M.Sc. Human Genetics Semester Ist

1. Course Title: Cell and Molecular Biology **Course Code: P2HGTC101**

COURSE OUTCOMES:

- **CO1:** Students will understand cell structure in prokaryotes and eukaryotes, including organelles and the cytoskeleton.
- **CO2:** Students will learn cell cycle processes like mitosis, meiosis, and apoptosis, and how they are regulated.
- **CO3:** Students will study DNA functions, including replication, transcription, translation, and related experiments.
- **CO4:** Students will explore gene regulation and mutation types, along with DNA repair mechanisms.
- **CO5:** Students will understand cell signaling and communication through various receptors and signal transduction pathways.

2. Course Title : Physiology of Human Systems **Course Code: P2HGTC102**

COURSE OUTCOMES:

- **CO1:** Students will understand the structure and function of the human skeletal and muscular systems, including bone classification, muscle types, contraction mechanisms, and neuromuscular junctions.
- **CO2:** Students will studythe human digestive and respiratory systems, covering anatomy, physiology, related hormones, and mechanisms of gas exchange and respiratory control.
- **CO3:** Students will gain knowledge of cardiovascular and nervous systems, including heart function, neural anatomy, action potentials, and neurotransmission.
- **CO4:** Students will explore the human excretory system, focusing on nephron structure, urine formation, and excretory physiology.
- **CO5:** Students will learn the basics of endocrinology and reproduction, including major glands, hormone types, reproductive organs, and common endocrine disorders.

3. Course Title : Fundamentals of Genetics **Course Code: P2HGTC103**

COURSE OUTCOMES:

- **CO1:** Students will understand the structural organization of chromosomes in both prokaryotic and eukaryotic systems, including chromatin dynamics, nucleosome models, telomere architecture, and mitochondrial genome-related diseases.
- **CO2:** Students will explore the principles of heredity and genetic variation, emphasizing Mendelian and non-Mendelian inheritance, gene interactions, and cytogenetic foundations of hereditary traits.
- **CO3:** Students will examine chromosomal nomenclature and mechanisms of sex determination, including chromosomal landmarks, dosage compensation, and non-chromosomal determinants of sex.
- **CO4:** Students will analyze genetic linkage and recombination processes, applying gene mapping techniques, LOD score analysis, and tetrad analysis to understand genetic distances and inheritance patterns.
- **CO5:** Students will interpret patterns of genetic inheritance through pedigree analysis, while considering complex traits such as sex-linked inheritance, polygenic traits, and the influence of environmental and genetic variance on phenotypic expression.

4. Course Title : Fundamentals of Genetics **Course Code: P2HGTC107**

COURSE OUTCOMES:

- **CO1:** Students will comprehend core principles and applications of molecular separation and analysis techniques, including centrifugation, chromatography, electrophoresis, and spectrophotometry, for macromolecule isolation and quantification.
- **CO2:** Students will understand and apply modern molecular biology techniques, such as PCR, gene cloning, genome editing (CRISPR-Cas9), and next-generation sequencing, for genetic analysis and manipulation.

- **CO3:** Students will gain hands-on knowledge of bioinstrumentation tools like pH meters, microscopes, sterilization systems, and cell counters, essential for routine lab diagnostics and aseptic handling.
- **CO4:** Students will explore advanced analytical technologies, including mass spectrometry, flow cytometry, electron/confocal microscopy, and microarrays, with emphasis on their roles in diagnostics, proteomics, and biomedical research.
- **CO5:** Students will investigate structural biology and biosensing tools, such as NMR, X-ray crystallography, SPR, and lab-on-chip technologies, focusing on their diagnostic, therapeutic, and drug discovery applications.

5. Course Title: Microbial Genetics **Course Code: P2HGTC108**

COURSE OUTCOMES:

- **CO1**: Students will gain the competence to demonstrate the fundamentals of microbiology, including its history, scope, and the structural and functional characteristics of bacteria, viruses, and fungi.
- **CO2**: Students will be able to explain microbial genetic exchange mechanisms, such as transformation, conjugation, transduction, and phage genetics, and their applications in gene mapping.
- **CO3**: Students will be able to describe plasmid and phage genetics, including the use of various vectors and molecular assays like EMSA and luciferase for gene regulation studies.
- **CO4**: Students will explore major microbial pathogens, associated diseases, microbial markers, and the role of the human microbiome in health and disease.
- **CO5**: Students will understand and apply microbial tools and techniques, including cloning, CRISPR, metagenomics, and reporter gene systems for genetic analysis and functional studies.

M.Sc. Human Genetics Semester 2nd

1. Course Title: Molecular Basis of Human Genetics **Course Code: P2HGTC201**

COURSE OUTCOMES:

- **CO1**: Students will understand the structure and replication of nucleic acids, and explore key molecular techniques such as hybridization, recombinant DNA technology, and gene cloning with relevance to human diseases.
- **CO2**: Students will develop the skill to analyse the molecular basis of genetic mutations and disorders, including nomenclature, loss/gain of function mutations, chromosomal abnormalities, and the role of epigenetics in human pathology.
- **CO3**: Students will be able to evaluate gene identification strategies, such as positional and candidate gene approaches, mutation screening, and the implications of genome instability in disease development.
- **CO4**: Students be prepared to explore large-scale genomic and proteomic projects, including the Human Genome Project and pangenome initiatives, and study transcriptomic and proteomic tools for understanding gene expression and regulation.
- **CO5**: Students apply knowledge to examine modern diagnostics and therapeutic strategies, including gene therapy, genome editing (CRISPR), enzyme replacement therapy, and the use of model organisms in studying human genetic diseases.

2. Course Title: Human Embryology & Developmental Genetics

Course Code: P2HGTC202

COURSE OUTCOMES:

- **CO1**: Students will understand the basic molecular and cellular events in early human development.
- **CO2**: Students will learn the stages of embryonic and fetal development, including organ formation.

- **CO3**: Students will be able to explore how genes and cells guide tissue differentiation and body structure.
- **CO4**: Students will have the competence to examine how environmental factors and maternal health affect fetal development.
- **CO5**: Students will develop the skill to Identify and understand common congenital and reproductive developmental disorders.

3. Course Title: Human Cytogenetics **Course Code: P2HGTC203**

COURSE OUTCOMES:

- **CO1**: Students will develop the skill to identify and classify chromosomal abnormalities by recognizing structural changes (such as deletions, duplications, inversions, and translocations) and numerical changes (like aneuploidies) in human chromosomes.
- **CO2**: Students will be able to understand the mechanisms underlying chromosomal abnormalities, including errors during cell division, particularly in meiosis, and their implications for human health.
- **CO3**: Students gain the competence to explore the concept of genomic imprinting and its role in gene expression, highlighting how the parental origin of alleles can influence phenotypic outcomes.

4. Course Title: Fundamentals of Biochemistry **Course Code: P2HGTC204**

COURSE OUTCOMES:

- **CO1**: Students will be able to explore inborn errors of metabolism, highlighting the genetic and biochemical basis, clinical features, and diagnostic approaches of disorders like galactosemia, phenylketonuria, and Tay-Sachs disease.
- **CO2**: Students gain the competence to discuss the interdependence of metabolic pathways and how disruptions can lead to metabolic and systemic diseases, with emphasis on clinical correlations.

- **CO3**: Equip students with diagnostic and interpretive skills to recognize metabolic disorders through symptomatology, lab findings, and appropriate management strategies.

5. Course Title: Research Design and Methodology **Course Code: P2HGTE208**

COURSE OUTCOMES:

- **CO1**: Students will be able to introduce the fundamentals of scientific research, including formulation of research problems, hypotheses, and objectives.
- **CO2**: Students will develop skills in scientific writing and publishing, including manuscript preparation, citation, editing, and ethical considerations like plagiarism and conflict of interest.
- **CO3**: Familiarize students with various research study designs such as cohort, case-control, cross-sectional, and clinical trials, along with their applications and limitations.
- **CO4**: Students acquire knowledge and skills for designing of effective research tools, including questionnaires, consent forms, and appropriate sampling strategies with power and sample size calculations.
- **CO5**: Promote safe laboratory practices, emphasizing proper specimen handling, biosafety protocols, and management of hazardous materials in biomedical research.

6. Course Title: Genetic Diagnostics **Course Code: P2HGTE209**

COURSE OUTCOMES:

- **CO1**: Students will understand the principles and applications of molecular diagnostic techniques, including PCR, DNA sequencing, SNP analysis, and screening methods for genetic and disease diagnosis.
- **CO2**: Students will explore cytogenetic techniques such as karyotyping, FISH, MLPA, CGH, and GISH, and their role in detecting chromosomal abnormalities.
- **CO3**: Students will learn fundamental laboratory methods including centrifugation, electrophoresis, spectrophotometry, microscopy, blotting, and chromatography, and their applications in molecular diagnostics.

- **CO4**: Students will examine prenatal diagnostic methods, both invasive and non-invasive, and the role of NGS and point-of-care devices in early disease detection.
- **CO5**: Students will gain competence to Stay informed about emerging technologies in molecular diagnostics, including the latest advancements in sequencing platforms and diagnostic tools.

7. Course Title: Genetic Diagnostics and Genetic Counseling Course Code: P2HGVC251

- **<u>COURSE OUTCOMES:</u>**
- **CO1**: Students will understand core molecular and cytogenetic techniques including DNA isolation, lymphocyte culture, karyotyping, and diagnosis of chromosomal abnormalities.
- **CO2**: Students will be able to analyze genetic variants and interpret sequencing data using advanced technologies such as MLPA, NGS, and Optical Genome Mapping.
- **CO3**: Students will develop skill to Utilize genomic databases and bioinformatics tools for variant classification, annotation, and interpretation in clinical genetics.
- **CO3**: Students will be able to demonstrate knowledge and application of genetic counseling principles, including ethical considerations, pedigree analysis, and patient interaction.
- **CO5**: Students will gain knowledge to evaluate ethical, legal, and social implications (ELSI) of genetic testing and counseling, focusing on regulations, consent, and psychosocial aspects.

M.Sc. Human Genetics Semester 3rd

1. Course Title: Medical Genetics & Genomics **Course Code: P2HGTC301**

COURSE OUTCOMES:

- **CO1**: Students will be able to illustrate an in-depth understanding of the spectrum and inheritance patterns of genetic diseases, including autosomal, sex-linked, mitochondrial, and multifactorial disorders.
- **CO2**: Apply modern genomic technologies such as NGS, WGS, and WES for the detection, screening, and management of inherited and somatic genetic diseases.
- **CO3**: Interpret and analyze principles of personalized medicine, including pharmacogenomics, nutrigenomics, and preventive genomics, in the context of clinical applications.
- **CO4**: Evaluate the molecular basis of cancer by identifying oncogenes, tumor suppressor genes, and genomic alterations, and assess the role of oncogenomics in diagnostics and ethical clinical practices.
- **CO5**: Examine emerging technologies in medical genetics, including synthetic biology, transcriptomics, metabolomics, and reproductive technologies, along with their ethical and intellectual property considerations.

2. Course Title: Population & Evolutionary Genetics **Course Code: P2HGTC302**

COURSE OUTCOMES:

- **CO1**: Students will understand the fundamental principles of biological evolution, including natural selection, speciation, and human evolutionary pathways.
- **CO2**: Students will be able to learn the concepts and tools of phylogenetics, with emphasis on molecular phylogeny, comparative genomics, and the molecular clock.
- **CO3**: Students will develop the skill to explain the genetic structure of populations, using models like Hardy-Weinberg Equilibrium and various genetic association study designs.

- **CO4**: Students will explore the roles of mutation, selection, and genetic variation in shaping populations, including estimation techniques and adaptive mechanisms.
- **CO5**: Students will analyze the effects of inbreeding, genetic drift, and migration, including calculations of inbreeding coefficients and implications for genetic health and diversity.

3. Course Title: Basics of Bioinformatics & Biostatistics Course Code: P2HGTC303

COURSE OUTCOMES:

- **CO1**: Students will gain knowledge about the foundational concepts in descriptive and inferential statistics, including measures of central tendency, probability distributions, hypothesis testing, and regression analysis relevant to biological data.
- **CO2**: Familiarize students with core bioinformatics resources, including primary and secondary nucleotide and protein sequence databases, and their classification systems.
- **CO3**: Students will get a comprehensive overview of genome projects (e.g., Human Genome Project, Genome India Project), genome mapping and sequencing techniques, and their applications in modern biology.

4. Course Title: Fundamentals of Clinical Genetics Course Code: P2HGTC304

COURSE OUTCOMES:

- **CO1**: Students will understand the interplay between genetic and environmental factors in the development of clinical disorders and assess genetic risk using tools like polygenic risk scores.
- **CO2**: Students will recognize the genetic basis, inheritance patterns, and clinical features of monogenic and multifactorial disorders, including both autosomal and X-linked conditions.
- **CO3**: Students will analyze complex diseases with polygenic and environmental components, such as cardiovascular, neurodegenerative, and psychiatric disorders, to inform diagnosis and management.

- **CO4:** Students will be ableto explore the role of dermatoglyphics in identifying genetic disorders and its clinical applications.
- **CO5:** Students will understand the diagnosis and genetic basis of congenital anomalies and the use of emerging reproductive technologies.

5. Course Title: Stem Cell Technology **Course Code: P2HGTE308**

COURSE OUTCOMES:

- **CO1**: Students will be able to learn the fundamental concepts of stem cell biology, including stemness, types of stem cells, their sources, and laboratory techniques for isolation, characterization, and maintenance.
- **CO2**: Students will explore the therapeutic potential and applications of mesenchymal and induced pluripotent stem cells (iPSCs) in regenerative medicine and disease modeling.
- **CO3**: Students will acquire understanding of the ethical, legal, and regulatory frameworks governing stem cell research, including national and international guidelines and the role of biobanks in clinical and research settings.

6. Course Title: Cancer Biology **Course Code: P2HGTE309**

COURSE OUTCOMES:

- **CO1**: Students will acquire foundational knowledge of cancer biology, including cancer types, stages, and hallmark characteristics, with emphasis on molecular and cellular mechanisms of oncogenesis.
- **CO2**: Students will be able to analyze genetic, epigenetic, and environmental factors contributing to cancer development, including tumor suppressor genes, oncogenes, chromosomal instability, and the tumor microenvironment.
- **CO3**: Familiarize students with modern approaches to cancer diagnosis, treatment, and genetic counseling, including personalized therapies, immunotherapy, liquid biopsies, and polygenic risk assessment following established guidelines (e.g., MCC – Multidisciplinary Cancer Care Guidelines).

M.Sc. Human Genetics Semester 4th

1. Course Title : Essentials of Genetic Counseling **Course Code: P2HGTC401**

COURSE OUTCOMES:

- **CO1**: Students will gain foundational knowledge of genetic counseling, including its types, process, and significance in Mendelian and non-Mendelian disorders.
- **CO2**: Students will explore the psychosocial, ethical, and behavioural dimensions of counseling for individuals, families, and groups affected by genetic conditions.
- **CO3**: Students will examine genetic counseling approaches in specific disorders, such as neuromuscular diseases, infertility, hereditary cancers, and developmental anomalies.
- **CO4**: Students will understand national and international ethical guidelines, informed consent, genetic discrimination, and the functioning of genetic counselling clinics.
- **CO5**: Students will be familiarized with legal frameworks, including the PCPNDT Act, regulations on genetic services, and the legal responsibilities of genetic counsellors.

2. Course Title: Fundamentals of Immunology **Course Code: P2HGTC402**

COURSE OUTCOMES:

- **CO1**: Students will be able to explain the organization and function of the immune system, including the roles of various immune cells, antigens, antibodies, and the molecular basis of immune recognition and response.
- **CO2**: Students will develop skill to demonstrate mechanisms underlying humoral and cell-mediated immunity, antigen presentation, complement activation, and cytokine function in immune regulation.
- **CO3**: Students will be able to analyze immunological dysfunctions such as hypersensitivity reactions, autoimmune diseases, immunodeficiency disorders, and graft rejection, including their cellular and molecular basis.
- **CO4**: Students will be able to demonstrate immunological techniques such as ELISA, immunoblotting, flow cytometry, and immunoelectrophoresis for the diagnosis of diseases and characterization of immune responses.

- **CO5**: Students will acquire knowledge to evaluate modern immunotherapies, including CAR-T cell therapy, monoclonal antibodies, and vaccine strategies, and assess their clinical applications and mechanisms of action.

3. Course Title: Basics of Artificial Intelligence **Course Code: P2HGTE405**

COURSE OUTCOMES:

- **CO1**: Students will be able to introduce the fundamentals of Artificial Intelligence and biological data, including types of data, data processing techniques, and ethical concerns such as privacy and algorithmic bias.
- **CO2**:Students will be able to explore core machine learning and deep learning techniques, including supervised, unsupervised, and reinforcement learning, with practical applications in biological research using tools like BioPython and AlphaFold.
- **CO3**: Students will be able to demonstrate real-world applications of AI in biology, such as drug discovery, disease diagnosis, crop improvement, and environmental sustainability, highlighting ethical considerations in AI-driven biological research.

4. Course Title: Bioethics and IPR **Course Code: P2HGTE406**

COURSE OUTCOMES:

- **CO1:** Students will be able tofamiliarize with the fundamentals of Intellectual Property Rights (IPRs) and their specific applications in biotechnology, including patents, trademarks, copyrights, and sui generis protections.
- **CO2:** Students will be able tounderstand the procedures and challenges of patenting in the life sciences, including patent filing, licensing, technology transfer, and the roles of national and international patent authorities.
- **CO3:** Students will be able to critically examine ethical and legal issues in biotechnology, including gene therapy, GMOs, organ transplantation, and environmental protection, guided by national policies and international bioethical principles.