MGM INSTITUTE OF HEALTH SCIENCES

(Deemed to be University u/s 3 of UGC Act, 1956)
Grade 'A' Accredited by NAAC
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CHOICE BASED CREDIT SYSTEM

(CBCS)

(with effect from 2025-26 Batches)

Curriculum for

M.Sc. Medical Genetics

Amended as per AC-51/2025, Dated 29/04/2025

Amended History

1. Amended as per AC-51/2025, [Resolution No. 3.1 (Annexure-3.2)], [Resolution No. 3.5 (Annexure-7)]; Dated 29/04/2025.

Resolution No. 3.1 of Academic Council (AC-51/2025): Resolved to approve the CBCS syllabus, including Program Outcomes (POs), Course Outcomes (COs), and PO-CO Mapping for 15 two-year postgraduate programs under MGMSBS for Semesters I and II. These include: M.Sc. Medical Biotechnology , **M.Sc. Medical Genetics**, M.Sc. Clinical Embryology, M.Sc. Clinical Nutrition, M.Sc. Medical Dialysis Technology, M.Sc. Molecular Biology, M.Sc. Medical Radiology & Imaging Technology , M.Sc. Cardiac Care Technology , M.Sc. Operation Theatre and Anaesthesia Technology, M.Sc. Emergency and Trauma Care, M. Optometry, Master in Hospital Administration, Master of Public Health, M.Sc. Health Informatics & M.Sc. Clinical Research to be effective from batch admitted in Academic Year 2025-26 onwards [ANNEXURE-3.1 to 3.30].

Annexure-3.2 of AC-51/2025

MGM SCHOOL OF BIOMEDICAL SCIENCES

(A constituent unit of MGM INSTITUTE OF HEALTH SCIENCES)
(Deemed to be University u/s 3 of UGC Act 1956)
Grade "A^{++}" Accredited by NAAC
Sector 1, Kamothe, Navi Mumbai-410209,Tel.No.:022-2743763, 27437632, 27432890
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CHOICE BASED CREDIT SYSTEM (CBCS)

(Academic Year 2025 - 26)

Curriculum for

M.Sc. Allied Health Sciences

M.Sc. Medical Genetics

Semester I & II

DIRECTOR'S MESSAGE

Welcome Message from the Director

Dear Postgraduate Students,

Welcome to **MGM School of Biomedical Sciences (MGMSBS), MGMIHS**, a premier institution dedicated to advancing allied and health sciences education. As you embark on this transformative academic journey, you are joining a community that fosters excellence in research, clinical expertise, and innovation**.**

MGMIHS, accredited with **NAAC 'A^{++}' Grade (CGPA 3.55, 2022)** and recognized as a **Category I Institution by UGC**, offers an ecosystem that nurtures both academic and professional growth. With **NIRF (151-200 rank band) recognition, NABH-accredited hospitals, NABL-accredited diagnostic labs, and JCI accreditation for MGM New Bombay Hospital**, we uphold global benchmarks in education and healthcare.

At MGMSBS, our **15 postgraduate programs** are meticulously designed to align with the National Commission for Allied and Healthcare Professionals **(NCAHP)** standards**,** National Education Policy **(NEP)** 2020**,** and the National Credit Framework **(NCrF).** We have implemented the **Choice-Based Credit System (CBCS)** to provide academic flexibility while ensuring rigorous training in clinical and technical skills**.** Our state-of-the-art research laboratories, digital classrooms, and the Central Research Laboratory (CRL) foster an environment that encourages innovation and evidence-based learning**.**

Postgraduate education at MGMSBS goes beyond theoretical learning—our curriculum integrates **hands-on clinical training, interdisciplinary collaboration, and exposure to real-world healthcare challenges**. We emphasize **research-driven education**, encouraging students to actively participate in **scientific discoveries, publications, and international collaborations**.
Beyond academics, we believe in **holistic development**, with initiatives such as the **AARAMBH Science and Wellness Club**, which promotes **mental well-being, leadership, and professional networking**.

As you step into this **next phase of academic and professional growth**, we encourage you to explore new ideas, engage in impactful research, and contribute meaningfully to the **healthcare ecosystem**. We are confident that your journey at MGMSBS will shape you into **skilled, compassionate, and visionary professionals**, ready to lead in the ever-evolving healthcare landscape.

We look forward to witnessing your achievements and contributions!

Dr. Mansee Thakur
Director, MGM School of Biomedical Sciences
MGM Institute of Health Sciences, Navi Mumbai

ABOUT MGM SCHOOL OF BIOMEDICAL SCIENCES

Mission

To improve the quality of life, both at individual and community levels by imparting quality medical education to tomorrow's doctors and medical scientists and by advancing knowledge in all fields of health sciences though meaningful and ethical research.

Vision

By the year 2020, MGM Institute of Health Sciences aims to be top-ranking Centre of Excellence in Medical Education and Research. Students graduating from the Institute will have the required skills to deliver quality health care to all sections of the society with compassion and benevolence, without prejudice or discrimination, at an affordable cost. As a research Centre, it shall focus on finding better, safer and affordable ways of diagnosing, treating and preventing diseases. In doing so, it will maintain the highest ethical standards.

About – School of Biomedical Sciences

MGM School of Biomedical Sciences is formed under the aegis of MGM IHS with the vision of offering basic Allied Science and Medical courses for students who aspire to pursue their career in the Allied Health Sciences, teaching as well as research.

School of Biomedical Sciences is dedicated to the providing the highest quality education in basic medical sciences by offering a dynamic study environment with well-equipped labs. The school encompasses 23 courses each with its own distinct, specialized body of knowledge and skill. This includes 8 UG courses and 15 PG courses. The college at its growing years started with mere 100 students has recorded exponential growth and is now a full-fledged educational and research institution with the student strength reaching approximately **800** at present.

Our consistent theme throughout is to encourage students to become engaged, be active learners and to promote medical research so that ultimately they acquire knowledge, skills, and understanding so as to provide well qualified and trained professionals in Allied Health Sciences to improve the quality of life.

As there is increased need to deliver high quality, timely and easily accessible patient care system the collaborative efforts among physicians, nurses and allied health providers become ever more essential for an effective patient care. Thus the role of allied health professionals in ever-evolving medical system is very important in providing high-quality patient care.

Last but by no means least, School of Biomedical Sciences envisions to continuously grow and reform. Reformations are essential to any growing institution as it fulfills our bold aspirations of providing the best for the students, for us to serve long into the future and to get ourselves updated to changing and evolving trends in the health care systems.

Name of the Degree: M.Sc. Medical Genetics

AIMS OF THE PROGRAM

Innovative biotechnologist are in great demand of India and abroad. This program is designed to train students to deal in technological applications involved biological application systems, living organisms, or derivatives thereof, to make or modify products to processes for specific use to bridge the gap between industry requirements and the growing demand for skilled manpower in Genetics sector.

Postgraduate qualification in Genetics can earn to placements in research laboratories run by the government and the corporate sector. Private sector placements are in both technical and managerial positions. The biotech business is growing at an accelerated rate, with a number of companies launching innovative biotech applications. The entry of corporate sector in Genetics makes career prospects in this field bright.

In academics, one can go for higher qualifications like Ph.D. in various field of biology. There is a great demand of this course abroad as most of the foreign countries are looking for expert in this field. After completion of the course, one can work as Marketing manager, Bioinformationist, Business development Manager.

Duration of Study: The duration of the study for M.Sc. Medical Genetics will be of four semesters spread over two years.

Program pattern

- First Semester: July
- Second Semester: January
- Third Semester: July
- Fourth Semester: January

Eligibility Criteria: As a minimum criterion of eligibility, aspiring candidates are needed to have attained a B.Sc. in any discipline of Life Sciences, Biosciences, Bachelor's degree in any of Physics, Biological Sciences, M.B.B.S, BDS, BAMS, BHMS, B.Pharm., B.Tech (Biotechnology), Bachelor’s Degree in Agricultural, Veterinary and Fishery Sciences, or equivalent examination with a minimum aggregate score of 50%.

For any query visit the website: www.mgmsbsnm.edu.in

Program Objectives & Outcome

Programme Objectives	The **M.Sc. Medical Genetics** program aims to: 1. **Build a Strong Foundation in Medical Genetics**: Provide in-depth theoretical and practical knowledge in molecular biology, genetic engineering, immunology, bioinformatics, animal and plant biotechnology, medical biochemistry, and microbiology. 2. **Enhance Research and Analytical Competency**: Train students in advanced research methodologies, experimental design, data analysis, and scientific interpretation for biomedical applications. 3. **Develop Expertise in Diagnostics and Therapeutics**: Equip students with skills in molecular diagnostics, biopharmaceutical development, gene therapy, and regenerative medicine. 4. **Foster Innovation and Entrepreneurship**: Encourage problem-solving, translational research, and the development of cost-effective healthcare solutions. 5. **Promote Bioethics, Regulatory Compliance, and Industry Readiness**: Educate students on biosafety, intellectual property rights, regulatory frameworks, and industrial applications in biotechnology. 6. **Prepare for Diverse Career Opportunities**: Develop expertise for careers in academia, research, pharmaceuticals, hospitals, and the healthcare industry.
Programme Outcome	Upon completing the program, graduates will be able to: 1. **Apply Biotechnological Knowledge in Medical Sciences**: Utilize molecular, cellular, and computational techniques in medical biotechnology for disease diagnosis, treatment, and research. 2. **Conduct Independent and Collaborative Research**: Design and execute experiments, analyze data, and contribute to scientific advancements in medical biotechnology. 3. **Utilize Advanced Molecular and Analytical Techniques**: Demonstrate proficiency in PCR, flow cytometry, sequencing technologies, protein analysis, and bioinformatics tools. 4. **Solve Complex Biological Problems**: Address medical challenges through biotechnological approaches such as genome editing, stem cell therapy, and personalized medicine. 5. **Demonstrate Ethical and Professional Responsibility**: Adhere to bioethical principles, regulatory guidelines, and good laboratory practices in research and industry. 6. **Communicate Effectively in Scientific and Industrial Settings**: Present research findings, write scientific papers, and engage in effective interdisciplinary communication. 7. **Adapt to Emerging Trends in Biotechnology**: Stay updated with advancements in precision medicine, nanobiotechnology, synthetic biology, and artificial intelligence in healthcare. 8. **Contribute to Public Health and Biomedical Innovation**: Develop cost-effective, innovative solutions for disease prevention, diagnostics, and therapeutics for societal impact.

Course Outcomes
Semester I

MMGEN 101 T	Cell Biology	Mapped POs	Teaching-Learning Methodologies	Assessment Tools
CO1	Differentiate between prokaryotic and eukaryotic cells based on structural and functional aspects.	**PO1, PO4**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO2	Describe the organization and roles of cellular organelles and the cytoskeleton in maintaining cell integrity and function.	**PO1, PO3**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO3	Explain mammalian cell types, their differentiation pathways, and their significance in tissue architecture.	**PO1, PO4, PO6**	Lecture, Practical Demonstration, Assignment, Group Discussion, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO4	Analyse various cell-cell interactions, junctions, and extracellular matrix components in maintaining cellular communication.	**PO1, PO4**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO5	Illustrate mechanisms of membrane transport, vesicular trafficking, and the impact of cellular signalling pathways in physiological processes.	**PO1, PO3**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO6	Evaluate the regulation of the cell cycle, mechanisms of cell death, and their roles in embryogenesis, development, and disease pathology.	**PO1, PO2, PO4**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO7	Apply knowledge of cellular biology to understand stem cell biology, regenerative medicine, and cancer biology.	**PO1, PO2, PO4, PO5, PO7, PO8**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
MMGEN 102 T	**Immunology**	**Mapped POs**	**Teaching-Learning Methodologies**	**Assessment Tools**
CO1	Describe the key components and mechanisms of innate and adaptive immunity.	**PO1**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO2	Differentiate immune system organs and cell types, explaining their roles in immune responses.	**PO1, PO3**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO3	Explain antigen-antibody interactions, major histocompatibility complex (MHC) molecules, and antigen presentation mechanisms.	**PO1, PO3**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.

CO4	Analyze immune signaling pathways, the complement system, and cytokine-mediated regulation of immune responses.	**PO1, PO4**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO5	Evaluate immunological disorders such as autoimmunity, hypersensitivity, and immunodeficiency diseases.	**PO1,PO4, PO6, PO8**	Lecture, Practical Demonstration, Group Discussion, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO6	Apply immunological principles in clinical diagnostics, transplant immunology, tumor immunology, and infectious disease management.	**PO1, PO2, PO3, PO8**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO7	Discuss vaccine development strategies, monoclonal antibody production, CAR-T cell therapy, and immunotherapeutic advancements.	**PO1, PO2, PO7, PO8**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO8	Demonstrate knowledge of immunogenetics and antibody engineering for therapeutic and research applications.	**PO1, PO3, PO5, PO7**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
MMGEN 103 T	**Biomolecules**	**Mapped POs**	**Teaching-Learning Methodologies**	**Assessment Tools**
CO1	Describe the structure and function of carbohydrates, proteins, lipids, and nucleic acids.	**PO1**	Lecture, Assignment, Seminar	Internal Exam, University Exam(Theory Exam)
CO2	Explain the concepts of pH, buffers, and their physiological relevance in biological systems.	**PO1, PO3**	Lecture, Assignment, Seminar	Internal Exam, University Exam(Theory Exam)
CO3	Analyze enzyme kinetics, inhibition mechanisms, and regulatory pathways in metabolic reactions.	**PO1, PO3, PO2**	Lecture, Assignment, Seminar	Internal Exam, University Exam(Theory Exam)
CO4	Illustrate energy production through bioenergetics, the electron transport chain, and oxidative phosphorylation.	**PO1, PO4**	Lecture, Assignment, Seminar	Internal Exam, University Exam(Theory Exam)
CO5	Compare key metabolic pathways, including glycolysis, gluconeogenesis, lipid metabolism, and amino acid catabolism.	**PO1, PO4**	Lecture, Assignment, Seminar	Internal Exam, University Exam(Theory Exam)
CO6	Evaluate the biochemical basis of metabolic disorders such as diabetes, obesity, and dyslipidemia.	**PO1, PO4, PO5**	Lecture, Assignment, Seminar	Internal Exam, University Exam(Theory Exam)
CO7	Interpret liver and kidney function tests, their clinical significance, and hormonal regulation disorders.	**PO1, PO3, PO6, PO8**	Lecture, Assignment, Seminar	Internal Exam, University Exam(Theory Exam)
CO8	Apply biochemical principles to understand disease markers in cancer, cardiovascular diseases, and oxidative stress-related disorders.	**PO1, PO4, PO7, PO8**	Lecture, Assignment, Seminar	Internal Exam, University Exam(Theory Exam)

CC 001 T	Research Methodology & Biostatistics (Core Course)	Mapped POs	Teaching-Learning Methodologies	Assessment Tools
CO1	Student will be able to understand develop statistical models, research designs with the understating of background theory of various commonly used statistical techniques as well as analysis, interpretation & reporting of results and use of statistical software.	PO1, PO2, PO4, PO6, PO7, PO8	Lecture, Practical, Experiential, Assignment, Problem Based Learning, E-learning	Internal Exam, University Exam (Theory and Practical), Seminar.
MMGEN 104 P	**Practical Lab I – (MMGEN 101 & MMGEN 102)**	**Mapped POs**	**Teaching-Learning Methodologies**	**Assessment Tools**
CO1	Operate a microscope efficiently and analyze different cell types and structures along with viability and counting.	PO1,PO2, PO3,PO4, PO5,PO6, PO8	Practical and Problem Based Learning	Internal Exam, University Exam (Practical Exam), Viva
CO2	Conduct blood group typing using haemagglutination tests.	PO1,PO2, PO3,PO4, PO5,PO6, PO8	Practical and Problem Based Learning	Internal Exam, University Exam (Practical Exam), Viva
CO3	Understand and demonstrate the principles of immunodiagnostic tests such as VDRL/Widal (demonstration-based).	PO1,PO2, PO3,PO4, PO5,PO6, PO8	Practical and Problem Based Learning	Internal Exam, University Exam (Practical Exam), Viva
CO4	Analyze the histological organization of lymphoid organs.	PO1,PO2, PO3,PO4, PO5,PO6, PO8	Practical and Problem Based Learning	Internal Exam, University Exam (Practical Exam), Viva
CO5	Perform antigen-antibody interaction studies using ELISA.	PO1,PO2, PO3,PO4, PO5,PO6, PO8	Practical and Problem Based Learning	Internal Exam, University Exam (Practical Exam), Viva
CO6	Interpret Western blotting results for protein analysis (demonstration-based).	PO1,PO2, PO3,PO4, PO5,PO6, PO8	Practical and Problem Based Learning	Internal Exam, University Exam (Practical Exam), Viva
CO7	Apply immunological techniques for disease diagnosis using commercial kits	PO1,PO2, PO3,PO4, PO5,PO6, PO8	Practical and Problem Based Learning	Internal Exam, University Exam (Practical Exam), Viva
CO8	Correlate theoretical knowledge with practical applications in immunology and cellular biology.	PO1,PO2, PO3,PO4, PO5,PO6, PO7,PO8	Practical and Problem Based Learning	Internal Exam, University Exam (Practical Exam), Viva
MMGEN 105 CP	**MGEN Directed Clinical Education-I**	**Mapped POs**	**Teaching-Learning Methodologies**	**Assessment Tools**
CO1	Demonstrate proficiency in diagnostic and therapeutic techniques used in hospital laboratories.	PO1,PO3, PO5, PO8	Pre-Clinical Orientation, Laboratory Hands-on Training, Problem-Based Learning.	Daily log book, Direct observation and feedback by mentors

CO2	Effectively communicate and collaborate with healthcare professionals and patients.	**PO1,PO3, PO5, PO8**	Pre-Clinical Orientation, Laboratory Hands-on Training, Problem-Based Learning.	Daily log book, Direct observation and feedback by mentors
CO3	Apply QA and QC protocols in a regulated laboratory environment.	**PO1,PO3, PO5, PO8**	Pre-Clinical Orientation, Laboratory Hands-on Training, Problem-Based Learning.	Daily log book, Direct observation and feedback by mentors
CO4	Analyze and troubleshoot clinical and diagnostic challenges using biotechnological approaches.	**PO1,PO3, PO5, PO8**	Pre-Clinical Orientation, Laboratory Hands-on Training, Problem-Based Learning.	Daily log book, Direct observation and feedback by mentors
CO5	Understand and adhere to hospital regulatory standards and accreditation requirements (NABH/NABL).	**PO1,PO3, PO5, PO8**	Pre-Clinical Orientation, Laboratory Hands-on Training, Problem-Based Learning.	Daily log book, Direct observation and feedback by mentors
CO6	Develop decision-making skills for effective healthcare management and administration.	**PO1,PO3, PO5, PO8**	Pre-Clinical Orientation, Laboratory Hands-on Training, Problem-Based Learning.	Daily log book, Direct observation and feedback by mentors
CO7	Gain practical insights into biotechnology-based clinical applications and patient care.	**PO1,PO3, PO5, PO8**	Pre-Clinical Orientation, Laboratory Hands-on Training, Problem-Based Learning.	Daily log book, Direct observation and feedback by mentors
CO8	Prepare for professional roles in clinical research, diagnostics, and hospital-based biotechnology settings.	**PO1,PO3, PO5, PO8**	Pre-Clinical Orientation, Laboratory Hands-on Training, Problem-Based Learning.	Daily log book, Direct observation and feedback by mentors

Semester II

MMGEN 106 T	Molecular Biology	Mapped POs	Teaching-Learning Methodologies	Assessment Tools
CO1	Explain the central dogma of molecular biology and its significance in gene expression	**PO1**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO2	Describe the structure and function of DNA and RNA, including their types, modifications, and regulatory elements.	**PO1, PO2**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO3	Compare prokaryotic and eukaryotic DNA replication mechanisms, including DNA damage and repair processes.	**PO1, PO3**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO4	Illustrate transcription and translation mechanisms, their regulation, and RNA processing events such as splicing and RNA interference.	**PO1, PO3**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO5	Analyze operon models (lac, trp, and ara operons) and their regulation mechanisms in prokaryotes.	**PO1, PO4, PO5**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO6	Discuss epigenetic modifications, chromatin remodelling, and the role of non-coding RNAs in gene expression regulation.	**PO1, PO7, PO6, PO8**	Lecture, Practical Demonstration, Quiz, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO7	Evaluate the impact of post-translational modifications (phosphorylation, glycosylation, ubiquitination) on protein function.	**PO1, PO3**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO8	Apply molecular biology concepts to understand genetic regulation, gene expression control, and its implications in disease and biotechnology.	**PO1, PO4, PO8**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
MMGEN 107 T	**Analytical Biotechnology**	**Mapped POs**	**Teaching-Learning Methodologies**	**Assessment Tools**
CO1	Explain the significance of analytical techniques in biotechnology and biomedical research.	**PO1, PO3**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO2	Describe the principles and applications of various spectroscopic techniques (UV-Vis, fluorescence, IR, Raman, NMR, MS) in biomolecular analysis.	**PO1, PO3**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.

CO3	Demonstrate proficiency in chromatography and electrophoresis techniques for separation and purification of biomolecules.	**PO1, PO3, PO4**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO4	Apply immunoassays (ELISA, RIA) and biosensors for disease diagnostics and biomarker detection.	**PO1, PO3, PO8**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO5	Utilize advanced analytical tools such as flow cytometry, microarrays, PCR, and NGS for genetic and proteomic analysis.	**PO1, PO3, PO7**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO6	Analyze data obtained from analytical techniques and interpret results for biomedical and biotechnological applications.	**PO1, PO2, PO6, PO5**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO7	Evaluate the role of analytical methodologies in pharmaceutical biotechnology, clinical diagnostics, and therapeutic development.	**PO1, PO6, PO7, PO8**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
MMGEN 108 T	**Genetic Engineering**	**Mapped POs**	**Teaching-Learning Methodologies**	**Assessment Tools**
CO1	Explain the history, principles, and applications of genetic engineering.	**PO1**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO2	Demonstrate proficiency in DNA and RNA extraction, PCR techniques, and molecular cloning strategies.	**PO1, PO3**	Lecture, Practical Demonstration, Assignment, Seminar Lecture	Internal Exam, University Exam (Theory and Practical), Seminar.
CO3	Analyze the role of restriction enzymes, ligases, and vectors in gene cloning and expression.	**PO1, PO2, PO3**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO4	Apply genome editing tools like CRISPR-Cas, RNA interference, and gene silencing for genetic modifications.	**PO1, PO3, PO4, PO7**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO5	Evaluate the applications of gene therapy in the treatment of inherited and acquired diseases.	**PO1, PO5, PO6, PO8**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO6	Assess the role of recombinant DNA technology in vaccine development and regenerative medicine.	**PO1, PO8**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO7	Discuss biosafety concerns, ethical issues, and regulatory frameworks in genetic engineering research.	**PO1, PO5**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
MMGEN 109 T	**Bioinformatics**	**Mapped POs**	**Teaching-Learning Methodologies**	**Assessment Tools**

CO1	Explain the principles and applications of bioinformatics in medical and biological research.	**PO1, PO3, PO7**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO2	Navigate major biological databases such as GenBank, UniProt, PDB, and KEGG for data retrieval and analysis.	**PO1, PO2, PO3**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO3	Perform sequence alignment using tools like BLAST and understand primer design strategies.	**PO1, PO3**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO4	Analyze protein structures using homology modeling, ab initio methods, and structure visualization tools.	**PO1, PO3, PO4**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO5	Apply network pharmacology concepts to study multi-target drugs and systems biology approaches.	**PO1, PO4, PO7**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO6	Demonstrate the fundamentals of molecular docking and drug-target interaction analysis.	**PO1, PO3, PO4, PO5**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
CO7	Utilize molecular dynamics simulation and QSAR modeling in drug discovery and optimization	**PO1, PO6, PO8**	Lecture, Practical Demonstration, Assignment, Seminar	Internal Exam, University Exam (Theory and Practical), Seminar.
MMGEN 110 P	**Practical Lab II (MMGEN 106 & MMGEN 107)**	**Mapped POs**	**Teaching-Learning Methodologies**	**Assessment Tools**
CO1	Perform centrifugation for biomolecule separation and Extract DNA and RNA from biological samples with high purity.	**PO1,PO2, PO3,PO4, PO5,PO6, PO8**	Practical and Problem Based Learning	Internal Exam, University Exam (Practical Exam), Viva
CO2	Analyze nucleic acids and proteins using UV-Visible spectroscopy.	**PO1,PO2, PO3,PO4, PO5,PO6, PO8**	Practical and Problem Based Learning	Internal Exam, University Exam (Practical Exam), Viva
CO3	Conduct Agarose gel electrophoresis for DNA visualization and integrity assessment.	**PO1,PO2, PO3,PO4, PO5,PO6, PO8**	Practical and Problem Based Learning	Internal Exam, University Exam (Practical Exam), Viva
CO4	Execute PCR and real-time PCR (qPCR) for molecular diagnostics and gene amplification.	**PO1,PO2, PO3,PO4, PO5,PO6, PO8**	Practical and Problem Based Learning	Internal Exam, University Exam (Practical Exam), Viva
CO5	Separate and analyze proteins using SDS-PAGE and Western blotting.	**PO1,PO2, PO3,PO4, PO5,PO6, PO8**	Practical and Problem Based Learning	Internal Exam, University Exam (Practical Exam), Viva
CO6	Apply HPLC techniques for the purification and separation of biomolecules.	**PO1,PO2, PO3,PO4, PO5,PO6, PO8**	Practical and Problem Based Learning	Internal Exam, University Exam (Practical Exam), Viva

CO7	Document and interpret results using gel documentation systems. Understand and apply analytical techniques in clinical and research settings.	**PO1,PO2, PO3,PO4, PO5,PO6, PO8**	Practical and Problem Based Learning	Internal Exam, University Exam (Practical Exam), Viva
CO8	Develop problem-solving skills for biomolecular analysis in medical biotechnology.	**PO1,PO2, PO3,PO4, PO5,PO6, PO7,PO8**	Practical and Problem Based Learning	Internal Exam, University Exam (Practical Exam), Viva
MMGEN 111 P	**Practical Lab III (MMGEN 108 & MMGEN 109)**	**Mapped POs**	**Teaching-Learning Methodologies**	**Assessment Tools**
CO1	Isolate plasmid DNA from bacteria and perform restriction digestion and ligation for genetic manipulation.	**PO1,PO2, PO3,PO4, PO5,PO6, PO8**	Practical and Problem Based Learning	Internal Exam, University Exam (Practical Exam), Viva
CO2	Conduct bacterial transformation and confirm the presence of recombinant DNA.	**PO1,PO2, PO3,PO4, PO5,PO6, PO8**	Practical and Problem Based Learning	Internal Exam, University Exam (Practical Exam), Viva
CO3	Perform RFLP analysis for genetic variation studies.	**PO1,PO2, PO3,PO4, PO5,PO6, PO8**	Practical and Problem Based Learning	Internal Exam, University Exam (Practical Exam), Viva
CO4	Demonstrate bacterial conjugation and understand horizontal gene transfer.	**PO1,PO2, PO3,PO4, PO5,PO6, PO8**	Practical and Problem Based Learning	Internal Exam, University Exam (Practical Exam), Viva
CO5	Retrieve and analyze nucleotide and protein sequences using NCBI and BLAST and Perform multiple sequence alignment and construct phylogenetic trees for evolutionary studies.	**PO1,PO2, PO3,PO4, PO5,PO6, PO8**	Practical and Problem Based Learning	Internal Exam, University Exam (Practical Exam), Viva
CO6	Utilize molecular docking tools to analyze protein-ligand interactions in drug discovery.	**PO1,PO2, PO3,PO4, PO5,PO6, PO8**	Practical and Problem Based Learning	Internal Exam, University Exam (Practical Exam), Viva
CO7	Apply homology modeling techniques to predict protein structures using Swiss-Model.	**PO1,PO2, PO3,PO4, PO5,PO6, PO8**	Practical and Problem Based Learning	Internal Exam, University Exam (Practical Exam), Viva
CO8	Integrate genetic engineering and bioinformatics approaches for biomedical and biotechnological research applications.	**PO1,PO2, PO3,PO4, PO5,PO6, PO7,PO8**	Practical and Problem Based Learning	Internal Exam, University Exam (Practical Exam), Viva
MMGEN 112 CP	**MGEN Directed Clinical Education-II**	**Mapped POs**	**Teaching-Learning Methodologies**	**Assessment Tools**
CO1	Demonstrate proficiency in diagnostic and therapeutic techniques used in hospital laboratories.	**PO1,PO3, PO5, PO8**	Pre-Clinical Orientation, Laboratory Hands-on	Daily log book, Direct observation and feedback by mentors

			Training, Problem-Based Learning.	
CO2	Effectively communicate and collaborate with healthcare professionals and patients.	**PO1,PO3, PO5, PO8**	Pre-Clinical Orientation, Laboratory Hands-on Training, Problem-Based Learning.	Daily log book, Direct observation and feedback by mentors
CO3	Apply QA and QC protocols in a regulated laboratory environment.	**PO1,PO3, PO5, PO8**	Pre-Clinical Orientation, Laboratory Hands-on Training, Problem-Based Learning.	Daily log book, Direct observation and feedback by mentors
CO4	Analyze and troubleshoot clinical and diagnostic challenges using biotechnological approaches.	**PO1,PO3, PO5, PO8**	Pre-Clinical Orientation, Laboratory Hands-on Training, Problem-Based Learning.	Daily log book, Direct observation and feedback by mentors
CO5	Understand and adhere to hospital regulatory standards and accreditation requirements (NABH/NABL).	**PO1,PO3, PO5, PO8**	Pre-Clinical Orientation, Laboratory Hands-on Training, Problem-Based Learning.	Daily log book, Direct observation and feedback by mentors
CO6	Develop decision-making skills for effective healthcare management and administration.	**PO1,PO3, PO5, PO8**	Pre-Clinical Orientation, Laboratory Hands-on Training, Problem-Based Learning.	Daily log book, Direct observation and feedback by mentors
CO7	Gain practical insights into biotechnology-based clinical applications and patient care.	**PO1,PO3, PO5, PO8**	Pre-Clinical Orientation, Laboratory Hands-on Training, Problem-Based Learning.	Daily log book, Direct observation and feedback by mentors
CO8	Prepare for professional roles in clinical research, diagnostics, and hospital-based biotechnology settings.	**PO1,PO3, PO5, PO8**	Pre-Clinical Orientation, Laboratory Hands-on Training, Problem-Based Learning.	Daily log book, Direct observation and feedback by mentors
SEC 001 T	**Innovation and Entrepreneurship**	**Mapped POs**	**Teaching-Learning Methodologies**	**Assessment Tools**
CO1	Students will grasp the concepts of innovation, its ecosystem, and the role of various stakeholders such as government policies, startups, and innovation hubs.	**PO5, PO8**	Lecture, Practical, Quiz, Assignment, Seminar, group discussion	Theory exam, Practical exam, Seminar, Journal club, case study presentation, station exercise
+CO2	Cultivating an entrepreneurial mindset and leadership qualities necessary for driving innovation and leading ventures.	**PO5, PO8**	Lecture, Practical, Quiz, Assignment, Seminar, group discussion	Theory exam, Practical exam, Seminar, Journal club, case study presentation, station exercise
CO3	Understanding the intersection of technology and innovation and leveraging emerging technologies for entrepreneurial ventures	**PO1, PO5, PO6, PO8**	Lecture, Practical, Quiz, Assignment, Seminar, group discussion	Theory exam, Practical exam, Seminar, Journal club, case study presentation, station exercise
SEC 002 T	**Comprehensive Molecular Diagnostics and Advanced Gene Expression Analysis (NPTEL)**	**Mapped POs**	**Teaching-Learning Methodologies**	**Assessment Tools**

CO1	Explain the principles of molecular diagnostics and its role in modern healthcare.	**PO1, PO2, PO3, PO5**	Lecture, Assignment	Online NPTEL MCQ test
CO2	Describe the significance of biomarkers in disease detection and prognosis.	**PO1, PO4, PO8**	Lecture, Assignment	Online NPTEL MCQ test
CO3	Demonstrate proper methods for sample collection, storage, and processing in a diagnostic lab.	**PO1, PO3, PO5, PO7**	Lecture, Assignment	Online NPTEL MCQ test
CO4	Perform molecular diagnostic techniques such as PCR, ELISA, and immunohistochemistry.	**PO1, PO6, PO3**	Lecture, Assignment	Online NPTEL MCQ test
CO5	Analyze the applications of molecular diagnostics in infectious diseases and cancer.	**PO1, PO8**	Lecture, Assignment	Online NPTEL MCQ test
CO6	Evaluate the role of emerging diagnostic technologies like NGS and CRISPR-based methods.	**PO1, PO7**	Lecture, Assignment	Online NPTEL MCQ test
CO7	Apply biosafety and biomedical waste disposal protocols in a molecular diagnostics lab.	**PO1, PO5**	Lecture, Assignment	Online NPTEL MCQ test

OUTLINE OF COURSE CURRICULUM
M. Sc. MEDICAL GENETICS
Semester I

Code No.	Core Course	Credits/Week					Hrs/Semester					Marks		
		Lecture (L)	Tutorial (T)	Practical (P)	Clinical Posing/ Rotation (CP)	Total Credits (C)	Lecture (L)	Tutorial (T)	Practical (P)	Clinical Posing/ Rotation (CP)	Total (hrs.)	Internal Assement (IA)	Semester End Exam (SEE)	Total
Discipiline Specific Core Theory														
MMGEN 101 T	Cell Biology	4	-	-	-	**4**	60	-	-	-	**60**	**20**	**80**	**100**
MMGEN 102 T	Immunology	3	-	-	-	**3**	45	-	-	-	**45**	**20**	**80**	**100**
MMGEN 103 T	Biomolecules	3	-	-	-	**3**	45	-	-	-	**45**	**20**	**80**	**100**
CC 001 T	Research Methodology & Biostatistics (Core Course)	3	-	-	-	**3**	45	-	-	-	**45**	-	**50**	**50**
Discipiline Specific Core Practical														
MMGEN 104 P	Practical Lab I (MMGEN101 & MMGEN102)	-	-	8	-	**4**	-	-	120	-	**120**	**10**	**40**	**50**
MMGEN 105 CP	MGEN Directed Clinical Education-I	-	-	-	9	**3**	-	-	-	135	**135**	-	**50**	**50**
CC 001 P	Research Methodology & Biostatistics (Core Course)	-	-	4	-	**2**	-	-	60	-	**60**	-	**50**	**50**
Total		**13**	**0**	**12**	**9**	**22**	**195**	**0**	**180**	**135**	**510**	**70**	**430**	**500**

OUTLINE OF COURSE CURRICULUM
M. Sc. MEDICAL GENETICS
Semester II

Code No.	Core Course	Credits/Week					Hrs/Semester					Marks		
		Lecture (L)	Tutorial (T)	Practical (P)	Clinical Posing/ Rotation (CP)	Total Credits (C)	Lecture (L)	Tutorial (T)	Practical (P)	Clinical Posing/ Rotation (CP)	Total (hrs.)	Internal Assement (IA)	Semester End Exam (SEE)	Total
Discipiline Specific Core Theory														
MMGEN 106 T	Molecular Biology	3	-	-	-	**3**	45	-	-	-	**45**	**20**	**80**	**100**
MMGEN 107 T	Analytical Biotechnology	3	-	-	-	**3**	45	-	-	-	**45**	**20**	**80**	**100**
MMGEN 108 T	Genetic Engineering	3	-	-	-	**3**	45	-	-	-	**45**	**20**	**80**	**100**
MMGEN 109 T	Bioinformatics	3	-	-	-	**3**	45	-	-	-	**45**	**20**	**80**	**100**
Discipiline Specific Core Practical														
MMGEN 110 P	Practical Lab II (MMGEN 106 & MMGEN107)	-	-	4	-	**2**	-	-	60	-	**60**	**10**	**40**	**50**
MMGEN 111 P	Practical Lab III (MMGEN 108 & MMGEN 109)	-	-	4	-	**2**	-	-	60	-	**60**	**10**	**40**	**50**
MMGEN 112 CP	MGEN Directed Clinical Education-II	-	-	-	12	**4**	-	-	-	180	**180**	-	**50**	**50**
Skill Ehancement Course														
SEC 001 T	Innovation and Entrepreneurship	3	-	-	-	**3**	45	-	-	-	**45**	-	**100**	**100**
SEC 002 T	Comprehensive Molecular Diagnostics and Advanced Gene Expression Analysis (NPTEL)													
Total		**15**	**0**	**8**	**12**	**23**	**225**	**0**	**120**	**180**	**525**	**100**	**550**	**650**

FIRST YEAR

M. Sc. MEDICAL GENETICS

SEMESTER-I

Code No.	Core Subjects
Discipline Specific Core Theory	
MMGEN 101 T	Cell Biology
MMGEN 102 T	Immunology
MMGEN 103 T	Biomolecules
CC 001 T	Research Methodology & Biostatistics (Core Course)
Discipline Specific Core Practical	
MMGEN 104 P	Practical Lab I – (MMGEN 101 & MMGEN 102)
MMGEN 105 CP	MGEN Directed Clinical Education-I
CC 001 P	Research Methodology & Biostatistics (Core Course)

Name of the Program	M. Sc. Medical Genetics
Semester	Semester I
Name of the Subject	Cell Biology
Subject Code	MMGEN 101 T

Course Objective	• To provide fundamental knowledge of cell structure, function, and organization in both prokaryotic and eukaryotic systems. • To understand the types of mammalian cells, their interactions, and the role of cellular communication in development and physiology. • To explore mechanisms of cellular transport, protein trafficking, and signal transduction pathways. • To analyze the regulatory aspects of the cell cycle, programmed cell death, and implications in diseases like cancer. • To develop an integrative understanding of cellular functions, differentiation, and their biomedical applications.
Course Outcomes	After completing the course, students will be able to: • Differentiate between prokaryotic and eukaryotic cells based on structural and functional aspects. • Describe the organization and roles of cellular organelles and the cytoskeleton in maintaining cell integrity and function. • Explain mammalian cell types, their differentiation pathways, and their significance in tissue architecture. • Analyze various cell-cell interactions, junctions, and extracellular matrix components in maintaining cellular communication. • Illustrate mechanisms of membrane transport, vesicular trafficking, and the impact of cellular signaling pathways in physiological processes. • Evaluate the regulation of the cell cycle, mechanisms of cell death, and their roles in embryogenesis, development, and disease pathology. • Apply knowledge of cellular biology to understand stem cell biology, regenerative medicine, and cancer biology.

Sr. No.	Topics	No. of Hrs.
1.	**Introduction to Cell Biology:** Evolution of Cell Theory, Typical Prokaryotic Cell, Typical Eukaryotic Cell (Membrane: structure and composition, Membrane proteins: types, topology, and functions, Mitochondria: structure, function, and genome, Chloroplasts and other plastids, Nucleus: structure and function, Endoplasmic reticulum: structure, Golgi apparatus: structure, Lysosomes and peroxisomes: structure and function, Vacuoles: structure and function, Cytoskeleton), Difference between prokaryotes and eukaryotes.	**15**
2.	**Cell Types and Cellular Interactions :** Mammalian cell types and differentiation (Epithelial cells: structure and function, Connective tissue cells: structure and function, Neural cells: types, structure and function, Muscle cells: structure and function, Stem cells and progenitors: Adult, Embryonic and Umbilical Stem Cells), Cell-cell interactions, Cell junctions: Tight Junctions, Gap-Junction, Desmosomes, Hemidesmosomes, Cell adhesion molecules, Extracellular matrix: composition and function.	**15**

3.	**Cell Transport and Signaling :** Transport across membranes, Vesicular transport and protein trafficking, Signaling molecules, Signal transduction receptors, Protein kinases and phosphatases, Cell signaling cascades, Crosstalk between signaling pathways, Embryonic Development pathways, Nerve Conduction	**15**
4.	**Cell Cycle :** Cell cycle phases and regulation, Cyclins and cyclin-dependent kinases, Checkpoints and control mechanisms, Mitosis and meiosis, Programmed cell death, Apoptosis, Autophagy, Necrosis, Gametogenesis and Fertilization, Cell cycle disorders and cancer	**15**
Total		**60 hrs**

Reference Books:

1. **Molecular Biology of the Cell** – Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter
2. **Cell and Molecular Biology: Concepts and Experiments** – Gerald Karp
3. **The Cell: A Molecular Approach** – Geoffrey M. Cooper, Robert E. Hausman
4. **Essential Cell Biology** – Bruce Alberts, Karen Hopkin, Alexander Johnson
5. **The Biology of Cancer** – Robert A. Weinberg

Name of the Program	M. Sc. Medical Genetics
Semester	Semester I
Name of the Subject	Immunology
Subject Code	MMGEN 102 T

Course Objective	• To provide a comprehensive understanding of the fundamental concepts of immunology, including innate and adaptive immunity. • To study the cellular and molecular components of the immune system, including immune organs, cells, and signaling pathways. • To explore immune mechanisms such as antigen recognition, antigen processing, complement activation, and immune regulation. • To analyze immune system disorders, including hypersensitivity, autoimmunity, immunodeficiency, and immune responses in transplantation and cancer. • To understand the applied aspects of immunology in diagnostics, vaccine development, immunotherapy, and infectious disease management.
Course Outcomes	After completing this course, students will be able to: • Describe the key components and mechanisms of innate and adaptive immunity. • Differentiate immune system organs and cell types, explaining their roles in immune responses. • Explain antigen-antibody interactions, major histocompatibility complex (MHC) molecules, and antigen presentation mechanisms. • Analyze immune signaling pathways, the complement system, and cytokine-mediated regulation of immune responses. • Evaluate immunological disorders such as autoimmunity, hypersensitivity, and immunodeficiency diseases. • Apply immunological principles in clinical diagnostics, transplant immunology, tumor immunology, and infectious disease management. • Discuss vaccine development strategies, monoclonal antibody production, CAR-T cell therapy, and immunotherapeutic advancements. • Demonstrate knowledge of immunogenetics and antibody engineering for therapeutic and research applications.

Sr. No.	Topics	No. of Hrs.
1	**Fundamentals of Immunology:** Innate and Adaptive Immunity: Overview, components, and mechanisms. Immune System Organs and Cells: Primary and secondary lymphoid organs, Immune Cells, antigen-presenting cells and Production and Maturation of T-cells and B-cells. Antigens and Antibodies: Structure, function, and diversity. MHC molecules and Antigen Presentation: MHC types, antigen processing pathways. Immunological Disorders: Autoimmunity, hypersensitivity, and immunodeficiency.	**15**

2	**Molecular and Cellular Immunology:** Immune Cell Signaling: Key pathways in lymphocyte activation and differentiation. Complement System: Activation pathways and biological significance. Vaccinology: Principles, types of vaccines, and vaccine development strategies. Immunogenetics: Genetic basis of immune responses. Cytokines and Chemokines: Types, roles, and signaling pathways.	**15**
3	**Applied Immunology:** Clinical Immunology: Diagnostic assays (e.g., ELISA, Western blot, Flow cytometry). Transplantation Immunology: Types, mechanisms, and challenges. Tumor Immunology: Immune evasion, immunotherapy strategies. Infectious Disease Immunology: Immune responses to bacterial, viral, and parasitic infections. Immunotherapeutics: Monoclonal antibodies, CAR-T cells, cytokine therapy. Antibody Engineering: Monoclonal and polyclonal antibodies, hybridoma technology.	**15**
Total		**45 hrs**

Reference Books:

1. **Janeway's Immunobiology** – Kenneth Murphy, Casey Weaver
2. **Kuby Immunology** – Judy Owen, Jenni Punt, Sharon Stranford
3. **Roitt's Essential Immunology** – Peter J. Delves, Seamus J. Martin, Dennis R. Burton
4. **Cellular and Molecular Immunology** – Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai
5. **Fundamental Immunology** – William E. Paul

Name of the Program	M. Sc. Medical Genetics
Semester	Semester I
Name of the Subject	Biomolecules
Subject Code	MMGEN 103 T

Course Objective	• To provide fundamental knowledge of biomolecules, their structure, function, and physiological significance. • To understand enzyme kinetics, mechanisms, regulation, and bioenergetics in cellular metabolism. • To explore metabolic pathways of carbohydrates, lipids, proteins, and nucleotides, along with their regulation. • To analyze the biochemical basis of metabolic disorders and disease pathophysiology. • To apply biochemical principles in clinical diagnostics and understand the role of biochemical markers in diseases.
Course Outcomes	After completing this course, students will be able to: • Describe the structure and function of carbohydrates, proteins, lipids, and nucleic acids. • Explain the concepts of pH, buffers, and their physiological relevance in biological systems. • Analyze enzyme kinetics, inhibition mechanisms, and regulatory pathways in metabolic reactions. • Illustrate energy production through bioenergetics, the electron transport chain, and oxidative phosphorylation. • Compare key metabolic pathways, including glycolysis, gluconeogenesis, lipid metabolism, and amino acid catabolism. • Evaluate the biochemical basis of metabolic disorders such as diabetes, obesity, and dyslipidemia. • Interpret liver and kidney function tests, their clinical significance, and hormonal regulation disorders. • Apply biochemical principles to understand disease markers in cancer, cardiovascular diseases, and oxidative stress-related disorders.

Sr. No.	Topics	No. of Hrs.
1	**Fundamentals of Biochemistry:** Structure and function of biomolecules: Carbohydrates, Proteins, Lipids, and Nucleic Acids, pH, buffers, and physiological significance, Water and electrolyte balance, Enzyme classification, kinetics, and inhibition, Mechanism of enzyme action and regulation, Bioenergetics and ATP generation, Mitochondrial electron transport chain and oxidative phosphorylation.	**15**

2	**Metabolism and its Regulation:** Carbohydrate metabolism: Glycolysis, Gluconeogenesis, TCA cycle, Glycogen metabolism, Lipid metabolism: Beta-oxidation, Fatty acid biosynthesis, Lipoprotein metabolism, Protein and amino acid metabolism: Transamination, Deamination, Urea cycle, Nucleotide metabolism and disorders.	**15**
3	**Clinical Biochemistry and Disease Pathophysiology:** Biochemical basis of metabolic disorders (Diabetes, Obesity, Dyslipidemia). Liver function tests, Kidney function tests, and their clinical relevance. Hormonal regulation and disorders (Thyroid, Adrenal, Pancreatic hormones). Biochemical markers in cancer and cardiovascular diseases. Oxidative stress and free radicals in disease mechanisms. Inborn errors of metabolism: Carbohydrate metabolism disorders, protein metabolism disorders, Lipid metabolism disorders, Lysosomal storage disorders.	**15**
Total		**45 hrs**

Reference Books:

1. **Lehninger Principles of Biochemistry** – David L. Nelson, Michael M. Cox
2. **Biochemistry** – Jeremy M. Berg, John L. Tymoczko, Lubert Stryer
3. **Harper's Illustrated Biochemistry** – Victor W. Rodwell, David Bender
4. **Biochemistry** – Donald Voet, Judith G. Voet
5. **Enzymes: Biochemistry, Biotechnology, and Clinical Chemistry** – Trevor Palmer

Name of the Program	M. Sc. Medical Genetics
Semester	Semester I
Name of the Subject	Research Methodology & Biostatistics (Core Course)
Subject Code	CC 001 T

Teaching Objective	• The course is intended to give an overview of research and statistical models commonly used in medical and bio-medical sciences. The goal is to impart an intuitive, understanding and working knowledge of research designs and statistical analysis. The strategy would be to simplify, analyze the treatment of statistical inference and to focus primarily on how to specify and interpret the outcome of research.
Learning Outcomes	• Student will be able to understand develop statistical models, research designs with the understating of background theory of various commonly used statistical techniques as well as analysis, interpretation & reporting of results and use of statistical software.

Sr. No	Topic	No. of Hrs.
A	**Research Methodology:**	**23**
1	**Scientific Methods of Research**: Definition of Research, Assumptions, Operations and Aims of Scientific Research. Research Process, Significance and Criteria of Good Research, Research Methods versus Methodology	4
2	**Research Designs**: Observational Studies: Descriptive, explanatory, and exploratory, Experimental Studies: Pre-test design, post-test design, Follow-up or longitudinal design, Cohort Studies, Case – Control Studies, Cross-sectional studies, Intervention studies.	5
3	**Sampling Designs**: Census and Sample Survey, Need and importance for Sampling, Implications of a Sample Design, Different Types of Sample Designs (Probability sampling and non-probability sampling), Systematic sampling, Stratified sampling, Cluster sampling, Multi-stage sampling, Sampling with probability proportional to size, Sequential sampling.	5
4	**Measurement in research**: Measurement Scales, Sources of Error in Measurement,	3
5	**Methods of Data Collection**: Types of data, Collection of Primary Data, Observation Method, Interview Method	4
6	Research Ethics and plagiarism	2
B	**Biostatistics**	**22**
7	**Data Presentation**: Types of numerical data: Nominal, Ordinal, Ranked, Discrete and continuous. Tables: Frequency distributions, Relative frequency, Graph: Bar charts, Histograms, Frequency polygons, scatter plots, line graphs	3
8	**Measures of Central Tendency and Dispersion**: Mean, Median, Mode, Range, Inter quartile range, variance and Standard Deviation, Coefficient of variation, grouped mean and grouped standard deviation (including merits and demerits).	3
9	**Testing of Hypotheses**: Definition, Basic Concepts, Procedure for Hypothesis Testing, power of test, Normal distribution, Parametric Tests including Z-test, t-test, and ANOVA	4
10	**Chi-square Test**: Chi-square as a Non-parametric Test, Applications.	2

11	**Measures of Relationship**: Correlation and Simple Regression Analysis	3
12	**Non-parametric test**: Sign test, Wilcoxon signed-Rank Test, Wilcoxon Rank Sum Test: Mann-Whitney U test, Kruskal Walli's test, Friedman's test, and Spearman Rank correlation test.	3
13	**Vital Health Statistics**: rate, crude rate, age specific rate, Measurement of fertility, Rate, Measures of mortality.	4
Total		**45 hrs**

CC 001 P–Research Methodology & Biostatistics

Sr. No.	Topics	No. of Hrs.
A	**Research Methodology**	
1	Research Article Presentation (Seminar)	**5**
B	**Biostatistics**	
2	Data Presentation	**4**
3	Measures of Central Tendency and Dispersion	**6**
4	Testing of Hypotheses	**16**
5	Chi-square Test	**4**
6	Measures of Relationship	**6**
7	Analysis of Variance	**5**
8	Non parametric or Distribution-free Tests	**8**
9	Computer Application Using Statistical Software including SPSS	**6**
Total		**60 hrs**

Reference Books:

1. Daniel WW. Biostatistics: A foundation for analysis in the health sciences. 10th ed. Wiley; 2013.
2. Gupta SC, Kapoor VK. Fundamentals of mathematical statistics. Sultan Chand & Sons; 2020 Sep.
3. Kothari CR, Garg G. Research methodology: Methods and techniques.2019.
4. Mahajan BK. Methods in biostatistics for medical students and research workers. 7th ed. Jaypee Brothers Medical Publishers; 2010.
5. Murthy MN. Sampling theory and methods. Statistical Publishing Society; 1967.
6. Singh YK. Fundamental of research methodology and statistics. New Age International; 2006.

Resolution No. 3.5 of Academic Council (AC-51/2025):

Resolved to approve the submitted list of recommended books for M.Sc. Clinical Nutrition and the course on **Biostatistics and Research Methodology** [ANNEXURE-7].

Annexure-7 of AC-51/2025

Biostatistics & Research Methodology Books List

Subject	Book Name	Author
Biostatistics & Research Methodology	Biostatistics: A Foundation for Analysis in the Health Sciences (10th ed.)	Daniel WW.
	Biostatistical Analysis (5th ed.)	Zar JH.
	Research Methodology: Methods and Techniques	Kothari CR, Garg G.
	Methods in Biostatistics for Medical Students and Research Workers (7th ed.)	Mahajan BK.
	Sampling Theory and Methods	Murthy MN.
	Fundamentals of Research Methodology and Statistics	Singh YK.
	Fundamentals of Biostatistics (8th ed.)	Rosner B.
	An Introduction to Medical Statistics (4th ed.)	Bland M.

Name of the Program	M. Sc. Medical Genetics
Semester	Semester I
Name of the Subject	Practical Lab I (MMGEN 101 & MMGEN 102)
Subject Code	MMGEN 104 P

Course Objective	• Provide hands-on training in microscopy techniques for analyzing cell structures and blood components. • Develop proficiency in cell counting, viability assays, and differential staining methods. • Train students in immunological techniques such as antigen-antibody interactions, blood typing, and immunodiagnostic assays. • Enhance skills in the identification of blood cells and the study of lymphoid organ microanatomy. • Introduce students to widely used immunological diagnostic tests such as ELISA, Western blotting, and serological assays.
Course Outcomes	After completing this course, students will be able to: • Operate a microscope efficiently and analyze different cell types and structures along with viability and counting. • Conduct blood group typing using haemagglutination tests. • Understand and demonstrate the principles of immunodiagnostic tests such as VDRL/Widal (demonstration-based). • Analyze the histological organization of lymphoid organs. • Perform antigen-antibody interaction studies using ELISA. • Interpret Western blotting results for protein analysis (demonstration-based). • Apply immunological techniques for disease diagnosis using commercial kits. • Correlate theoretical knowledge with practical applications in immunology and cellular biology.

Sr. No.	Topics	No. of Hrs.
1	Microscopy and Cell Structure Analysis	**12**
2	Cell counting (using Haemocytometer) a) WBC- Differential Staining b) Total Count	**12**
3	Cell Viability Assay- (using Typhan blue Stain)	**12**
4	Identification of Blood Cells by Peripheral Blood Smear	**12**
5	Blood group typing using haemagglutination tests.	**12**
6	VDRL test (Demonstration) /Widal test (Demonstration)	**12**
7	Immunodiagnostics (demonstration using commercial kits)	**12**
8	Lymphoid organs and their microscopic organization	**12**
9	Antigen-Antibody Interaction by ELISA	**12**
10	Western-blotting (Demonstration)	**12**
Total		**120 hrs**

Name of the Program	M. Sc. Medical Genetics
Semester	Semester I
Name of the Subject	MGEN Directed Clinical Education-I
Subject Code	MMGEN 105 CP

Course Objective	• To provide hands-on exposure to diagnostic and therapeutic procedures in a hospital setting. • To enhance students' ability to interact with patients and healthcare professionals, fostering practical understanding of medical biotechnology applications. • To Train students in quality assurance (QA) and quality control (QC) practices in NABH- and NABL-accredited laboratories. • To develop problem-solving skills for addressing clinical and healthcare management challenges. • To equip students with knowledge of regulatory standards, hospital administration, and healthcare best practices. • To strengthen their competency for careers in clinical diagnostics, research, and hospital-based biotechnology applications.
Course Outcomes	After completing this course, students will be able to: • Demonstrate proficiency in diagnostic and therapeutic techniques used in hospital laboratories. • Effectively communicate and collaborate with healthcare professionals and patients. • Apply QA and QC protocols in a regulated laboratory environment. • Analyze and troubleshoot clinical and diagnostic challenges using biotechnological approaches. • Understand and adhere to hospital regulatory standards and accreditation requirements (NABH/NABL). • Develop decision-making skills for effective healthcare management and administration. • Gain practical insights into biotechnology-based clinical applications and patient care. • Prepare for professional roles in clinical research, diagnostics, and hospital-based biotechnology settings.

Community orientation & clinical visit (Including related Practical to the Parent course)

Medical Genetics students will gain extensive clinical exposure in a hospital setting, allowing them to refine their skills in various diagnostic and therapeutic procedures. Under the supervision of experienced professionals, they will progressively interact with patients and healthcare personnel, enhancing their understanding of medical genetics applications in real-world scenarios. Their training will encompass quality assurance (QA) and quality control (QC) in NABH and NABL-accredited laboratories, ensuring they are well-versed in regulatory standards and best practices. Additionally, students will develop problem-solving skills and learn to address complications in healthcare management. This hands-on experience will also prepare them for administrative roles in hospital settings, equipping them with the knowledge, skills, and aptitude required for effective healthcare delivery. Through this structured clinical education, students will be immersed in a dynamic hospital environment, strengthening their competency in medical genetics. **(Total -135 hrs.)**

FIRST YEAR

M.Sc. Medical Genetics

SEMESTER- II

Code No.	Core Subjects
Discipline Specific Core Theory	
MMGEN 106 T	Molecular Biology
MMGEN 107 T	Analytical Biotechnology
MMGEN 108 T	Genetic Engineering
MMGEN 109 T	Bioinformatics
Discipline Specific Core Practical	
MMGEN 110 P	Practical Lab II (MMGEN 106 & MMGEN 107)
MMGEN 111 P	Practical Lab III (MMGEN 108 & MMGEN 109)
MMGEN 112 CP	MGEN Directed Clinical Education-II
Skill Enhancement Course	
SEC 001 T	Innovation and Entrepreneurship
SEC 002 T	Comprehensive Molecular Diagnostics and Advanced Gene Expression Analysis (NPTEL)

Name of the Program	M. Sc. Medical Genetics
Semester	Semester II
Name of the Subject	Molecular Biology
Subject Code	MMGEN 106 T

Course Objective	• To provide a comprehensive understanding of the central dogma and molecular mechanisms governing genetic information flow. • To study the structure and functions of DNA and RNA, along with variations such as SNPs, STRs, and transposons. • To explore the mechanisms of DNA replication, damage, and repair in prokaryotic and eukaryotic systems. • To analyze transcription and translation processes, their regulation, and post-transcriptional and post-translational modifications. • To understand gene expression regulation mechanisms in prokaryotes and eukaryotes, including operon models, epigenetics, and non-coding RNAs.
Course Outcomes	After completing this course, students will be able to: • Explain the central dogma of molecular biology and its significance in gene expression. • Describe the structure and function of DNA and RNA, including their types, modifications, and regulatory elements. • Compare prokaryotic and eukaryotic DNA replication mechanisms, including DNA damage and repair processes. • Illustrate transcription and translation mechanisms, their regulation, and RNA processing events such as splicing and RNA interference. • Analyze operon models (lac, trp, and ara operons) and their regulation mechanisms in prokaryotes. • Discuss epigenetic modifications, chromatin remodeling, and the role of non-coding RNAs in gene expression regulation. • Evaluate the impact of post-translational modifications (phosphorylation, glycosylation, ubiquitination) on protein function. • Apply molecular biology concepts to understand genetic regulation, gene expression control, and its implications in disease and biotechnology.

Sr. No.	Topics	No. of Hrs.
1	**Introduction to molecular biology:** Central Dogma its importance and functions, DNA and RNA: Structure, types, and functions, Repetitive DNA, single nucleotide polymorphisms (SNPs), and short tandem repeats (STRs), Transposons. DNA Replication Prokaryotic vs. eukaryotic replication mechanisms. DNA Damage and Repair. Models of homologous recombination: Holliday junction, double-strand break repair model.	**15**
2	**Transcription and Translation:** Prokaryotic Transcription, Eukaryotic Transcription, General and specific transcription factors. Regulatory elements: Enhancers, silencers, and insulators. Mechanisms of transcription regulation, RNA splicing and processing, Alternate splicing and its regulation, Post-transcriptional gene silencing (RNA interference). Prokaryotic vs. eukaryotic translation mechanisms. Regulation of	**15**

	translation: Translational control in prokaryotes and eukaryotes. Co- and post-translational modifications of proteins, Phosphorylation, glycosylation, ubiquitination, and proteolytic cleavage.	
3	**Regulation of Gene Expression:** Prokaryotic Regulation, Operon theory: lac operon, trp operon, and ara operon. Mechanisms of regulation: Induction, repression, attenuation, positive and negative control. Catabolite repression, cAMP-CRP interaction. Eukaryotic Regulation, Epigenetic regulation: DNA methylation, histone modification. Role of non-coding RNAs (e.g., miRNAs, lncRNAs) in gene expression. Chromatin remodeling complexes (e.g., SWI/SNF).	**15**
Total		**45 hrs**

Reference Books

1. **Molecular Biology of the Gene** – James D. Watson, Tania A. Baker
2. **Molecular Biology** – Robert F. Weaver
3. **Lewin's Genes XII** – Jocelyn E. Krebs, Elliott S. Goldstei
4. **Molecular Biology of the Cell** – Alberts, Johnson, Lewis, Raff, Roberts, Walter
5. **Advanced Molecular Biology**- R. M. Twyman.

Name of the Program	M. Sc. Medical Genetics
Semester	Semester II
Name of the Subject	Analytical Biotechnology
Subject Code	MMGEN 107 T

Course Objective	• To introduce fundamental analytical techniques essential for biotechnology research and diagnostics. • To explore spectroscopic methods such as UV-Vis, fluorescence, IR, Raman, NMR, and MS for biomolecular characterization. • To understand chromatographic and electrophoretic separation techniques used in clinical and pharmaceutical biotechnology. • To provide knowledge of immunoassays and biosensors for biomolecule detection and diagnostics. • To familiarize students with advanced analytical techniques such as flow cytometry, PCR, and NGS for biomedical applications.
Course Outcomes	After completing this course, students will be able to: • Explain the significance of analytical techniques in biotechnology and biomedical research. • Describe the principles and applications of various spectroscopic techniques (UV-Vis, fluorescence, IR, Raman, NMR, MS) in biomolecular analysis. • Demonstrate proficiency in chromatography and electrophoresis techniques for separation and purification of biomolecules. • Apply immunoassays (ELISA, RIA) and biosensors for disease diagnostics and biomarker detection. • Utilize advanced analytical tools such as flow cytometry, microarrays, PCR, and NGS for genetic and proteomic analysis. • Analyze data obtained from analytical techniques and interpret results for biomedical and biotechnological applications. • Evaluate the role of analytical methodologies in pharmaceutical biotechnology, clinical diagnostics, and therapeutic development.

Sr. No.	Topics	No. of Hrs.
1	**Introduction to Analytical Biotechnology:** Importance of analytical techniques in biotechnology. Sample preparation and handling for biological analysis. Quality control and validation in biotechnology. UV-Visible spectroscopy and its applications in biomolecule quantification. Fluorescence spectroscopy and its use in protein/DNA analysis. Infrared (IR) and Raman spectroscopy for biomolecular characterization. Nuclear Magnetic Resonance (NMR) spectroscopy in structural biology. Mass spectrometry (MS) and its applications in proteomics and metabolomics. Centrifugation, Preparative and analytical centrifuges; RCF, zonal, equilibrium and density gradients	**15**

2	**Chromatographic and Electrophoresis techniques:** Principles of chromatography: Adsorption, partition, ion exchange, size exclusion. High-Performance Liquid Chromatography (HPLC) and Gas Chromatography (GC). Thin Layer Chromatography (TLC) and Paper Chromatography. Affinity chromatography and its applications in protein purification. Applications of chromatography in clinical and pharmaceutical biotechnology. Gel electrophoresis (Agarose, PAGE, SDS-PAGE), Capillary electrophoresis and its biomedical applications, Western, Southern, and Northern blotting techniques, Microarrays and their applications in genomics and transcriptomics.	**15**
3	**Immunoassays, Biosensors and Advance Analytical techniques:** ELISA: Principles, types, and applications in medical diagnostics. Radioimmunoassay (RIA) and its clinical applications. Biosensors: Types (optical, electrochemical, piezoelectric) and applications in diagnostics. Surface Plasmon Resonance (SPR) for biomolecular interactions. Flow cytometry and its applications in immunophenotyping. PCR and Next-generation sequencing (NGS) for genetic analysis.	**15**
Total		**45 hrs**

Reference Books:

1. Biophysical chemistry-Principles and techniques, Upadhyay; Upadhyay and Nath, H Himalaya Publishing House
2. Physical biochemistry- applications to biochemistry and molecular biology, David
3. Freifelder, Freeman and Co.
4. **Principles of Instrumental Analysis** – Douglas A. Skoog, F. James Holler, Stanley R. Crouch
5. Tools and techniques of biotechnology, Mousumi Debnath, Pointer Publishers

Name of the Program	M. Sc. Medical Genetics
Semester	Semester II
Name of the Subject	Genetic Engineering
Subject Code	MMGEN 108 T

Course Objective	• To provide an understanding of the fundamental principles and historical significance of genetic engineering. • To introduce molecular tools, gene cloning strategies, and expression systems used in recombinant DNA technology. • To explore genome editing technologies such as CRISPR-Cas, TALENs, and ZFNs and their applications. • To familiarize students with gene therapy approaches and their role in treating genetic disorders. • To discuss transgenic research, including applications in medicine, agriculture, and biotechnology. • To emphasize ethical, biosafety, and regulatory aspects of genetic modifications.
Course Outcomes	After completing this course, students will be able to: • Explain the history, principles, and applications of genetic engineering. • Demonstrate proficiency in DNA and RNA extraction, PCR techniques, and molecular cloning strategies. • Analyze the role of restriction enzymes, ligases, and vectors in gene cloning and expression. • Apply genome editing tools like CRISPR-Cas, RNA interference, and gene silencing for genetic modifications. • Evaluate the applications of gene therapy in the treatment of inherited and acquired diseases. • Assess the role of recombinant DNA technology in vaccine development and regenerative medicine. • Discuss biosafety concerns, ethical issues, and regulatory frameworks in genetic engineering research.

Sr. No.	Topics	No. of Hrs.
1	**Introduction to Genetic Engineering :** History and scope of genetic engineering, Gene cloning strategies and molecular tools, Applications in medicine, agriculture, and industry, Enzymes used in Genetic Engineering, Restriction enzymes and DNA ligases, DNA and RNA extraction technique, PCR and its applications (rRT-PCR, qPCR, digital PCR). Ethical and biosafety considerations in transgenic research.	**15**
2	**Gene Cloning and Expression Systems:** DNA Transfer in Microbes, Transformation, transduction and conjugation. Vectors: Plasmids, bacteriophages, cosmids, BACs, YACs. Expression systems: Bacterial, yeast, insect, and mammalian cells. Reporter genes and their applications.	**15**
3	**Genome Editing and Gene Therapy:** Principles of gene editing: CRISPR-Cas, TALENs, and ZFNs, RNA interference (RNAi) and gene silencing, Applications of gene therapy in genetic and acquired diseases, Generation of knockout and knock-in models, Stem cell and	**15**

	regenerative medicine application, Transgenic animals and plants: Methods and applications. Mechanism and Production of recombinant Vaccines. Implications of human genome editing.	
Total		**45 hrs**

Reference Books:

1. **Principles of Gene Manipulation and Genomics** – Sandy B. Primrose & Richard Twyman
2. **Molecular Cloning: A Laboratory Manual** – Michael R. Green & Joseph Sambrook
3. **Gene Cloning and DNA Analysis: An Introduction** – T. A. Brown
4. **Genome Editing: Principles and Applications** – Krishnarao Appasani
5. **Biotechnology and Biosafety** – R. S. Thakur

Name of the Program	M. Sc. Medical Genetics
Semester	Semester II
Name of the Subject	Bioinformatics
Subject Code	MMGEN 109 T

Course Objective	• To introduce the fundamentals of bioinformatics and its applications in medical research. • To familiarize students with major biological, protein, medical, and small molecule databases. • To develop an understanding of sequence alignment techniques and structure prediction methods. • To provide knowledge on computational approaches used in drug discovery and network pharmacology. • To enable students to perform molecular docking, drug-target interaction analysis, and ligand optimization. • To introduce the basics of molecular dynamics simulation and quantitative structure-activity relationship (QSAR) modeling.
Course Outcomes	After completing this course, students will be able to: • Explain the principles and applications of bioinformatics in medical and biological research. • Navigate major biological databases such as GenBank, UniProt, PDB, and KEGG for data retrieval and analysis. • Perform sequence alignment using tools like BLAST and understand primer design strategies. • Analyze protein structures using homology modeling, ab initio methods, and structure visualization tools. • Apply network pharmacology concepts to study multi-target drugs and systems biology approaches. • Demonstrate the fundamentals of molecular docking and drug-target interaction analysis. • Utilize molecular dynamics simulation and QSAR modeling in drug discovery and optimization.

Sr. No.	Topics	No. of Hrs.
1	**Introduction to Bioinformatics:** Introduction to bioinformatics in medical research, History and Evolution and Applications. Major biological databases, Types of databases, Primary, Secondary, Specified, Primary databases: Gen Bank, EMBL, DDBJ, Protein databases: Uni Prot, PDB, String, Medical databases: OMIM, Clin Var, db SNP, Small Molecules databases: Drug Bank, Pub Chem, Pathways Browsers: Kegg, Reactome, Data submission and retrieval methods.	**15**
2	**Sequence Analysis and structure prediction:** FASTA file formats, Alignment Algorithms, Pairwise sequence alignment, Multiple sequence alignment, BLAST and its variants, Primer design basics, Protein structure hierarchy, Primary, Secondary, Tertiary and Quaternary, Structure prediction/modeling methods, Homology, Ab-initio, threading, 3D structure visualization	**15**

3	**Computational Approaches to Drug Discovery:** Basics of Network Pharmacology, Principles: multi-target drugs and systems biology approaches. Introduction to key tools and databases. Protein-protein interaction (PPI) networks. Gene-disease and drug-target networks. Molecular docking basics, Key concepts and principles, Docking Algorithm Types, Scoring Functions. Drug-target interaction analysis, Visualization, Active site prediction, Molecular Dynamics Simulation. Ligand Optimization, Basics of QSAR, ADMET, Tools for making structural modifications.	**15**
Total		**45 hrs**

Reference Books:

1. **Bioinformatics: Basics, Algorithms, and Applications** – Ruchi Singh
2. **Developing Bioinformatics Computer Skills** – Cynthia Gibas & Per Jambeck
3. **Bioinformatics: Sequence, Structure, and Databanks** – Des Higgins & Willie Taylor
4. **Computational Drug Discovery and Design** – Riccardo Baron

Name of the Program	M.Sc. Medical Genetics
Semester	Semester II
Name of the Subject	Practical Lab II (MMGEN 106 & MMGEN 107)
Subject Code	MMGEN 110 P

Course objective	• To develop hands-on expertise in centrifugation techniques for biomolecule separation. • To train students in DNA and RNA extraction from biological samples for molecular analysis. • To familiarize students with UV-Visible spectroscopy for nucleic acid and protein quantification. • To provide proficiency in electrophoretic techniques (Agarose gel & SDS-PAGE) for biomolecular analysis. • To introduce polymerase chain reaction (PCR) and real-time PCR (qPCR) for genetic analysis and disease diagnosis. • To equip students with knowledge of chromatographic techniques (HPLC) for biomolecule purification. • To train in Western blotting for protein detection and analysis.
Course Outcomes	After completing this course, students will be able to: • Perform centrifugation for biomolecule separation and Extract DNA and RNA from biological samples with high purity. • Analyze nucleic acids and proteins using UV-Visible spectroscopy. • Conduct Agarose gel electrophoresis for DNA visualization and integrity assessment. • Execute PCR and real-time PCR (qPCR) for molecular diagnostics and gene amplification. • Separate and analyze proteins using SDS-PAGE and Western blotting. • Apply HPLC techniques for the purification and separation of biomolecules. • Document and interpret results using gel documentation systems. Understand and apply analytical techniques in clinical and research settings. • Develop problem-solving skills for biomolecular analysis in medical biotechnology.

Sr. No.	Topics	No. of Hrs.
1	Practical based on Centrifugation: Density gradient centrifugation	**6**
2	DNA Extraction from Biological Samples	**6**
3	RNA Extraction from Biological Samples	**6**
4	Quantification and Purity Assessment of Nucleic Acids using UV-Visible Spectroscopy	**6**
5	Quantification of Proteins by using Spectroscopy technique	**6**
6	Agarose Gel Electrophoresis for DNA Analysis	**6**
7	Polymerase Chain Reaction (PCR) and Gel Documentation	**6**
8	Protein Separation using SDS-PAGE and Western Blotting	**6**
9	Chromatographic Separation of Biomolecules using HPLC	**6**
10	Real-time PCR and Its application in Disease diagnosis	**6**
Total		**60 hrs**

Name of the Program	M.Sc. Medical Genetics
Semester	Semester II
Name of the Subject	Practical Lab III (MMGEN 108 & MMGEN 109)
Subject Code	MMGEN 111 P

Course Objective	• Provide hands-on training in plasmid DNA isolation, restriction digestion, ligation, and transformation for gene cloning. • Introduce RFLP and bacterial conjugation techniques for genetic analysis. • Train students in bioinformatics tools for sequence retrieval, alignment, and phylogenetic analysis. • Develop skills in molecular docking and protein-ligand interaction studies for drug discovery. • Familiarize students with biological databases (GenBank, EMBL, DDBJ) for nucleic acid sequence analysis. • Teach homology modeling using Swiss-Model for protein structure prediction.
Course Outcomes	After completing this course, students will be able to: • Isolate plasmid DNA from bacteria and perform restriction digestion and ligation for genetic manipulation. • Conduct bacterial transformation and confirm the presence of recombinant DNA. • Perform RFLP analysis for genetic variation studies. • Demonstrate bacterial conjugation and understand horizontal gene transfer. • Retrieve and analyze nucleotide and protein sequences using NCBI and BLAST and perform multiple sequence alignment and construct phylogenetic trees for evolutionary studies. • Utilize molecular docking tools to analyze protein-ligand interactions in drug discovery. • Apply homology modeling techniques to predict protein structures using Swiss-Model. • Integrate genetic engineering and bioinformatics approaches for biomedical and biotechnological research applications.

Sr. No.	Topics	No. of Hrs.
1	Isolation of Plasmid DNA from Bacteria	**6**
2	Restriction Digestion and Ligation of DNA	**6**
3	Transformation of Recombinant DNA into Bacteria	**6**
4	RFLP technique	**6**
5	Bacterial Conjugation	**6**
6	Sequence Retrieval and Analysis using NCBI and BLAST	**6**
7	Multiple Sequence Alignment and Phylogenetic Tree Construction	**6**
8	Molecular Docking and Protein-Ligand Interaction Analysis	**6**
9	Nucleic Acid sequence databases: Gen Bank, EMBL, DDBJ	**6**
10	Homology Modeling of Proteins using Swiss-Model	**6**
Total		**60 hrs**

Name of the Program	M.Sc. Medical Genetics
Semester	Semester II
Name of the Subject	MMGEN Directed Clinical Education-II
Subject Code	MGEN 112 CP

Course Objective	• To provide hands-on exposure to diagnostic and therapeutic procedures in a hospital setting. • To enhance students' ability to interact with patients and healthcare professionals, fostering practical understanding of medical biotechnology applications. • To Train students in quality assurance (QA) and quality control (QC) practices in NABH- and NABL-accredited laboratories. • To develop problem-solving skills for addressing clinical and healthcare management challenges. • To equip students with knowledge of regulatory standards, hospital administration, and healthcare best practices. • To strengthen their competency for careers in clinical diagnostics, research, and hospital-based biotechnology applications.
Course Outcomes	After completing this course, students will be able to: • Demonstrate proficiency in diagnostic and therapeutic techniques used in hospital laboratories. • Effectively communicate and collaborate with healthcare professionals and patients. • Apply QA and QC protocols in a regulated laboratory environment. • Analyze and troubleshoot clinical and diagnostic challenges using biotechnological approaches. • Understand and adhere to hospital regulatory standards and accreditation requirements (NABH/NABL). • Develop decision-making skills for effective healthcare management and administration. • Gain practical insights into biotechnology-based clinical applications and patient care. • Prepare for professional roles in clinical research, diagnostics, and hospital-based biotechnology settings.

Community orientation & clinical visit (Including related Practical to the Parent course)

Medical Genetics students will gain extensive clinical exposure in a hospital setting, allowing them to refine their skills in various diagnostic and therapeutic procedures. Under the supervision of experienced professionals, they will progressively interact with patients and healthcare personnel, enhancing their understanding of medical genetics applications in real-world scenarios. Their training will encompass quality assurance (QA) and quality control (QC) in NABH and NABL-accredited laboratories, ensuring they are well-versed in regulatory standards and best practices. Additionally, students will develop problem-solving skills and learn to address complications in healthcare management. This hands-on experience will also prepare them for administrative roles in hospital settings, equipping them with the knowledge, skills, and aptitude required for effective healthcare delivery. Through this structured clinical education, students will be immersed in a dynamic hospital environment, strengthening their competency in medical genetics. **(Total -180 hrs.)**

SKILL ENHANCEMENT COURSE

Name of the Program	**M.Sc. Molecular Biology**
Semester	**Semester II**
Name of the Subject	**Innovation and Entrepreneurship**
Subject Code	**SEC 001 T**

Course Outcome	• Students will grasp the concepts of innovation, its ecosystem, and the role of various stakeholders such as government policies, startups, and innovation hubs. • Cultivating an entrepreneurial mindset and leadership qualities necessary for driving innovation and leading ventures. • Understanding the intersection of technology and innovation and leveraging emerging technologies for entrepreneurial ventures.

Sr. No.	Topics	No. of Hrs.
1	Innovation and Innovation Eco-System, The Policy Framework, Startup L and scape and Innovation Hubs, - Digital India and Make in India, - Linking Innovation with Intellectual Property Rights, Raising Finance for Startups in India, Innovation in Indian Context, Writing a business plan	**15**
2	Creativity and Research, Converting Research to Innovation: Innovation Types and Models, Product Development, IPR and its Commercialization, Support System to Develop Culture of Research and Innovation, commercialization of research and innovation, Fund raising – Research and Innovation, Envisioning Innovation and Scenario Building	**15**
3	Introduction to Innovation in Entrepreneurship, Idea Generation and Validation, Design Thinking in Entrepreneurship, Business Model Innovation, Technology and Innovation, Funding Innovation, Entrepreneurial Mindset, Leadership & amp; Intellectual Property, Scaling and Growth Strategies, sustainability & amp; Social Innovation	**15**
Total		**45 hrs**

Name of the Program	M.Sc. Medical Biotechnology
Semester	Semester II
Name of the Subject	Comprehensive Molecular Diagnostics and Advanced Gene Expression Analysis (NPTEL)
Subject Code	SEC 002 T

Course Objectives	• To introduce the principles and significance of molecular diagnostics in healthcare. • To provide knowledge on biomarkers and their role in disease detection. • To familiarize students with sample collection, processing, and quality control in molecular diagnostics. • To impart hands-on knowledge of various molecular diagnostic techniques, including PCR, ELISA, and immunoassays. • To explore the application of molecular diagnostics in infectious diseases and cancer detection. • To introduce emerging technologies like NGS, CRISPR-based diagnostics, and point-of-care devices.
Course Outcomes	After completing this course, students will be able to: • Explain the principles of molecular diagnostics and its role in modern healthcare. • Describe the significance of biomarkers in disease detection and prognosis. • Demonstrate proper methods for sample collection, storage, and processing in a diagnostic lab. • Perform molecular diagnostic techniques such as PCR, ELISA, and immunohistochemistry. • Analyze the applications of molecular diagnostics in infectious diseases and cancer. • Evaluate the role of emerging diagnostic technologies like NGS and CRISPR-based methods. • Apply biosafety and biomedical waste disposal protocols in a molecular diagnostics lab.

Sr. No.	Topics	No. of Hrs.
1	Basic Concepts including Central Dogma in Molecular Biology Definition and Scope of Molecular Diagnostics and Historical Developments Importance and advantages of molecular diagnostics over traditional methods, Nucleic Acid Structure and Function, DNA Replication and Repair, RNA Transcription and Processing, Protein Synthesis from mRNA-Translation	**3**
2	Tools of Molecular diagnostics and Gene expression Analysis (I) PCR (Polymerase Chain Reaction) Fundamentals, RT PCR and qPCR, Modifications of PCR-Hot start, Touch down, nested PCR, Multiplex, Modifications of PCR 2-Long-range PCR,Single-cell PCR,Fast-cycling PCR, Methylation-specific PCR (MSP), Digital Droplet PCR-modern implications, PCR-based mutation analysis	**4**
3	Tools of Molecular diagnostics and Gene expression Analysis (II) Principles (Sanger sequencing, Overview of NGS Technologies and Platform, Application of NGS in Molecular Diagnostics, Clinical Interpretation of NGS Data, Whole genome vs Whole exome sequencing, Targeted gene panels, NGS library preparations)	**4**
4	Tools of Molecular diagnostics and Gene expression Analysis (III) DNA Microarray, FISH (Fluorescence in situ Hybridization), Serial analysis of gene expression, RNA sequencing, Tiling array, DNA protein interaction- chromatin immune precipitation.	**4**

5	Techniques of Gene Manipulation: RNA interference and detection methods, Recombinant DNA Technology, CrispR-CAS9 technology, Epigenetics and diseases, DNA methylation analysis.	**4**
6	Proteomics: Clinical Applications Overview of proteomics techniques and workflows, Protein separation techniques-brief discussion of gel electrophoresis and chromatography, mass spectrometry, label-free and isotope labelling methods, role of metabolomics in laboratory diagnosis.	**4**
7	Proteomics: Advanced topics in Clinical Proteomics High throughput proteomics like-Shotgun and data independent acquisition (DIA), Single cell proteomics and spatial profiling, methods to detect post translational modification and protein-protein interaction, proteomic data analysis and bioinformatic tools, Luminex multiplex assays and its application in biomarker analysis.	**4**
8	Molecular Diagnostics in Infectious Diseases Syndromic Panels and Multiplex Assay, Molecular identification of Microorganism- covering bacterial, viral, fungal and parasitic diseases, antimicrobial resistance testing, POC Molecular diagnostics for infectious diseases, Molecular diagnostics in Hospital acquired infections.	**4**
9	Molecular Diagnostics in Cancer Management Cancer markers, Liquid biopsies in cancer detection, circulating Tumour DNA (ctDNA) analysis, Monitoring treatment response with molecular diagnostics, Molecular diagnostics in targeted therapy, Digital PCR, Molecular diagnostics quality control	**4**
10	Molecular Diagnostics in Genetic and Inherited Disorders Genetic testing and inherited diseases, Non-Invasive Prenatal testing (NIPT) and reproductive genetics, Molecular diagnostics in rare genetic disorders, Pharmacogenomics and Personalized Medicine, genetic counselling and patient education.	**3**
11	Molecular Diagnostics in Medicine Molecular diagnostics in Metabolic disease, Molecular diagnostics in Neurodegenerative disease, Molecular diagnostics in Respiratory, Molecular diagnostics in Gastrointestinal disorders, Molecular diagnostics in Endocrine disorders, Molecular diagnostics in Autoimmune disorders, Molecular diagnostics in Cardiovascular diseases, Molecular diagnostics in Transplantation diseases.	**4**
12	Molecular Diagnostics: Quality control and Ethical Concerns in and Futuristic Trends Quality control in molecular diagnostics, Ethical Concerns in Molecular Diagnostics, Microfluidics and Lab-on-chip in molecular diagnostics, AI and ML in molecular diagnostics, Nanotechnology based molecular diagnostics, Single cell Analysis, Integration of Multi-omics Data.	**3**
Total		**45 hrs**

Reference Books:

1. **Molecular Diagnostics: Fundamentals, Methods, and Clinical Applications** – Lela Buckingham & Maribeth L. Flaws
2. **Principles of Molecular Diagnostics and Personalized Cancer Medicine** – Dongfeng Tan & Henry T. Lynch
3. **Handbook of Molecular and Cellular Methods in Biology and Medicine** – Leland J. Cseke, Peter B. Kaufman, Gopi K. Podila
4. Molecular Cloning: A Laboratory Manual by David W. Russell and Joseph Sambrook
5. "Molecular Diagnostics: Fundamentals, Methods, & Clinical Applications" by Lela Buckingham and Maribeth L. Flaws
6. "Cancer Genomics: From Bench to Personalized Medicine" by Graham Dellaire and Jason N. Berman
7. Pharmacogenomics: Challenges and Opportunities in Therapeutic Implementation" by Urs A. Meyer and FolefacAminkeng

***Note:** Attaint the NPTEL Course with title and course code as "**Comprehensive Molecular Diagnostics and Advanced Gene Expression Analysis (Course Code: noc25-ge07) (NPTEL)".**

Scheme of University Examination Theory for PG Program:

General structure / patterns for setting up question papers for Theory / Practical courses, their evaluation weightages for PG programs of MGMSBS are given in the following tables

Marks scheme for the University exam:

Final theory marks will be 100 marks (80 marks University Theory exam + 20 Marks Internal assessment).

Question		**Marks distribution**	**Marks allotted per section**	**Marks**
Sec: A	MCQ	10 x 1 M = 10	10	10
Sec: B	SAQ	3/4x 5 M = 15	15	35
Sec: B	LAQ	2/3 x 10 M = 10	20	
Sec: C	SAQ	3/4x 5 M = 15	15	35
Sec: C	LAQ	2/3x 10 M = 10	20	
Total				**80 Marks**

Marks Scheme for the University Examination (50 Marks)

Final theory marks will be 50 marks University Theory exam pattern Research Methodology & Biostatistics (Core course)

Question	**Question No.**	**Question Type**	**Marks Distribution**	**Marks**
Sec: A	1.	LAQ (2 out of 3)	2 X 10 Marks = 20	20
Sec: B	2.	SAQ (6 out of 8)	6 X 05 Marks = 30	30
Total				**50 Marks**

Marks Scheme for the University Examination (100 Marks)

Final theory marks will be 100 marks University Theory exam pattern Elective Course

Question	**Question No.**	**Question Type**	**Marks Distribution**	**Marks**
Sec: A	1.	LAQ (10 out of 12)	10 X 10 Marks = 100	100
Total				**100 Marks**

Practical exam pattern: Total 40 marks with following breakup:

Exercise	Description	Marks
Q No 1	Practical exercise - 1	1 x15=15 M
Q No 2	Station exercise	2x5M=10 M
Q No 3	VIVA	10 M
Q No 4	Journal	5M
Total		**40 Marks**

Practical exam pattern Research Methodology & Biostatistics (Core course)
Total 50-mark distribution:

Exercise	Description	Marks
Q No 1	**Practical/Problem-Solving:** These questions can assess statistical analysis, research design, hypothesis testing, or interpretation of data etc	2 × 10 marks each) = **20 marks**
Q No 2	Identification of study designs, Critical appraisal of research papers, Application of biostatistical tools, Sampling techniques etc	(4 × 5 marks each) = **20 marks**
Q No 3	**Viva Voce (Oral Examination)** Assessing conceptual clarity, application of research methodology, and statistical reasoning.	**10 marks**
Total		**50 Marks**

Practical to be conducted at respective departments and marks submitted jointly by the parent department to the university.

Breakup of theory IA calculation for 20 marks

Description	Marks
Internal exam (at department)	15 marks
Seminar	5 marks
Total	**20 Marks**

Breakup of practical IA calculation:

Description	Marks
Internal exam (at department)	10 marks
Viva	5 marks
Journal	5 marks
Total	**20 Marks**

Note –20 marks to be converted to 10 marks weightage for submission to the university.

Model Checklist for Evaluation of the Clinical Directed Posting (PG)

Name of the student: _____Date:_____
Program: _____
Semester: _____ Name of the Internal faculty/Observer: _____
Name of the External Faculty/Observer: _____

Core Competencies	Marks allotted	Marks obtained
Students will begin to develop critical thinking abilities utilizing the allied health personnel roles of communicator and caregiver. Students will learn principles of professional allied health personnel practice and provide direct care to individuals within a medical surgical setting while recognizing the diverse uniqueness of individuals with health alterations.		
Clinical Teaching		
a. Demonstrate beginning competency in technical skills.	10	
Independent Work by Student guided by faculty		
a. Develop effective communication skills (verbally and through charting) with patients, team members, and family	2.5	
b. Identify intra and inter-professional team member roles and scopes of practice. Establish appropriate relationships with team members.	2.5	
Hands on practical work by students		
a. Protect confidentiality of electronic/manual health records data, information, and knowledge of technology in an ethical manner	05	
Independent work by student		
a. Demonstrate expected behaviors and complete tasks in a timely manner. Arrive to clinical experiences at assigned times. Maintain professional behavior and appearance.	05	
Log book	10	
Viva	10	
Attendance	05	
Total	**50 Marks**	

Sign of Internal Examiner: _____
Sign of External Examiner: _____

MGM INSTITUTE OF HEALTH SCIENCES

(Deemed to be University u/s 3 of UGC Act, 1956)

Grade 'A' Accredited by NAAC

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