course Code : **MGS302** Course Type : **Core** No. of Credits : **4.00** No. of Hours : **60**	**Course Title** **Omics in Biology**

Course Objectives:

- To introduce the fundamental concepts of genomics, transcriptomics, proteomics, and metabolomics.
- To understand high-throughput technologies such as sequencing and mass spectrometry.
- To develop knowledge of genome organization, gene expression, and protein/metabolite profiling

Course Outcomes (COs):

- CO1:Explain the principles and scope of different omics technologies.
- CO2: Describe genome structure, sequencing methods, and annotation techniques.
- CO3: Analyze gene expression data using transcriptomic approaches.
- CO4: Understand protein structure, proteomics techniques, and metabolomics analysis.
- CO5: Utilize bioinformatics tools and databases for omics data analysis.

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	–	–	–	–	–	–	2
CO2 Explain & interpret	3	2	2	2	2	–	–	–	–	–	–	1
CO3 Apply Models	2	3	3	2	2	1	–	–	–	–	–	1
CO4 Analyse & evaluate	2	3	3	3	3	2	3	3	–	–	–	2
CO5 Research & create	2	3	3	3	3	2	–	–	2	2	2	2

Course Outline:

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

Introduction to the concept of genomics, transcriptomics, proteomics, and metabolomics. Overview of high-throughput technologies used in omics studies. Basic principles of sequencing and mass spectrometry. Applications of omics in modern biological research.

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

Structure and organization of genomes in prokaryotes and eukaryotes. Gene expression analysis and RNA sequencing techniques

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

Genome sequencing methods and annotation. Genomics of Arabidopsis thaliana, Rice and Humans. Protein structure, function, and protein profiling methods. Techniques such as 2D-gel electrophoresis and mass spectrometry.

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

Metabolite identification and metabolic pathway analysis. Applications in disease diagnosis and biomarker discovery. Introduction to bioinformatics tools and biological databases.

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

Basic data analysis and interpretation of omics data. Integration of multi-omics data. Applications of omics in personalized medicine and biotechnology.

Suggested Readings:

- Brown, T. A. (2017). Genomes 4. 4th Edition. Garland Science.
- Primrose, S. B., & Twyman, R. M. (2014). Principles of Gene Manipulation and Genomics.

7th Edition. Wiley-Blackwell.

- Lesk, A. M. (2019). Introduction to Bioinformatics. 5th Edition. Oxford University Press.
- Glick, B. R., Pasternak, J. J., & Patten, C. L. (2017). Molecular Biotechnology: Principles and Applications of Recombinant DNA. 5th Edition. ASM Press.
- Liebler, D. C. (2002). Introduction to Proteomics: Tools for the New Biology. Humana Press.
- Dettmer, K., Aronov, P. A., & Hammock, B. D. (2007). Mass Spectrometry-Based Metabolomics. Mass Spectrometry Reviews.

References:

- Alberts, B. et al. (2022). Molecular Biology of the Cell. 7th Edition. Garland Science.
- Lewin, B. (2018). Lewin's Genes XII. Jones & Bartlett Learning.
- Mount, D. W. (2004). Bioinformatics: Sequence and Genome Analysis. 2nd Edition. Cold Spring Harbor Laboratory Press.
- Pevsner, J. (2015). Bioinformatics and Functional Genomics. 3rd Edition. Wiley-Blackwell.
- Aebersold, R., & Mann, M. (2016). Mass spectrometry-based proteomics. Nature.
- Nicholson, J. K., Lindon, J. C., & Holmes, E. (1999). 'Metabonomics': Understanding metabolic responses. Xenobiotica.

Course Code : **MGS303** Course Type : **Core** No. of Credits : **4.00** No. of Hours : **60**	**Course Title** **Drug Discovery Design and Development**

Course Objectives:

- To provide a comprehensive understanding of the drug discovery and development pipeline.
- To introduce key concepts of medicinal chemistry, target identification, and validation.
- To familiarize students with screening methods, clinical trials, and regulatory requirements

Course Outcomes (COs):

- CO1: Explain the complete drug discovery process from target identification to commercialization.
- CO2: Analyze disease targets and apply modern approaches such as genomics and proteomics in drug design.
- CO3: Interpret Structure–Activity Relationships (SAR) and apply rational drug design strategies.
- CO4: Evaluate drug candidates using in vitro and in vivo screening models.
- CO5: Understand clinical trial design, phases, and ethical considerations.

COs /POs Mapping:

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

Course Outline:

Unit-I: [12 Hours]

Overview of drug discovery process from target identification to commercialization. Concepts of disease targets, receptors, enzymes and signaling pathways. Traditional vs modern drug discovery approaches.

Unit-II: [12 Hours]

Role of genomics, proteomics and bioinformatics in target validation. Basics of medicinal chemistry and Structure–Activity Relationship (SAR). Rational drug design: ligand-based and structure-based drug design

Unit-III: [14 Hours]

Lead identification, lead optimization and combinatorial chemistry. ADME properties and drug-likeness (Lipinski's rule of five). In vitro and in vivo screening models for drug evaluation. Toxicological studies: acute, sub-acute and chronic toxicity testing.

Unit-IV: [10 Hours]

Clinical trial phases (I–IV): objectives and study design. Pharmacokinetics (PK), Pharmacodynamics (PD) and dose optimization. Regulatory frameworks (FDA, EMA, CDSCO) and drug approval process

Unit-V: [12 Hours]

Good Laboratory Practices (GLP), Good Clinical Practices (GCP), GMP guidelines. Pharmacovigilance and post-marketing surveillance. Emerging technologies: Biologics, biosimilars, nanomedicine and AI in drug discovery.

Suggested Readings:

Rang, H. P., Dale, M. M., Ritter, J. M., & Flower, R. J. Rang and Dale's Pharmacology, 9th Edition, Elsevier, 2020.

Patrick, G. L. An Introduction to Medicinal Chemistry, 6th Edition, Oxford University Press, 2017.

Katzung, B. G. Basic and Clinical Pharmacology, 15th Edition, McGraw Hill, 2021.

Silverman, R. B., & Holladay, M. W. The Organic Chemistry of Drug Design and Drug Action, 3rd Edition, Academic Press, 2014.

Crommelin, D. J. A., Sindelar, R. D., & Meibohm, B.Pharmaceutical Biotechnology: Fundamentals and Applications, 5th Edition, Springer, 2019.

References:

Lemke, T. L., Williams, D. A., Roche, V. F., & Zito, S. W. Foye's Principles of Medicinal Chemistry, 7th Edition, Wolters Kluwer, 2013.

Vogel, H. G.Drug Discovery and Evaluation: Pharmacological Assays, 4th Edition, Springer, 2013.

Friedman, L. M., Furberg, C. D., & DeMets, D. L.Fundamentals of Clinical Trials, 5th Edition, Springer, 2015.

Walsh, G. Biopharmaceuticals: Biochemistry and Biotechnology, 3rd Edition, Wiley, 2013.

Course Code : **MGS304** Course Type : **Elective** No. of Credits : **4.00** No. of Hours : **60**	**Course Title** **IPR, Biosafety and Bioethics**

Course Objectives:

- . To provide fundamental knowledge of Intellectual Property Rights (IPR) and their role in innovation and research.
- To understand different forms of IPR such as patents, copyrights, trademarks, and geographical indications.
- To introduce IPR issues specific to biotechnology including biopatenting, plant variety protection, and traditional knowledge

Course Outcomes (COs):

- CO1: Explain the concept and importance of Intellectual Property Rights in scientific research and innovation.
- CO2: Differentiate between patents, copyrights, trademarks, and geographical indications.
- CO3: Analyze IPR issues in biotechnology such as gene patenting, biodiversity protection, and farmers' rights.
- CO4: Describe biosafety levels (BSL-1 to BSL-4) and apply laboratory safety practices effectively.
- CO5: Conduct basic risk assessment for handling pathogens and genetically modified organisms

COs /POs Mapping:

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

Course Outline:

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

Introduction to Intellectual Property Rights patents, copyrights, trademarks and trade secrets, and role in promoting research and technological development.

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

Copyright and scientific publications, software and creative works, Trademarks and geographical indications. Patenting of biological materials, genes and microorganisms, along with plant variety protection and farmers' rights

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

Biodiversity conservation, traditional knowledge protection and ethical concerns related to biopatenting. Biosafety, classification of Biosafety Levels (BSL-1 to BSL-4) based on risk assessment and containment strategies. Proper handling of pathogens and genetically modified organisms requires use of personal protective equipment, waste disposal methods and emergency spill management procedures

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

Environmental and agricultural biosafety focuses on risk assessment of genetically modified crops, field trials and safe environmental release. Biosafety measures in transgenic animals and addresses public concerns through effective biosafety communication.

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

Bioethics in life sciences and medical research. Ethical considerations in genetic engineering, GMOs, cloning and gene editing technologies such as CRISPR. Biopiracy, protection of indigenous knowledge and responsible use of emerging biotechnologies. Role of ethics committees is crucial in ensuring that research and technological advancements are conducted responsibly and in accordance with societal values.

Suggested Readings:

- P. Narayanan – Intellectual Property Law (3rd Edition)
- B.L. Wadhera – Law Relating to Intellectual Property (5th Edition)
- R. Renuka – Intellectual Property Rights in Biotechnology (Latest Edition)
- S. Ignacimuthu – Bioethics (1st Edition)
- G.K. Suraishkumar & M.T. Ramasamy – Biotechnology and Bioethics (1st Edition)

References:

- World Intellectual Property Organization (WIPO) – Understanding Intellectual Property (Latest Edition)
- UNESCO – Bioethics Core Curriculum (Latest Edition)
- IISc & DBT Guidelines (India) – Biosafety Guidelines for Recombinant DNA Research
- M.K. Sateesh – Bioethics and Biosafety (2nd Edition)
- Kankanala C. & Prabhakar S. – Intellectual Property Law in India (2nd Edition)

Course Code : **MGS305** 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**
CO2 **Explain & interpret**	**3**	**2**	–	–	–	–	–	–	–	–	–	–
CO3 **Apply Models**	–	**3**	**3**	–	**2**	–	–	–	–	–	–	–
CO4 **Analyse & evaluate**	–	**2**	–	**3**	–	**2**	**3**	**3**	–	–	–	–
CO5 **Research & create**	–	–	**3**	**3**	–	–	–	–	**2**	**2**	**2**	–

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 :**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 : **MGS325** Course Type : **LAB** No. of Credits :**2.00** No. of Hours : **60**	**Course Title** **LAB-III** **(Based on MGS -301,302,303)**

Course Outline:

1. Retrieval and Basic Exploration of Multi-Omics Data from Public Databases

2. Basic RNA-Seq Data Analysis (Differential Gene Expression – Demonstration Level)

3. Protein Structure Visualization and Functional Annotation

4. Sequence Similarity Search and Phylogenetic Analysis Using BLAST

5. Modelling the Bacteriophage Lambda Genetic Switch

6. Protein Structure Visualization and Molecular Docking

7. Structure-Based Drug Design – Molecular Docking & Target Validation.

8. Evaluation of Drug-Likeness Using Lipinski's Rule

Suggested Readings:

- Practical Bioinformatics: A Laboratory Manual – Sufang Wang & Michael Gribskov, 1st Edition, 2025
- Bioinformatics: A Practical Guide to Next Generation Sequencing Data Analysis – Hamid D. Ismail, 1st
- Edition, 2023
- RNA-Seq Data Analysis: A Practical Approach – Eija Korpelainen et al., 1st Edition, 2015
- Structural Bioinformatics: Applications in Preclinical Drug Discovery Process –
- C. Gopi Mohan (Ed.), 1st Edition, 2019
- Basic Applied Bioinformatics – Chandra Sekhar Mukhopadhyay et al., 1st Edition, 2017

References

- Practical Bioinformatics: A Laboratory Manual – Sufang Wang & Michael Gribskov, 1st Edition, 2025
- Bioinformatics: A Practical Guide to Next Generation Sequencing Data Analysis – Hamid D. Ismail, 1st Edition, 2023
- RNA-Seq Data Analysis: A Practical Approach – Eija Korpelainen et al., 1st Edition, 2015
- Structural Bioinformatics: Applications in Preclinical Drug Discovery Process – C. Gopi Mohan (Ed.), 1st Edition, 2019
- Basic Applied Bioinformatics – Chandra Sekhar Mukhopadhyay et al., 1st Edition, 2017

SEMESTER-IV

Course Code : **MGS401** 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: **[7 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: **[8 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 : **MGS402** Course Type: Dissertation No. of Credits : **12**	**Course Title** **Project Work /Dissertation**

Each student will work on a project towards a dissertation by applying the knowledge acquired in Genomic Science, 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 either at the CUAP or 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.