CENTRAL UNIVERSITY OF PUNJAB

M.Sc. in Human Genetics

Batch: 2025-2027

Department of Human Genetics and Molecular Medicine

Graduate Attributes

The graduates of the Master of Science in Human Genetics will acquire the following:

- **Context of Society**

The students of this course will understand the significant role human genetics/genomics, human cytogenetics, epidemiology and public health research, pharmacogenomics, nutrigenomics, therapies for genetic diseases and cell and molecular biology play 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 human genetics, molecular biology, bioinformatics, and translational research through the subject content across a broad range of modules for the students. The development of skills in human genetics will enhance employability in the field of human genetics on account of their inclusion in clinical practice. 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. Exposure to genetic diseases, therapies, and counseling will help the students to take up the profession of a genetic counselor who helps families to understand the significance of genetic disorders in the context of cultural, personal, and familial situations.

- **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 human genetics relevant research areas. Geneticists are now equipped with powerful tools for genome editing. Exposure to these tools will help the graduates to explore the application of this research more broadly in both research and medicine.

Syllabus
M.Sc. in Human Genetics (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)	02 (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
M.Sc. in Human Genetics (Batch: 2025-2027)

Course Structure of the Programme

Semester-I

Course Code	Course Title	Course Type	Hours			Credit Hours
			L	T	P	
Core Course						
MHGE.516	Advanced Human Genetics	Core	3	0	0	3
MHGE.517	Advances in Immunology	Core	3	0	0	3
MMME.517	Cellular and Molecular Biology	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
MHGE.520	Advanced Human Genetics (Practical)	Skill Based	0	0	4	2
Discipline Elective Course (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						

Course Structure of the Programme
Semester-II

Course Code	Course Title	Course Type	Hours			Credit Hours
			L	T	P	
Core Course						
MHGE.521	Human Embryology and Developmental Genetics	Core	3	0	0	3
MHGE.522	Genetic Diseases, Therapies, and Counseling	Core	3	0	0	3
MMME.523	Genetic Engineering and Recombinant Therapeutics	Core	3	0	0	3
Skill Based Course						
MHGE.524	Clinical Genetics (Practical)	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 the Life Science 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 (select anyone)						
MMME.511	Fundamentals of Behaviour 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
M.Sc. in Human Genetics (Batch: 2025-2027)

Course Structure of the Programme
Semester-III

Course Code	Course Title	Course Type	Hours			Credit
			L	T	P	
MHGE.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
M.Sc. in Human Genetics (Batch: 2025-2027)

Course Structure of the Programme
Semester-IV

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

Semester I

Course Code: **MHGE.516**
Course Title: **Advanced Human Genetics**
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 the Mendelian and non-Mendelian inheritance patterns. Gather knowledge about genetic linkage and sex determination. .
CLO2: Apply molecular cytogenetic techniques for the identification of individual chromosomes and various chromosomal anomalies.
CLO3: Describe biochemistry and genetics of various blood group types, Distinguish different disorders caused due to abnormal variants of hemoglobin, lysosomal enzymes, lipids, and DNA nitrogenous bases.
CLO4: Analyze population dynamics, genotypic and allelic variations and frequencies.

Unit I **11 Hours** **Transmission Genetics**: Mendel's laws of inheritance and their applications; concept of segregation, independent assortment and dominance; pedigree analysis; epistasis; crossing over and recombination; gene linkage and genetic mapping; Extrachromosomal inheritance. Sex determination in humans and Drosophila.	**CLO1**
Unit II **12 Hours** **Molecular Cytogenetics** Cytogenetic and Molecular Cytogenetic Techniques: Methods of Chromosome preparation; chromosome banding techniques: G banding, Q banding, R banding and C banding; fluorescent in situ hybridization (FISH); different types of FISH probes: centromeric probes, chromosome specific probes and telomeric probes; reverse painting; flow cytometry; comparative genomic hybridization (CGH) mapping technique, whole chromosome painting; spectral karyotyping (SKY).	**CLO2**
Unit III **11 Hours** **Human Biochemical Genetics:** Blood groups and Haemoglobinopathies: Biochemical and genetic basis of blood group systems: ABO, Rh and MN; Haemoglobin structure, quantitative and qualitative disorders of globin chain synthesis, Sickle Cell Anaemia, Thalassemia; Inborn errors of metabolism: Lysosomal Storage disorders (LSDs)	**CLO3**
Unit IV **11 Hours** **Human Population Genetics:** Population Dynamics, conditions and deviations of the Hardy-Weinberg law; selection coefficient and fitness; heterozygous advantages; inbreeding, Genetic load; dynamics of migration and genetic drifts.	**CLO4**

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

Internal assessment shall be through any of the following: Report on novel chromosome aberrations in human, Discussion on transposable elements in human diseases, Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, Karyotype analysis presentations and discussions.

Suggested Readings:

1. Hartl, D.L. (2020). A Primer of Population Genetics and Genomics (Fourth Ed). Oxford University Press
2. Hartle, D.L. and Jones, E.W. (2017) Genetics: Analysis of Genes and Genomes. (Ninth Ed). Jones & Bartlett Learning.
3. Klug, W.S. and Cummings, M.R. (2019) Concepts of Genetics. (Twelfth Ed) Prentice-Hall.
4. Pierce, B.A. (2016)Genetics: A Conceptual approach. Freeman Publishers.
5. Snusted, D.P., Simmons, M. J. (2010). Principles of Genetics. John Wiley & Sons, New.

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.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: **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: Evaluate the basic concepts of Enzymes, Enzyme Kinetics, and its role in metabolic processes. Conceptualize the basic features of enzyme catalysis and regulation.
CLO2: Study the basic structural features of carbohydrates and its metabolism.
CLO3: Conceptualization of pathways in lipid metabolism.
CLO4: Study the structure of nucleic acids, amino acids and proteins and their metabolism.

Unit I **12 Hours** Enzymes: Importance & Classifications; Properties of enzymes; Isozymes; Enzyme nomenclature; Factors affecting enzyme action, Enzyme regulation; Mechanism of enzyme action; Enzyme kinetics & enzyme inhibitors; ES complex formation; Michaelis-Menten equation; Line-weaver Burk plot; Km value and its significance; Turnover number; Enzyme inhibitors, Allosteric enzymes. Ribozymes and Abzymes.	**CLO1**
Unit II **11 Hours** Carbohydrates: Structure and functions of monosaccharides, disaccharides, and polysaccharides; Epimers; Anomers; mutarotation. Reactions of carbohydrates. Carbohydrate's metabolism - General scheme of metabolism. Glycolysis, TCA cycle, Gluconeogenesis, Glycogenolysis, Pentose phosphate pathway, and their regulation; Oxidative phosphorylation	**CLO2**
Unit III **11 Hours** Lipids: Classification - simple, compound and derived lipids with examples and their role in the human body. Lipid metabolism: Beta oxidation - Pathway and regulation. Role of acyl carnitine in fatty acyl transport. Biosynthesis of cholesterol and regulation. Formation of Ketone bodies.	**CLO3**
Unit IV **11 Hours** Amino acids: Metabolism of Amino Acids. Proteins: Classification and biological importance of protein in human body; Secondary, Tertiary and Quaternary structure, Ramachandran plot. Oxygen binding proteins – Hemoglobin and myoglobin. Hill equation, Bohr's Effect. Nucleic Acids: Metabolism of purines and pyrimidines- Salvage and de novo 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:	**MHGE.520**
Course Title:	**Advanced Human Genetics (Practical)**
Total Hours:	**60**

L	T	P	C
0	0	2	2

Course Learning Outcomes:

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

1. Perform any experiments on Mendelian genetics
2. Perform pedigree analysis
3. Perform linkage based genetic analysis
4. Design genetic experiments using common model organisms

List of Practical work:

1	Problems on Monohybrid and dihybrid ratios, Multiple alleles, Epistasis	**CLO1**
2	Inheritance patterns in Human– Numerical on Pedigree analysis- Autosomal patterns, X–linked patterns, Y–linked patterns	**CLO 2**
3	Segregation analysis (Monohybrid, Dihybrid)	
4	Analysis on Linkage	**CLO3**
5	Linkage mapping	
6	Identification of inactivated X chromosome as Barr body	**CLO4**

Transactional Modes: Hands-on practical's; Demonstration**;** Virtual classrooms; Tutorial**;** Self-directed learning.

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: **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 healthcare; 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 variations and markers; Tag-markers; Haplotypes; Linkage disequilibrium (LD); QTL and eQTL; Databases of genetic variations: 1000 Genomes 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

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

Core Courses

Course Code: **MHGE.521**

Course Title: **Human Embryology and Developmental Genetics**

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: Conceptualize basics of reproductive physiology
CLO2: Correlate genetic regulation in different embryonic developmental stages
CLO3: Evaluate the role of biomolecules in embryonic development.
CLO4: Know different genetic and environmental triggers for post-natal development, ageing and senescence.

Unit I **12 Hours** **Basic concepts of Embryology:** Gametogenesis; fertilization; embryogenesis: gastrulation and implantation of embryo; fetal membrane and placenta; different stages of development: morula, blastula and gastrula; potency, commitment, specification, induction, competence, determination and differentiation.	**CLO1**
Unit II **11 Hours** **Gene expression regulation in developmen**t: Basics of gene expression regulation during early embryogenesis; homeotic genes, P granules, role of key developmental genes: Polycomb repressor complexes (PRC1 and PRC2), Sox proteins.	**CLO2**
Unit III **11 Hours** **Stem Cell and Organogenesis**: Stem cell: embryonic and adult; cell-cell communication; neural crest cells and axonal specificity; vertebrate eye and central nervous system development; hematopoiesis.	**CLO3**
Unit IV **11 Hours** **Birth defects, experimental human embryology and teratology:** Congenital birth defects and therapeutic interventions: morphological defects, etiology of birth defects. Experimental human embryology- pre-implantation genetic diagnosis of birth defects; ethics involved in blastomeric biopsy. Teratology: effect, types, risks and preventions	**CLO4**

Transactional Modes: Lecture; Demonstration; Tutorial; Virtual classrooms; 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.

Suggested Readings:

1. Gilbert, S.F. (2013). Developmental Biology. Tenth Edition.
2. Slack, J.M.W. (2012). Essentiel Developmental Biology. Third Edition.
3. Moody, A.A. (2014). Principles of Developmental Genetics. Second Edition.
4. Slack, J.M.W. (2018). The Science of Stem Cells. First Edition.
5. Milunsky, J. & Milunsky, A. (2010). Genetic Disorders and the Fetus: Diagnosis, Prevention & Treatment. Willey Blackwell India, New Delhi.
6. Prakash, G. (2007). Reproductive Biology. Narosa Publication House Pvt. Ltd., New Delhi.
7. Sadler, T.W., Tosney, K., Chescheir, N., C., Imseis, H., Leland, J. and Sadler-Redmond, S., L. (2011).Langman's Medical Embryology (Longmans Medical Embryolgy). Lippincott Williams and Wilkins.
8. Keith L. Moore BA, T. V. N. Persaud MD., Mark G. Torchia (2019) The Developing Human Clinically Oriented Embryology, Elsevier, Netherlands.
9. Bruce M. Carison (2023) Human Embryology and Developmental Biology, 7th Edition, Elsevier, Netherlands.
10. Kar, A. (2021) Birth Defects in India: Epidemiology and Public Health Implications, Springer Nature.

Course Code:	**MHGE.522**
Course Title:	**Genetic Diseases, Therapies and Counseling**
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 the genetic causes of monogenic disorders and common multifactorial diseases
CLO2: Understand the genetic basis of Genomic imprinting. Analyze the consequences of altered epigenetic processes in causing genetic disorders
CLO3: Understanding genetic screening and counseling
CLO4: Define pharmacogenomics and will understand its application in clinical setting. The students will be aware about the challenges in the field on account of different ethnic background.

Unit I **11** Hours Monogenic Disorders and current therapeutic interventions: Cystic fibrosis; Huntington's disease; Duchenne Muscular dystrophy; X-linked rickets. Multifactorial Diseases: Diabetes type 2; Cancers; Hypertension; Obesity; Stroke. Stem cell therapies; gene therapies; crispr gene editing	**CLO1**
Unit I **11** Hours Genomic Imprinting and Human Diseases: Uniparental disomy and genomic imprinting; Imprinting syndromes: Prader-Willi and Angelman syndrome; Beckwith-Wiedemann syndrome and Silver Russell Syndrome; Role of Imprinting in brain development and behavior.	**CLO2**
Unit III **11** Hours Genetic Screening and Counseling: Pre symptomatic testing for genetic diseases and malignancy, carrier detection; prenatal and postnatal screening; Fetal cells and DNA in maternal blood, Preimplantation diagnosis; Effect of mutagenic and teratogenic exposure in early pregnancy; Genetic Counseling-Role of genetic counsellors, Diagnostic problems in genetic counseling, Psychosocial aspects of genetic counselling.	**CLO3**
Unit IV **12** Hours Pharmacogenomics: Pharmacokinetics and pharmacodynamics; drug-metabolizing enzymes: cytochrome P450s, VKORC1 and TPMT; personalized treatment: example of warfarin, anti-epileptic and anti-cancer drugs like methotrexate and tamoxifen, trastuzumap; heredity disorders with altered drug response: porphrriavariegata, hemoglobinopathies, Grigler-najjar syndrome; concept of pharmacogenomics.	**CLO4**

Transactional Modes: Lecture**;** Demonstration**;** Tutorial**;** Virtual classrooms; 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, Assignment on various gene therapies in use currently, Group activity to explore regulatory requirements and prepare a report. Literature survey on current medicines based on pharmacogenomics, In-depth interview on ADRs.

Suggested Readings:

1. Brown, S.M., (2009). Essentials of Medical Genomics. Wiley-Blackwell.
2. Jocelyn, E. K., Elliot, S. G., Stephen, T. K. (2009), Lewin's Gene X. Jones &Barlett.
3. Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. (2014). Lewin's Genes XI. Jones and Bartlet India Pvt. Ltd.

4. Lodish, H., Berk, A., Chris, A. K., Krieger, M. (2008), Molecular Cell Biology. W.H. Freeman, USA.
5. Milunsky, A. (2021).Genetic disorders and the fetus diagnosis prevention and treatment 8th Edition. Wiley Blackwell.
6. Petris, G. (2021).Curing Genetic Diseases through Genome Reprogramming. Elsevier
7. https://www.rosenpublishing.com/series/Genetic-Diseases-and-Gene-Therapies
8. Altman RB, Flockhart D and Goldstein DB (2012). Principles of Pharmacogenetics and Pharmacogenomics. Cambridge University Press.
9. Yui-Wing Francis Lam Stuart Scott (2018) Pharmacogenomics: Challenges and Opportunities in Therapeutic Implementation, Elsevier, Netherlands.
10. https://www.frontiersin.org/research-topics/22282/insights-in-pharmacogenetics-and-pharmacogenomics-2021
11. https://www.frontiersin.org/research-topics/15354/pharmacogenomics-of-adverse-drug-reactions-adrs
12. Lam,Y.W.F. and Scott, S.(2018).Pharmacogenomics Challenges and opportunities in therapeutic implementation. Science Direct

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

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.

Skill Based Courses

Course Code:	**MHGE.524**
Course Title:	**Clinical Genetics (Practical)**
Total Hours:	**90**

L	T	P	C
0	0	6	3

Course Learning Outcomes:
On successful completion of the course the student will be able to:
CLO1: Interpret how genetic factors predispose to Mendelian and adult onset diseases
CLO2: Implications of these predispositions for diagnosis, prevention, and treatment.
CLO3: Appreciate the importance of genetic counseling to assert the birth of a children affected with genetic disorders
CLO4: Assess the clinical features of common chromosomal alterations.
CLO5: Gain an insight into the cytogenetics and analysis of karyotypes
CLO6: Application of appropriate molecular biology techniques for diagnosis, disease prediction and prevention.

List of Practical work:

1	Genetic assessment and drawing pedigree.	**CLO1**
2	Genetic counseling	**CLO2, CLO3**
3	Common chromosomal disorders-case studies	**CLO4**
4	Cytogenetics and karyotype analysis	**CLO5**
5	DNA and RNA isolation, quantification, gel electrophoresis (agarose/PAGE),	**CLO6**
6	PCR-RFLP	
7	RT-PCR	
8	ELISA	

Transactional Modes: Lecture**;** Demonstration**;** Virtual classrooms; Problem solving; Self-learning, Pedigree drawing.

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

Suggested Readings:

1. Brooker, R.J (2017). Genetics: analysis and principles. 6th Ed. New York, NY: McGraw-Hill Education.
2. Hartwell, L. et al (2017). Genetics: from genes to genomes. 6th Ed. New Your, NY: McGraw-Hill Education.
3. Helen, M.K. 2002. ABC of clinical Genetics. 3rd Ed. BMJ Publishing Group. London.

Course Code: **MHGE.525**

Course Title: **Tools of Bioinformatics (Practical)**

Total Hours: **90**

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
CLO3: Perform next generation sequence and microarray data analysis and functional annotation of genetic findings.
CLO4: Perform in-silico prediction of protein structures and interactions

1.	Access to sequence databases (downloading DNA/RNA/Protein sequences).	CLO1
2.	Genomic/Transcriptomic/proteomic data retrieval and analaysis	
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, Switserland.
5. Agostino, M. Practical Bioinformatics. 2012. Garland Science. Taylor & Francis Group. New York and London.

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

Course Code:	**MHGE.506**
Course Title:	**Intellectual Property in the Life Science Industry**
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: 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 Based 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:
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:	**MHGE.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 Human Genetics.

- ***Industrial/hospital based training***

Understand industrial workflows, technologies, and research strategies in human genetics 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: **MHGE.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)

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.

Syllabus
M.Sc. in Human Genetics (Batch: 2025-2027)

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.