CENTRAL UNIVERSITY OF PUNJAB

M.Sc. in Molecular Medicine

Batch:2025-2027

Department of Human Genetics and Molecular Medicine

Graduate Attributes

Context of Society

The students of this course will understand the significant role of cell and molecular biology, Pathophysiology of common diseases and therapeutic strategies in the broader societal context. There will be an understanding of the basics of professional ethics, research ethics, biosafety issues, and the principles of professional practice.

Enterprising and Knowledgeable

The course content will develop skills in regenerative medicine, molecular biology, and bioinformatics and cutting-edge molecular techniques through the subject content across a broad range of modules among the students. The development of skills in molecular medicine will enhance employability in the field of biomedical sciences and clinical practices. The emphasis is on student-centric learning where they solve the patterns of inheritance by drawing pedigrees and discuss the current therapeutic interventions to treat specific genetic disorders.

Digital and research methodology-based skills

The students will be able to study and learn the effective use of digital tools to support academic writing, reference management and independent study using digital resources and learning materials. The understanding of the principles of experimental design and methods will help the students to explore new scientific approaches in translational research.

Syllabus
MSc in Molecular Medicine (Batch: 2025-2027)

Course Structure of the Programme

Total Credit: 80

	Discipline Specific Core Subjects	Elective Courses			Foundation Courses		Total Credit
		DE	ID	SB	CF	EF/VB	
Sem-I	04 (12 Cr)	01 (03 Cr)	--	02 (04 Cr)	--	--	**19**
Sem-II	03 (09 Cr)	--	01 (02 Cr)	03 (06 Cr)	01 (02 Cr)	01 (02 Cr)	**21**
SEM-III	--	--	--	01 (20 Cr Dissertation Part-I/Industrial/hospital based training/Internship)	--	--	**20**
SEM-IV	--	--	--	01 (20 Cr Dissertation Part-II/Industrial/hospital based training/Internship)	--	--	**20**
Credit Score	**21**	**03**	**02**	**50**	**02**	**02**	**80**

DE: Discipline Elective
ID: Interdisciplinary
SB: Skill based (Practicals); Dissertation
CF: Compulsory foundation
EF: Elective Foundation
VB: Value Based

Cr: Credit

Syllabus
MSc in Molecular Medicine (Batch: 2025-2027)

Course Structure of the Programme
Semester-I

Course Code	Course Title	Course Type	Hours			Credit Hours
			L	T	P	
MMME.516	Molecular Basis of Human Diseases	Core	3	0	0	3
MMME.517	Cellular and Molecular Biology	Core	3	0	0	3
MHGE.517	Advances in Immunology	Core	3	0	0	3
MMME.518	Biomolecules and Metabolism	Core	3	0	0	3
Skill Based Course						
MMME.519	Biomolecules and Metabolism (Practical)	Skill Based	0	0	4	2
MMME.520	Biostatistics and Research Methodology (Practical)	Skill Based	0	0	4	2
Discipline Elective Course-I (Any one of the following)						
MHGE.501	Public Health Research and Genetic Epidemiology	DE	3	0	0	3
MMME.501	Molecular Endocrinology and Signal Transduction	DE	3	0	0	3
	Option 1 (to be opted from other departments)	DE	3	0	0	3
	Option 2 (to be opted from other departments)	DE	3	0	0	3
					Total Credits	**19**
Additional: 01 non-credit course (2 hour) on individualized education plan/tutorials. The students can opt for Swayam plus courses to earn more credits. Level NCrF: 7						

Syllabus
MSc in Molecular Medicine (Batch: 2025-2027)

Course Structure of the Programme
Semester-II

Course Code	Course Title	Course Type	Hours			Credit Hours
			L	T	P	
MMME.521	Stem Cell and Regenerative Medicine	Core	3	0	0	3
MMME.522	Molecular and Cellular Oncology	Core	3	0	0	3
MMME.523	Genetic Engineering and Recombinant Therapeutics	Core	3	0	0	3
Skill Based Course						
MMME.524	Practical Course in Molecular Medicine	Skill Based	0	0	6	3
MHGE.525	Tools in Bioinformatics (Practical)	Skill Based	0	0	6	3
Compulsory Foundation Course						
MHGE.526	Biosafety, Bioethics and IPR	CF	2	0	0	2
Interdisciplinary Course (For other Departments)						
MHGE.506	Intellectual Property in Life Sciences Industry	IDC	2	0	0	2
	MOOC course from Swayam Portal	MOOC	2	0	0	2
	Choose from IDC courses offered by other Departments	IDC	2	0	0	2
Value Based Course-I (select anyone)						
MMME.511	Fundamentals of Behavioural Neuroscience	VB	2	0	0	2
	Value Added Course (From other departments)	VB	2	0	0	2
					Total Credits	**21**
Additional: 01 non-credit course (2 hour) on individualized education plan/tutorials. The students can opt for Swayam plus courses to earn more credits. Level NCrF: 7						

Syllabus
MSc in Molecular Medicine (Batch: 2025-2027)

Course Structure of the Programme
Semester-III

Course Code	Course Title	Course Type	Hours			Credit
			L	T	P	
MMME.599-1	Dissertation Part-I/ Industrial/ hospital based training/ Internship	Skill Based	0	0	40	20
Total			**0**	**0**	**40**	**20**
Level NCrF: 8						

Syllabus
MSc in Molecular Medicine (Batch: 2025-2027)

Course Structure of the Programme
Semester-IV

Course Code	Course Title	Course Type	Hours			Credit
			L	T	P	
MMME.599-2	Dissertation Part-II/ Industrial/ Hospital based training/ Internship	Skill Based	0	0	40	20
Total			**0**	**0**	**40**	**20**
Level NCrF: 8						

Syllabus
MSc in Molecular Medicine (Batch: 2025-2027)

Semester I

Course Code: **MMME.516**
Course Title: **Molecular Basis of Human Diseases**
Total Hours: **45**

L	T	P	C
3	0	0	3

Course Learning Outcomes:
On successful completion of the course the student will be able to:
CLO1: Acquire knowledge on basic mechanisms of non-communicable human diseases.
CLO2: Understand the molecular basis of human genetic disorders.
CLO3: Gain knowledge about molecular mechanisms underlying the pathogenesis of communicable human diseases.
CLO4: Know modern therapeutic approaches in development/clinical practice.

Unit I **11 Hours** Non-Communicable Diseases: Molecular basis of: Diabetes, Chronic obstructive pulmonary disease, Cardiomyopathies, Hypertension, Cancer and neuronal disorders such as Autism, Alzheimer's and Parkinson. Schizophrenia, Mental Retardation, Major depressive disorder, Anxiety disorder	**CLO 1**
Unit II **12 Hours** Genetic disorders: Classifications of genetic disorders, Intersex Disorders: Male Pseudo-hermaphrodite (MPH), Female Pseudo-hermaphrodite (FPH), True Hermaphrodites (TH), Mixed gonadal dysgenesis (MGD) & Dysgenetic male pseudohermaphrodite (DMP) and Persistent Mullerian duct syndrome (PMDS), Sickle cell anemia, Thalassemia, Hemophilia and Hematopoietic Malignancies. Muscular Dystrophy. Glycogen Storage Diseases (Pompe disease, Tay Sach disease, Niemann-Pick disease)	**CLO 2**
Unit III **12 Hours** Communicable Diseases: Mechanisms of Infection and Therapeutic Interventions of: HIV/AIDS, SARS, TB and Hepatitis. Molecular basis of antimicrobial resistance and its detection. Molecular approaches in clinical microbiology, antimicrobial agents; Sulfa drugs; Antibiotics: Penicillin and Cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics.	**CLO 3**
Unit IV **10 Hours** Novel therapies for diseases: Tyrosine kinase inhibitor, Monoclonal antibody, Chemo & Radio, Gene Therapies, Small peptides. Limitations, ethical and biosafety issues in gene therapies.	**CLO 4**

Transactional Modes: Lecture**;** Demonstration**;** Tutorial**;** Lecture cum demonstration; Problem solving; Self-learning.

Internal assessment shall be through any of the following: Surprise Tests, case analysis, simulated problem solving, classroom assignments, term paper, presentations, and discussions.

Suggested Reading:

1. Patch, H. S. C. (2017). Genetics for the Health Sciences. Scion Publishing Ltd., UK.
2. Brown, S. M., (2018). Essentials of Medical Genomics. Wiley-Blackwell.
3. Jocelyn, E. K., Elliot, S. G., & Stephen, T. K. (2018), Lewin's Gene X. Jones & Barlett Publishers.
4. Milunsky, A., & Milunsky, J. (2015). Genetic Disorders and the Fetus: Diagnosis, Prevention and Treatment, 6th Edition. Wiley-Blackwell publishers.
5. Trent, R. J. (2017). Molecular Medicine: Genomics to Personalized Healthcare. Academic Press.
6. Trent, R. J. (2015). Molecular Medicine: An Introductory Text. Academic Press.
7. Elles, R., & Mountford, R. (2012). Molecular Diagnosis of Genetic Diseases Series: Methods in Molecular Medicine.
8. Coleman, W. B., & Tsongalis, G. J. (2019). The Molecular Basis of Human Disease. Academic Press.
9. Nussbaum, R.L., McInnes, R. Mc., & Willard, H.F. (2017). Genetics in Medicine. Elsevier Inc., Philadelphia.
10. Read, A., & Donnai D. (2017). New clinical Genetics. Scion Publishing Lmt., Oxfordshire, UK.
11. Kandel, E. R., Schwartz, J. H., & Jessell, T. M. (2021), 6th edition, Principles of neural science. McGraw-Hill, Health Professions Division.

Course Code: **MMME.517**
Course Title: **Cellular and Molecular Biology**
Total Hours: **45**

L	T	P	C
3	0	0	3

Course Learning Outcomes:

On successful completion of the course the student will be able to:
CLO1: To understand the structural organization and dynamic interactions of cellular membranes, cytoskeleton, and extracellular matrix in eukaryotic cells
CLO2: Conceptualize the mechanisms of inter- as well as intra-cellular communications.
CLO3: Understanding the molecular processes of DNA replication
CLO4: Study the process of transcription, process of translation and post translational modifications in prokaryotes and eukaryotes.

Unit I **12 Hours** Structural Organization and Communication in Eukaryotic Cells: Membrane architecture and dynamics (lipid rafts, asymmetry, and curvature; Lateral mobility and membrane fluidity regulation), Transport of small molecules, ions and macromolecules across the membrane; diffusion (simple and facilitated), active transport (primary and secondary), vesicular transport	**CLO1**
Unit II **9 Hours** Protein secretion and sorting: Protein secretion, synthesis and targeting to mitochondria, peroxisomal proteins, translational modification in the ER. Intracellular traffic, vesicular traffic in the secretory pathway, protein sorting in the Golgi bodies, traffic in the endocytic pathway, exocytosis.	**CLO2**
Unit III **12 Hours** DNA replication : Mechanisms of DNA replication in eukaryotes, Enzymes and accessory proteins involved in DNA replication. End replication problem, Telomerase: role in the formation of telomeres and the molecular mechanism involved t-loop formation; DNA damage and repair mechanisms: Direct reversal repair system, Excision Repair system, Mismatch repair system. Double-strand DNA breaks repair system: Homologous recombination repair and non-homologous end-joining (NHEJ) repair systems.	**CLO3**
Unit IV **12 Hours** Transcription and mRNA processing: Eukaryotic transcription: Initiation, Elongation & Termination, general and specific transcription factors, RNA processing and editing, post transcriptional gene regulation. Translation: Genetic code, eukaryotic translation, the translation machinery, mechanisms of chain initiation, elongation and termination	**CLO4**

Transactional Modes: Lecture**;** Demonstration**;** Tutorial**;** Lecture cum demonstration; Problem solving; Self-learning.

Internal assessment shall be through any of the following: Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, presentations, and discussions.

Suggested Reading:

1. Alberts, B., Heald, R., Johnson, A., Morgan, D., Raff, M. Roberts, K., and Walter, P. (2022). Molecular Biology of the cell. Garland publishers, Oxford.
2. Celis, J.E. (2006). Cell biology: A laboratory handbook, Vol 1, 2, 3. Academic Press, UK.
3. Gupta, P.K. (2018). Cytology, Genetics and Evolution. Rastogi publications, Meerut, India.
4. Karp, G. (2022). Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons. Inc. New Delhi, India.
5. Sambrook, J., Fritsch, E. F., & Maniatis, T. (2015). Molecular cloning: a laboratory manual. Cold Spring Harbor Laboratory Press New York.

6. Berk, A. Chris, A.K. & Krieger, M. (2021). Molecular Cell Biology. W.H. Freeman, USA.
7. Robertis, (2017). Cell and Molecular Biology. Lippincott Williams & Wilkins.
8. Karp, G. (2019). Cell and molecular biology: concepts and experiments. John Wiley & Sons.
9. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2017). Lewin's Genes XII. Jones & Bartlett Learning.
10. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., & Levine, M. (2007). Molecular Biology of the Gene Benjamin Cummings.

Course Code: **MHGE.517**
Course Title: **Advances in Immunology**
Total Hours: **45**

L	T	P	C
3	0	0	3

Course Learning Outcomes:
On successful completion of the course the student will be able to:
CLO1: Evaluate basic concepts of the immune system.
CLO2: Gain knowledge about various key processes related to development of the immune system.
CLO3: Understand the concept of immune-based diseases as either a deficiency of components or excess activity as hypersensitivity.
CLO4: Apply the knowledge how the immune system is involved in diseases caused by internal or external factors.

Unit I **12 Hours** Immune System: The cells and organs of immune system, humoral immunity-immunoglobulin, basic structure, classes and subclasses, structural and functional relationships, nature of antigen, antigen-antibody reaction, antibody diversity, class switching, B and T cell development.	**CLO 1**
Unit II **11 Hours** Immune Effectors: Complement system, their structure, functions and mechanisms of activation by classical, alternative and lectin pathway. Th1 and Th2 response, various effector cells of the immune system: DC, NK, Monocytes etc.	**CLO 2**
Unit III **12 Hours** Mechanisms of Immune System Diversity: Structure and functions of Major Histocompatibility Complex (MHC) and Human Leukocyte Antigen (HLA) system, polymorphism, distribution, variation and their functions.	**CLO 3**
Unit IV **10 Hours** Immune System in Health and Diseases: Inflammation, hypersensitivity and autoimmunity, AIDS and immunodeficiency, **Transplantation immunology,** vaccine development.	**CLO 4**

Transactional Modes: Lecture**;** Demonstration**;** Tutorial**;** Lecture cum demonstration; Problem solving; Self-learning.
Internal assessment shall be through any of the following: Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, presentations and discussions.

Suggested Reading:

1. Kindt, T.J., Osborne, B.A. and Goldsby, R.A. (2018). Kuby Immunology. W.H. Freeman, USA.
2. Abbas. (2018). Cellular and Molecular Immunology.CBS Publishers & Distributors, India.
3. Charles, A. and Janeway, J.R. (2001). Immunobiology: The immune system in health and disease Blackwell Publishing, USA.
4. Delves, P.J., Roitt, I.M. and Seamus, J.M. (2016). Roitt's Essential Immunology (Series–Essentials). Blackwell Publishers, USA.
5. Elgert, K.D. (2015). Immunology: Understanding the immune system. Wiley-Blackwell, USA.
6. Tizard. (2018). Immunology: An Introduction. Cengage Learning, Thompson, USA.
7. Owen, Judith A; Punt, Jenni, Stranford, Sharon A. Kuby's Immunology (2013), W.H. Freeman and Company: New York, 2013

Course Code: **MMME.518**
Course Title: **Biomolecules and Metabolism**
Total Hours: **45**

L	T	P	C
3	0	0	3

Course Learning Outcomes:
On successful completion of the course the student will be able to:
CLO1: Explain the classification, catalytic properties, and regulatory mechanisms of enzymes, including the significance of Km, Vmax, enzyme inhibition, and their clinical applications in diagnostics and therapeutics.
CLO2: Illustrate the structural diversity and stereochemistry of carbohydrates, and analyze their biochemical reactivity and metabolic pathways, especially in contexts such as diabetes and hypoxia.
CLO3: Describe the classification and physiological roles of lipids and evaluate lipid metabolism pathways—such as β-oxidation, ketogenesis, and cholesterol synthesis—with reference to metabolic disorders.
CLO4: Interpret the metabolism of amino acids, proteins, and nucleotides, and assess their structural-functional relationships and clinical relevance in conditions like gout, purine salvage disorders, and hemoglobinopathies.

Unit I Enzymology and Catalytic Mechanisms **12 Hours** Classification and nomenclature of enzymes, Physiological significance of enzymes in metabolism and drug action, Properties of enzymes: specificity, turnover number, catalytic efficiency, Isozymes and their diagnostic value, Enzyme-substrate interaction and ES complex formation, Enzyme kinetics: Michaelis-Menten equation, Lineweaver-Burk plot, Determination of kinetic	**CLO1**

parameters: Km and Vmax, Types of enzyme inhibition (competitive, non-competitive, uncompetitive) and clinical applications, Allosteric enzymes and regulatory roles in metabolic control, Role of Ribozymes and Abzymes, Factors influencing enzyme activity: temperature, pH, substrate, cofactors, inhibitors. Application Focus: Drug-enzyme interactions, enzyme assays in diagnostics, designing enzyme inhibitors as therapeutic agents.	
Unit II Carbohydrates and Energy Metabolism 11 Hours Structural features and stereochemistry of monosaccharides, disaccharides, and polysaccharides, Epimers, anomers, and mutarotation, Key biochemical reactions of carbohydrates: oxidation, reduction, glycosidic bond formation, Glycolysis: energy yield and regulation at key enzymatic steps, Tricarboxylic Acid (TCA) Cycle: amphibolic nature and regulatory checkpoints, Gluconeogenesis and Glycogenolysis: reciprocal regulation and hormonal control, Pentose Phosphate Pathway: NADPH generation and nucleotide biosynthesis, Oxidative phosphorylation: chemiosmotic theory and ATP production efficiency. Application Focus: Metabolic disorders (e.g., diabetes, G6PD deficiency), ATP generation, bioenergetics in hypoxia and cancer.	**CLO2**
Unit III Lipids and Their Metabolic Integration 11 Hours Classification of lipids: simple, compound, and derived lipids with biological significance, Functional roles of lipids in membrane structure, signaling, and energy storage, Beta-oxidation of fatty acids: pathway, regulation, and energy yield, Role of acyl-carnitine shuttle in mitochondrial fatty acid transport, Cholesterol biosynthesis: key regulatory enzymes and feedback control, Clinical relevance of lipid metabolism: atherosclerosis, statin drugs, Ketogenesis: formation and utilization of ketone bodies during starvation and diabetes. Application Focus: Lipid profile interpretation, obesity-related metabolic syndrome, ketoacidosis, therapeutic targets in hyperlipidemia	**CLO3**
Unit IV Proteins, Amino Acids, and Nucleic Acids Metabolism 11 Hours Amino acid metabolism: transamination, deamination, urea cycle, Proteins: Hierarchical organization of protein structure: secondary, tertiary, quaternary, Use of Ramachandran plot in understanding protein folding and stability, Hemoglobin and myoglobin: structure-function relationship, cooperative binding, Hill equation, Bohr effect, Nucleic acid metabolism: de novo and salvage pathways for purine and pyrimidine biosynthesis, Regulatory control in nucleotide metabolism and clinical implications. Application Focus: Protein misfolding diseases, hemoglobinopathies, antimetabolite drugs, metabolic errors in purine/pyrimidine pathways.	**CLO4**

Transactional Modes: Lecture**;** Demonstration**;** Tutorial**;** Lecture cum demonstration; Problem solving; Self-learning.

Internal assessment shall be through any of the following: Surprise Tests, Group discussion, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, presentations, and discussions.

Suggested Readings:

1. Jeremy Berg, Gregory Gatto Jr., Justin Hines, John L. Tymoczko, Lubert Stryer (2023) Biochemistry. 10th Edition, Macmillan Learning, ISBN: 9781319498504

2. David L. Nelson and Michael M. Cox (2017). Lehninger Principles of Biochemistry. W. H. Freeman publisher. ISBN: 9781464126116
3. Donald Voet and Judith G. Voet (2016). Principles of Biochemistry, 5th edition. Wiley Publisher. ISBN: 9780470547847
4. Palmer, T., & Bonner, P. L. (2001). Enzymes: Biochemistry. Biotechnology, Clinical Chemistry. Horwood Publishing Chichester.
5. Christopher K. Mathews, Kensal Edward Van Holde, and Kevin G. Ahern (2000). Biochemistry. Oxford University Press Inc. New York.
6. Nicholas Price, University of Glasgow, and Lewis Stevens (1999). Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins. Oxford University Press. ISBN: 9780198502296

Course Code: **MMME.519**
Course Title: **Biomolecules and Metabolism (Practical)**
Total Hours: **60**

L	T	P	C
0	0	4	2

Course Learning Outcomes:
On successful completion of the course the student will be able to:
CLO1: Prepare buffers and solutions with varied concentration.
CLO2: Isolation of DNA from the blood samples
CLO3: Quantitative estimation of biomolecules and their role in health and disease
CLO4: Evaluate the effect of temperature, pH and substrate concentration on enzyme activity

List of Practicals

1. Preparation of Buffers	**CLO1**
2. Extraction of DNA, and purity check by electrophoresis.	**CLO2**
3. Quantitative estimation of Glucose. 4. Quantitative estimation of Cholesterol 5. Quantitative estimation of Proteins 6. Quantitative estimation of Nucleic Acids	**CLO3**
7. Assay of enzyme activity in saliva. 8. Effect of temperature on enzyme activity. 9. Effect of pH on enzyme activity.	**CLO4**

Suggested Readings:

1. Rajendran, S., Dhiman, P. (2019) Biochemistry Practical Manual. Elsevier India.
2. Plummer, D. (2004) An Introduction to Practical Biochemistry. Tata McGraw Hill Publishers Co. Ltd., India
3. Gupta, P.P., Gupta, N. (2017) Essentials of Practical Biochemistry. Jaypee Brothers Medical Publishers Pvt. Ltd. India.
4. Hofmann, A., Clokie, S. (2018). Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press, USA
5. Murphy M.J., Srivastava R., Deans, K. (2018) Clinical Biochemistry, 6th Edition. Elsevier's USA.

6. Swaminathan, R (2011) Handbook of Clinical Biochemistry, 2nd Edition, Publisher: World Scientific

Transactional Modes: Laboratory based practical; Problem solving; Self-learning.
Internal assessment shall be through any of the following: Case analysis, Lab Performance, Open book techniques, Instruments Demonstration, and Group discussions.
Evaluation criteria:

A. Continuous Assessment = **60 Marks (**Based on performance and good lab practices of the students and completion of the record book (60 divided by the number of practicals)
B. Final Examination = **40 Marks**
   i. Subjective question = 10 Marks
   ii. Performing experiment = 20 Marks
   iii. Viva voce = 10 Marks

Course Code: **MMME.520**
Course Title: **Biostatistics and Research Methodology (Practical)**
Total Hours: **60**

L	T	P	C
0	0	4	2

Course Learning Outcomes:
On successful completion of the course the student will be able to:

CLO1: Identify statistical data type and plot graphs using conventional tools. Perform basic statistics to check the data quality
CLO2: Test correlation and regression using two or more variables
CLO3: Perform standard parametric and non-parametric statistics on simple data
CLO4: Write and communicate scientific literatures.

List of Practical work:

1	Plotting different types of graphs and statistical tables using MS excel, GraphPad and/or relevant tools	CLO1
2	Plotting normal distribution from data given	
3	Problems on: central tendency, measurement of variance (standard deviation, standard error etc.)	
4	Problems of correlation	CLO2
5	Problems of regression	
6	Chi-square test	CLO3
7	Student's t-test	
8	Analysis of variance (ANOVA)	
9	Different techniques of sampling	
10	Scientific writing skill development	CLO4

11	Practice writing research reports, synopsis, poster etc.	

Transactional Modes: Laboratory based practical's; demonstration, Problem solving; Self-learning.

Evaluation criteria for practical courses:

- Continuous Assessment = 60 Marks

Based on performance and good lab practices of the students and completion of the record book (60 divided by the number of practical's)

- Final Examination = 40 Marks
    i. Subjective question = 10 Marks
    ii. Performing experiment = 20 Marks
    iii. Viva voce = 10 Marks

Course Code:	**MHGE.501**
Course Title:	**Public Health Research and Genetic Epidemiology**
Total Hours:	**45**

L	T	P	C
3	0	0	3

Course Learning Outcomes:

On successful completion of the course the student will be able to:

CLO1: Develop applicable knowledge on global and local public health issues.

CLO2: Perform public health data management and result interpretation.

CLO3: Perform different epidemiological studies to identify the cause-effect relationship in variety of human traits/diseases

CLO4: Design genetic studies and perform association and linkage analysis on any relevant data.

Unit I **11 Hours** Principles and Practices of Public Health: Scope and concerns of public health; Determinants and measurement of health and disease; Health equity, BioBanking.	**CLO1**
Unit II **11 Hours** Public health management: Occupational health; Exposure and risk management; Health informatics; Artificial Intelligence in Health Care; Genomic surveillance; Clinical trials.	**CLO2**
Unit III **12 Hours** Fundamentals of epidemiological studies: Cohort study; Cross-sectional studies; Methods of sampling; Methods of association studies; Genome-wide association studies (GWAS). Systematic review and meta-analysis, Mendelian randomization.	**CLO3**
Unit IV **11 Hours** Application of genetic variations: Genetic variation and markers; Tag markers; Haplotypes; Linkage disequilibrium (LD); QTL and eQTL; Database of Genetic Variation; 1000 Genome Project, Genome India Project.	**CLO4**

Transactional Modes: Lecture**;** Demonstration**;** Tutorial**;** Innovative ideation; Case study; Virtual classrooms; seminar presentation; Problem solving; Co-learning techniques; Self-learning.

Internal assessment shall be through any of the following:

Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, Seminars, term papers, discussions and presentations.

Suggested Readings:

1. Detela, R. Gulliford, M. Karim, Q.A. Tan, C.C. (2021). Global Public Health. Oxford University Press. 7th Ed.
2. Park, K. (2021). Preventive and Social Medicine. Bhanot Publishers. New Delhi.
3. U.S Department of Health and Human Services. (2012). Principles of Epidemiology in Public Health Practice. Updated Third Ed.
4. World Health Organization. (2001). Health Research Methodology: A guide for training in research methods. 2nd Ed.
5. Celentano, D.D. and Szklo, M. (2019) Gordis Epidemiology. Elsevier. 6th Ed.
6. Palmer LJ, Burton PR & Smith GD (2011). An introduction to genetic epidemiology (Policy Press, University of Bristol)
7. Dawn TM (2011). Genetic Epidemiology (Springer)
8. Austin M (2013). Genetic Epidemiology: Methods and Applications, 1st Edition (CABI Publishing).

Course Code: **MMME.501**
Course Title: **Molecular Endocrinology and Signal Transduction**
Total Hours: **45**

L	T	P	C
3	0	0	3

Syllabus
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Course Learning Outcomes:
On successful completion of the course the student will be able to:
CLO1: Know endocrine system and signal transduction at physiological levels
CLO2: Conceptualize and understand the endocrine cellular signaling
CLO2: Understand various human hormones.
CLO3: Develop understanding regarding disorders of the immune system.

Unit I **10 Hours** Endocrine glands, and hormones as chemical messengers, stimulus for hormone release: change in homeostasis, sensory stimulus and others.	**CLO 1**
Unit II **15 Hours** Cell Signaling and Mechanism of Hormone Action: G protein linked receptor family; Signal transduction pathways involving G-proteins, Adenylcyclases, Ca+2, Phosphoinositides, PI-3 Kinase, DAG, cAMP, cGMP, NO, Protein kinases (A,B,C,G), Phosphoprotein phosphatases & Phosphodiesterases. Receptor tyrosine kinase family- EGF receptor family, Insulin receptor family, & Cytokine/erythropoietin receptor family associated with non-receptor Tyrosine kinase (Signal transduction pathways involving: SH2 proteins, Ras, IRS-1, Raf, MEK, MAP kinase, JAK-STAT pathway).	**CLO 2**
Unit III **10 Hours** Hormones: Structures, Receptor type, Regulation of biosynthesis and release (including feedback mechanism), Physiological and Biochemical actions, Pathophysiology (hyper & hypo secretion). Hypothalamic Hormones: CRH, TRH, GnRH, PRL/PRIH, GHRH/GHRIH. Pituitary Hormones - Anterior Pituitary hormones- Growth hormone, Prolactin, POMC peptide family, LH, FSH, TSH; Posterior Pituitary: Vasopressin, Oxytocin, reproductive hormones, Other organs with endocrine function: Heart (ANP), Kidney (erythropoietin), Liver (Angiotensinogen, IGF-1), Adipose tissue (Leptin, adiponectin).	**CLO 3**
Unit IV **10 Hours** Endocrine disorders: Gigantism, Acromegaly, dwarfs, pigmies; Pathophysiology: Diabetes insipidus. Thyroid Hormone (include biosynthesis) Goiter, Graves' disease, Cretinism, Myxedema, Hashimoto's disease. Pancreatic Hormones: Insulin, Glucagon, Diabetes type I & II. Hormones associated with obesity: Ghrelin, Leptin.	**CLO 4**

Transactional Modes: Lecture**;** Demonstration**;** Tutorial**;** Lecture cum demonstration; Problem solving; Self-learning.
Internal assessment shall be through any of the following: Surprise Tests, case analysis, simulated problem solving, classroom assignments, term paper, presentations and discussions.

Suggested Reading:
1. Norris, D.O., & Carr, J.A. (2017). Vertebrate Endocrinology. Academic Press.

2. Widmaier, E.P., Raff, H., & Strang, K.T. (2013). Vander's Human Physiology. McGraw-Hill Higher Education.
3. Ari Sitaramayya (2012) Introduction to Cellular Signal Transduction (Hormones in Health and Disease), Springer science, New York.
4. Bastien D. G., IJsbrand M. K. and Peter E.R. T. (2015), 3rd edition, Signal Transduction, Academic Press, MA, USA

Semester II

Course Code: **MMME.521**
Course Title: **Stem Cell and Regenerative Medicine**
Total Hours: **45**

L	T	P	C
3	0	0	3

Course Learning Outcomes:
On successful completion of the course the student will be able to:
CLO1: Comprehend the basic concepts, types, and biological properties of stem cells, including embryonic, adult, and induced pluripotent stem cells.
CLO2: Analyze the molecular mechanisms and regulatory pathways involved in stem cell maintenance, differentiation, and reprogramming.
CLO3: Evaluate the therapeutic applications of stem cells in regenerative medicine, disease modeling, and tissue engineering.
CLO4: Critically assess the ethical, legal, and translational challenges associated with clinical use and commercialization of stem cell-based therapies.

Unit I Fundamentals of Stem Cell Biology **12 Hours** Definitions and classification of stem cells: totipotent, pluripotent, multipotent, unipotent, Sources of stem cells: embryonic stem cells (ESCs), adult stem cells (hematopoietic, mesenchymal, neural), umbilical cord stem cells, Properties: self-renewal, differentiation, asymmetric division, Induced pluripotent stem cells (iPSCs): reprogramming strategies and key factors (OCT4, SOX2, KLF4, c-MYC), Stem cell niche: composition, role in fate regulation, Organoids and stem cell-derived 3D culture systems.	**CLO1**
Unit II Molecular Regulation of Stem Cell Fate **11 Hours** Cell signaling pathways: Wnt, Hedgehog, Notch, TGF-β, FGF in stem cell maintenance and lineage commitment, Transcriptional and epigenetic control of stem cell pluripotency and differentiation, Non-coding RNAs (microRNAs, lncRNAs) in stem cell biology, CRISPR/Cas9 and other gene editing tools in stem cell research, Telomerase activity, senescence, and immortalization in stem cells, Techniques: immunophenotyping, lineage tracing, live cell imaging, clonal analysis.	**CLO2**
Unit III Stem Cells in Regenerative Medicine **11 Hours** Tissue engineering: scaffolds, hydrogels, and biomaterials in cell delivery, Application of stem cells in cardiac, neural, musculoskeletal, and hepatic	**CLO3**

regeneration, iPSCs in disease modeling and patient-specific therapies, Stem cells in gene therapy, Stem cell-based therapy for diabetes, retinal degeneration, and spinal cord injury, 3D bioprinting and organ-on-a-chip systems for translational applications.	
Unit IV Clinical, Ethical and Regulatory Aspects **11 Hours** Good Manufacturing Practices (GMP) in stem cell production, Preclinical and clinical trial design: safety, efficacy, endpoints, Approved and ongoing clinical trials: global and Indian perspectives, Stem cell banking: protocols and significance, National and International regulatory frameworks (ICMR, CDSCO, FDA, EMA), Ethical issues: use of embryonic stem cells, informed consent, commercialization, Stem cell tourism and challenges in unproven therapies.	**CLO4**

Transactional Modes: Lecture**;** Demonstration**;** Tutorial**;** Lecture cum demonstration; Problem solving; Self-learning.
Internal assessment shall be through any of the following: Group discussions, Surprise Tests, case analysis, simulated problem solving, classroom assignments, term paper, presentations and discussions.

Suggested Reading:

1. Lanza, R., Gearhart,J. (2016). Essential of Stem Cell Biology. Elsevier Academic Press.
2. Lanza, R., Klimanskaya, I. (2018). Essential Stem Cells Methods. Academic Press.
3. Mao, J. J. & (2017). Translational approaches in tissue engineering and regenerative medicine. Artech House.
4. Lanza, R. (2017). Principles of Tissue Engineering, 3rd Edition. Academic Press
5. Stein, G. S., Borowski, M., Luong, M. X., Shi, M. J., Smith, K. P., & Vazquez, P. (Eds.). (2011). Human stem cell technology and biology: A research guide and laboratory manual. John Wiley & Sons.
6. Lanza, R., Blau, H., Gearhart, J., Hogan, B., Melton, D., Moore, M., ... & Weissman, I. (Eds.). (2014). Handbook of Stem Cells, Two-Volume Set: Volume 1-Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells. Elsevier.

Course Code: **MMME.522**
Course Title: **Molecular and Cellular Oncology**
Total Hours: **45**

L	T	P	C
3	0	0	3

Course Learning Outcomes:
On successful completion of the course the student will be able to:
CLO1: Understand fundamentals of cancer.
CLO2: Gain knowledge about genetics and signal transduction involved in tumorigenesis.
CLO3: Learn about various tools used for diagnostic purposes.
CLO4: Understand basics principles of anticancer therapeutics as well as about recent developments of the field.

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Unit I **13 Hours** Fundamentals and Genetics of Cancer: Hallmarks of cancer, cancer classification, Mutagens, carcinogens and gene mutations, Chromosomal aberrations, tumor viruses and discovery of oncogenes, tumor suppressors and oncogenes, familial cancer syndromes, telomere regulation in cancer.	**CLO1**
Unit II **11 Hours** Signal Transduction in Cancer Progression: Deregulation of Cell cycle in cancer. Cell signaling in cancer; cancer metabolism; hypoxia and metastasis, angiogenesis, tumor microenvironment. DNA damage and repair defects and their relation to cancer, cancer stem cells	**CLO2**
Unit III **11 Hours** Cancer Detection: General and organ specific symptoms associated with cancer, techniques for cancer detection, biomarkers for cancer detection of various stages of cancer, In-vitro assays to detect angiogenesis, metastasis, cell proliferation, mice models to study cancer (transgenic, knock-out, knock-in, xenografts and patient derived xenografts), genomic and proteomic approaches to develop better cancer markers.	**CLO3**
Unit IV **10 Hours** Cancer Therapies and Recent Advances in Cancer Research: Traditional Chemotherapies, radiotherapy, Onco-surgery, Bone marrow transplantation, stem cell therapies, Immunotherapy, combinational therapies, natural products as therapeutics, cancer vaccines, gene therapies, targeted anticancer therapies, CAR T and Indian traditional medicine for cancer therapies.	**CLO4**

Transactional Modes: Lecture**;** Demonstration**;** Tutorial**;** Lecture cum demonstration; Problem solving; Self-learning.
Internal assessment shall be through any of the following: Surprise Tests, case analysis, simulated problem solving, classroom assignments, term paper, presentations and discussions.

Suggested Reading:

1. DeVita, V. T., Rosenberg, S. A., & Lawrence, T. S. (2018). DeVita, Hellman, and Rosenberg's cancer. Lippincott Williams & Wilkins.
2. Enders, G. H. (2010). Cell cycle deregulation in cancer. Humana Press, Springer science, New York.
3. Gusev, Y. (2019). Micro RNA Profiling in Cancer. Pan Standford publishing pvt.Ltd., Singapore.
4. Hiem, S., & Mitelman, F. (2019). Cancer Cytogenetics. IIIrd edition. Willey-Blackwell publishing, New Jersey.
5. Jocelyn, E. K., Elliot, S. G., Stephen, T. K. (2018). Lewin's Gene X. Jones &Barlett.
6. Wang, E. (2018). Cancer systems biology. CRC press, Taylor & Francis group, New York.
7. Jacques Robert (2015) Textbook of cell signalling in cancer, Springer science, New York.

8. Weinberg, Robert A. (2023), 3rd edition, The Biology of Cancer. New York: Garland Science

Related Weblink
http://www.insidecancer.org/
http://www.who.int/cancer/en/
http://www.cancer.gov/
http://www.icmr.nic.in/ncrp/cancer_reg.htm

Course Code:	**MMME.523**
Course Title:	**Genetic Engineering and Recombinant Therapeutics**
Total Hours:	**45**

L	T	P	C
3	0	0	3

Course Learning Outcomes:
On successful completion of the course the student will be able to:
CLO1: Know about genetic engineering and its applications.
CLO2: Gain knowledge about various cloning, expression vectors and their importance in research.
CLO3: Understand concept of artificial chromosomes and their potential applications.
CLO4: Learn therapeutics aspect of recombinant DNA technologies

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Unit I **11 Hours** Basics of Genetic Engineering: Gene manipulation tools for molecular cloning, restriction enzymes their types, cohesive and blunt and ligation, linkers, adaptors, homopolymeric tailing, transformation, transfection: chemical and physical methods, sequencing methods, gene cloning, in-silico methods of design.	**CLO 1**
Unit II **11 Hours** Gene Cloning Vectors: Plasmids, bacteriophages, cloning in M13 Vectors, phagemids, Lambda vectors; insertion and replacement vectors, Cosmid vectors, Artificial chromosome vectors (YACs, BACs), Animal virus derived vectors-Sv-40, retroviral vectors, Expression vectors	**CLO 2**
Unit III **11 Hours** Techniques in Genetic Engineering: Isolation and Detection of DNA, RNA and proteins by Southern blotting, Northern blotting, Western blotting and in situ hybridization, Site Directed Mutagenesis, Yeast two hybrid system, phage display, characterization of expressed proteins through various biophysical, biochemical methods,	**CLO 3**
Unit IV **12 Hours** Applications of recombinant DNA technology: Applications of rDNA in diagnosis of pathogens and abnormal genes, Gene Editing through CRISPR/CAS system, transgenic animals for production of proteins and pharmaceuticals, Biosafety and Ethical considerations in genetic engineering.	**CLO 4**

Transactional Modes: Lecture**;** Demonstration**;** Tutorial**;** Lecture cum demonstration; Problem solving; Self-learning.
Internal assessment shall be through any of the following: Surprise Tests, case analysis, simulated problem solving, classroom assignments, term paper, presentations, and discussions.

Suggested Reading:

1. R.W. Old., & S.B. Primrose. (2017). Principles of Gene Manipulation Blackwell science.
2. Bernard R. Glick., & Jack J. Pasternak. (2018) Molecular Biotechnology ASM Press Washington.
3. James, Watson Micheal Gilman Jan Witkowsk (2017) Recombinant DNA, CSHL, New York.
4. Cokin, R., & Bjorn, C. (2016). Basic Biotechnology Cambridge University press.
5. John E. Smith. (2019). Biotechnology by Cambridge University press.
6. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losicke, R. (2017). Molecular Biology of Gene by Watson CSHL Press New York.
7. Sambrook, J & Sambrook, R. (2018). Molecular cloning, CSHL Press, New York.

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Course Code:	**MHGE.525**
Course Title:	**Tools of Bioinformatics (Practical)**
Total Hours:	**60**

L	T	P	C
0	0	6	3

Course Learning Outcomes:
On successful completion of the course the student will be able to:
CLO1: Analyze publicly available and experimental genomics data
CLO2: Analyze sequence alignment and generation of PCR oligos
CLO2: Perform in-silico prediction of protein structures and interactions
CLO3: Perform next generation sequence and microarray data analysis and functional annotation of genetic findings.
CLO4: Demonstrate physical property of biomolecules in-silico

1.	Access to sequence databases (downloading DNA/RNA/Protein sequences),.	CLO1
2.	Genomic, transcriptomic and proteomic data retrieval and analysis	
3.	Primer designing for PCR and RT-PCR	CLO2
4.	Performing sequence alignment using various tools (BLAST, MSA)	
5.	Pipeline of Next generation RNA-seq/DNA sequencing analysis.	CLO3
6.	Genome wide association study and DNA microarray-data analysis	
7.	Analysis of linkage disequilibrium plots.	
6.	Prediction of Protein structure using sequence database	CLO4
9.	Practical insights of tertiary structure prediction and comparative modeling.	
7.	Protein-protein and protein-ligand docking	

Transactional Modes: Hands-on training; Demonstration**;** Tutorial**;** Lecture cum demonstration; Problem solving; Self-learning.
Internal assessment shall be through any of the following: Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, Seminars, term papers, discussions, and presentations.

Evaluation criteria for practical courses:
- Continuous Assessment = **60 Marks**

Based on performance and good lab practices of the students and completion of the record book (60 divided by the number of practicals)
- Final Examination = **40 Marks**
  - Subjective question = 10 Marks
  - Performing experiment = 20 Marks
  - Viva voce = 10 Marks

Suggested Readings:
1. Laboratory Protocols. Third Edition. 2005. CIMMYT Applied Molecular Genetics Laboratory.

2. Koliantz, G & Szymanski, D.B. Genetics A Laboratory Manual. Second Edition. 2009. American Society of Agronomy, Crop Science Society of America.
3. Sambrook, J & Green, M.R. Molecular Cloning: A laboratory manual. Fourth Edition. 2013. Cold Spring Harbor Laboratory Press, U.S.
4. Pazos, F & Chagoyen, M. Practical protein bioinformatics.2015. Springer International Publishing, Switzerland.
5. Agostino, M. Practical Bioinformatics. 2012. Garland Science. Taylor & Francis Group. New York and London.

Course Code: **MMME.524**
Course Title: **Practical Course in Molecular Medicine**
Total Hours: **90**

L	T	P	C
0	0	6	3

Course Learning Outcomes:
At the completion of this course, the students will learn:
CLO1: To evaluate biological experiments using the principles of molecular biology and its applied aspect.

CLO2: To analyze the experimental results based on a variety of techniques to prove biological hypotheses.

CLO3: To apply the gained knowledge in diagnosis and therapeutics practically.

CLO4: To acquire hands-on practice in cell culture and its applications in tissue engineering.

Practicals

1.	Agarose Gel Electrophoresis	CLO1
2.	Polymerase Chain Reaction for SNP Analysis	
3.	RNA extraction and cDNA synthesis	CLO2
4.	Real-Time PCR	
5.	Western Blotting	
6.	Genome Wide Association studies	CLO3
7.	Transcriptomic studies	
8.	Next Generation Sequencing	
9.	Epigenomic Studies	
10.	Cell Culturing	CLO4

Transactional Modes: Lecture**;** Demonstration**;** Virtual classrooms; Problem solving; Self-learning; YouTube demonstrations; Lab performances.

Evaluation criteria for practical courses:
- Continuous Assessment = **60 Marks**

Based on performance and good lab practices of the students and completion of the record book (60 divided by the number of practical's)
- Final Examination = **40 Marks**

Subjective question = 10 Marks

Performing experiment = 20 Marks
Viva voce = 10 Marks

Compulsory Foundation Course

Course Code:	**MHGE.526**
Course Title:	**Biosafety, Bioethics, and Intellectual Property Rights**
Total Hours:	**30**

L	T	P	C
2	0	0	2

Course Learning Outcomes:
On successful completion of the course the student will be able to:
CLO1: Interpret the bioethical issues concerning biotechnological advancements and while carrying out research work.
CLO2: Implement biosafety while carrying out research.
CLO3: Distinguish different types of Intellectual Property Rights.
CLO4: Understand the process of protection of invention under Patent.

Unit I **7 Hours** **Biosafety:** Good laboratory practices; Risk and safety assessment from genetically engineered organisms; biological containment (BC) and physical containment (PC); CDC biosafety levels; biohazard management.	**CLO1**
Unit II **8 Hours** **Bioethics:** Ethical considerations during research; Use of Animals for clinical research; Embryonic and adult stem cell research; the element of informed consent.	**CLO2**
Unit III **7 Hours** **Intellectual Property Rights (IPRs):** Various forms of IP – patents, industrial designs, trademark, geographical indications, and plant breeder's right; copyright: fair use, plagiarism; protection of indigenous intellectual property.	**CLO3**
Unit IV **8 Hours** **Protection of Invention under Patent**: Patent filing procedure in India and ways of patent protection in other countries: Determination of patentability of inventions, filing a patent application in India: timeline, procedure involved in the granting of a patent, patent cooperation Treaty (PCT).	**CLO4**

Transactional Modes: Lecture**;** Demonstration**;** Virtual classrooms; Tutorial**;** Lecture cum demonstration; Problem solving; Case study; Self-learning.
Internal assessment shall be through any of the following:
Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, Seminars, term papers, discussions, and presentations.

Suggested Readings:

1. Ahuja, V.K. (2017). Law relating to Intellectual Property Rights (3rd Ed). LexisNexis

2. Beauchamp, T.L. and Childress, J.F. (2019). Principles of Biomedical Ethics. Oxford University Press
3. Dawn, P.W. and Byers, K.B. (2017). Biological Safety: Principles and Practices (Fifth Ed). ASM Press
4. Neeraj, P. and Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.
5. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
6. Shannon, T.A. (2023). An Introduction to Bioethics (4th ed). Paulist Press, USA.

Interdisciplinary Course

		L	T	P	C
Course Code:	**MHGE.506**				
Course Title:	**Intellectual Property in the Life Science Industry**	**2**	**0**	**0**	**2**
Total Hours:	**30**				

Course Learning Outcomes:

On successful completion of the course the student will be able to:
CLO1: Understand the concept and genesis of IP
CLO2: Differentiate between plagiarism and fair use of copyright material
CLO3: Understand the Patent regime of India
CLO4: Understanding of role of IP in technology transfer, licensing for Industries

Unit I **8 Hours** **Types of Intellectual Property Rights:** patents, industrial designs, trademark, geographical indications, and plant breeder's right; copyright: fair use, plagiarism; protection of indigenous intellectual property	**CLO1**
Unit II **6 Hours** **Copyright:** Copyright and related rights; Plagiarism; Fair Use of copyright material; Layout Design Protection.	**CLO2**
Unit III **8 Hours** **Patent Regime in India:** Patents, patentability of inventions; non-patentable subject matter, Patent registration procedure in India; Protection of Traditional Knowledge, Assignment and license of patented technology; Patent filing routes for other countries: Convention Application and Patent Cooperation Treaty (PCT) application.	**CLO3**

Unit IV **8 Hours** **Industry-Academia Collaboration:** Collaborative research projects, Technology transfer, Licensing requirements.	**CLO4**

Transactional Modes: Lecture**;** Demonstration**;** Tutorial**;** Virtual classrooms; Lecture cum demonstration; Problem solving; Self-learning, Class activity based

Internal assessment shall be through any of the following: Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, term paper, Seminars.

Suggested Readings:

1. Dutfield G. (2003). Intellectual Property Rights and the Life Science Industries: A Twentieth Century History (Globalization and Law). Routledge.
2. Mahop, M.T. (2010). Intellectual Property, Community Rights and Human Rights: The Biological and Genetic Resources of Developing Countries. Routledge.
3. Khor M. (2002). Intellectual Property, Biodiversity and Sustainable Development: Resolving the Difficult Issues. Zed Books limited.
4. Ahuja, V.K. (2017). Law relating to Intellectual Property Rights. LexisNexis, India. 3rd Edition.
5. Mahop, M.T. (2010). Intellectual Property, Community Rights and Human Rights: The Biological and Genetic Resources of Developing Countries. Routledge, USA.
6. Neeraj, P. and Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.
7. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.

Weblinks:

1. World Intellectual Property Organization (https://www.wipo.int/about-ip/en/)
2. Office of the Controller General of Patents, Designs & Trademarks (http://www.ipindia.nic.in/)

Value added Course

Course Code:	**MMME.511**
Course Title:	**Fundamentals of Behavioural Neuroscience**
Total Hours:	**30**

L	T	P	C
2	0	0	2

Course Learning Outcomes:

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On successful completion of the course the student will be able to:

CLO1: To understand the neural mechanisms underlying behaviour
CLO2: To explore how development, plasticity, and hormones shape behaviour across the lifespan.
CLO3: To understand neural mechanisms of learning, memory, emotion, and motivation.
CLO4: To examine the neural basis of psychiatric and developmental disorders and their impact on social behaviour.

UNIT I **8 Hours** Introduction to Behavioural Neuroscience: Overview of the field, historical background, and key concepts, Contributions from neuroscience and psychology to understanding behaviour; Neuroanatomy and Neurophysiology: Structure and function of the central and peripheral nervous systems, Neuronal structure, resting membrane potential, and action potential generation; Neurotransmission and Neurotransmitters: Synaptic transmission and types of synapses, Overview of major neurotransmitter systems and their roles in behaviour.	**CLO 1**
UNIT II **6 Hours** Hormones, Neuroendocrinology, and Behaviour: Role of hormones in modulating behaviour, Interactions between the endocrine system and the brain; Neurodevelopment and Plasticity: Stages of brain development and critical periods, Mechanisms of neuroplasticity and remodeling throughout life.	**CLO 2**
UNIT III **10 Hours** Learning Mechanisms: Classical and Operant Conditioning: Principles of associative learning, Neural circuits involved in different types of learning; Memory Systems and Synaptic Plasticity: Short-term and long-term memory, hippocampal function, and cortical involvement; Emotion and Stress Responses: Neural circuits of fear, anxiety, and emotional regulation, The amygdala, prefrontal cortex, and the physiological effects of stress; Reward, Motivation, and Addiction: Dopaminergic reward pathways and reinforcement learning, Neural basis of addiction and the impact of substance use on the brain.	**CLO 3**
UNIT IV **6 Hours** Neurobiology of Psychiatric Disorders: Mood disorders (e.g., depression, bipolar disorder) and anxiety disorders, Neural circuits affected and current research on treatment strategies; Social Neuroscience and Behaviour: Neural basis of social cognition, empathy, and mirror neurons, Impact of social structures on brain function and behaviour.	**CLO 4**

Transactional Modes: Lecture**;** Demonstration**;** Tutorial**;** Lecture cum demonstration; Problem solving; Self-learning; MCQ practice.
Internal assessment shall be through any of the following: Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, Seminars, term papers, discussions, and presentations.

Suggested Readings:

1. Kandel, E. R., Schwartz, J. H., Jessell, T. M., Siegelbaum, S. A., & Hudspeth, A. J. (2013). *Principles of Neural Science*(5th Edition). McGraw-Hill.

2. Carlson, N. R., & Birkett, M. A. (2021). *Physiology of Behavior* (13th Edition). Pearson.
3. Bear, M. F., Connors, B. W., & Paradiso, M. A. (2015). *Neuroscience: Exploring the Brain* (4th Edition). Wolters Kluwer.
4. Purves, D., et al. (2018). *Neuroscience* (6th Edition). Oxford University Press.
5. Society for Neuroscience – BrainFacts.org

Semester III

Skill Based Course

Course Code: **MMME.599-1**
Course Title: **Dissertation Part-I/ Industrial/ Hospital based training/Internship**
Total Hours: **600**

L	T	P	C
0	0	40	20

Course Learning Outcomes:
On successful completion of the course the student will be able to:

Dissertation:
Critically review literature, define a research problem, formulate hypotheses, and design a feasible experimental or analytical approach in Molecular Medicine.

Industrial/ Hospital based training
Understand industrial workflows, technologies, and research strategies in molecular medicine and identify a project area aligned with their academic background (*Apprenticeship will be in Medical Diagnostic Company/Hospitals offering genetic, molecular diagnosis and counseling*)

Internship
Understand the research environment, explore ongoing projects and methodologies, and identify a specific research question to pursue under mentorship *(Internship will be carried out in Research Institutions/Universities of Eminence).*

Synopsis will be evaluated as per the University policy.
Evaluation criteria:

Examiner	Marks	Evaluation
Supervisor	50	Dissertation proposal and presentation
HoD and Senior-most faculty of the department	50	Dissertation proposal and presentation

Semester IV

Skill Based Course

Course Code:	**MMME.599-2**
Course Title:	**Dissertation Part-II/ Industrial/ Hospital based training/Internship**
Total Hours:	**600**

L	T	P	C
0	0	40	20

Course Learning Outcomes:
On successful completion of the course the student will be able to:

Dissertation:
Conduct experiments or data analysis, interpret results, and present their findings in a scientifically structured dissertation.

Industrial/ Hospital based training
Apply academic knowledge to industrial research, utilize specialized tools or techniques, and prepare a report linking academic concepts with real-world biomedical applications.

Internship
Execute a research project using appropriate methods, analyze and interpret results, and present their findings in a structured scientific report relevant to molecular medicine.

Dissertation will be evaluated by the Department, as per the University policy.
Evaluation criteria

Examiner	**Marks**	**Evaluation**
Supervisor	50	Continuous assessment (regularity in work, mid-term evaluation) dissertation report, presentation, final viva-voce
External expert, HoD and senior-most faculty of the department	50	Dissertation report (30), presentation (10), final viva-voce (10)

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Examination pattern and evaluation for Masters' students from 2025-27 session

Formative Evaluation: Internal assessment shall be 25 marks using any two or more of the given methods: tests, open book examination, assignments, term paper, etc. The Mid-semester test shall be of 25 marks including short answer and essay type. The number of questions and distribution of marks shall be decided by the teachers.

Summative Evaluation: The End semester examination (50 marks) with 70% descriptive type and 30% objective type shall be conducted at the end of the semester. The objective type shall include one-word/sentence answers, fill-in the blanks, MCQs', and matching. The descriptive type shall include short answer and essay type questions. The number of questions and distribution of marks shall be decided by the teachers. Questions for exams and tests shall be designed to assess course learning outcomes along with focus on knowledge, understanding, application, analysis, synthesis, and evaluation.

The evaluation for IDC, VAC and entrepreneurship, innovation and skill development courses shall include MST (50 marks) and ESE (50 marks). The pattern of examination for both MST and ESE shall be the same as ESE described above for other courses.

Evaluation of dissertation proposals in the third semester shall include 50% weightage by supervisor and 50% by HoD and senior-most faculty of the department. The evaluation of dissertation in the fourth semester shall include 50% weightage for continuous evaluation by the supervisor for regularity in work, mid-term evaluation, report of dissertation, presentation, and final viva-voce; 50% weightage based on average assessment scores by an external expert, HoD and senior-most faculty of the department. Distribution of marks is based on the report of dissertation (30%), presentation (10%), and final viva-voce (10%). The-- external expert may attend final viva-voce through offline or online mode.

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Examination pattern from 2025-27 session

Core, Discipline Elective, and Compulsory Foundation Courses			IDC, VAC, and Entrepreneurship, Innovation and Skill Development Courses	
	Marks	Evaluation	Marks	Evaluation
Internal Assessment	25	Various methods	-	-
Mid-semester test (MST)	25	Descriptive	50	Descriptive (70%) Objective (30%)
End-semester exam (ESE)	50	Descriptive (70%) Objective (30%)	50	Descriptive (70%) Objective (30%)

Dissertation-I (Third Semester)			Dissertation-II (Fourth Semester)		
	Marks	Evaluation		Marks	Evaluation
Supervisor	50	Dissertation proposal and presentation	Supervisor	50	Continuous assessment (regularity in work, mid-term evaluation) dissertation report, presentation, final viva-voce
HoD and senior-most faculty of the department	50	Dissertation proposal and presentation	External expert, HoD and senior-most faculty of the department	50	Dissertation report (30), presentation (10), final viva-voce (10)

Marks for internship shall be given by the supervisor, HoD and senior-most faculty of the department.

Some Guidelines for Internal Assessment

1. The components/pattern of internal assessment/evaluation should be made clear to students during the semester.

2. The results of the internal assessment must be shown to the students.

3. The question papers and answers of internal assessment should be discussed in the class.

4. The internal assessment shall be transparent and student-friendly and free from personal bias or influence.