

CENTRAL UNIVERSITY OF PUNJAB



Master of Science in Human Genetics

Session - 2021-23

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 of human genetics/genomics, human cytogenetics, 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, and bioinformatics through the subject content across a broad range of modules among 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.

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.

M.Sc. in Human Genetics (2021-2023)

Course Structure of the Programme

Total Credit: 86

	Core Subjects	Elective Courses			Foundation Courses		Total Credit
		DE	ID	SB	CF	EF/VB	
Sem-I	03 (9 Cr)	--	01 (2 Cr)	03 (3 Cr)	02 (6 Cr)	--	20
Sem-II	04 (12 Cr)	02 (6 Cr)	--	02 (4 Cr)	--	--	22
SEM-III	03 (9 Cr)	01 (3 Cr)	--	01 (3 Cr) 01 (4 Cr Dissertation)	01 (2 Cr) 01 (1 Cr)	01 (2 Cr)	24
SEM-IV	--	--	--	01 (20 Cr Dissertation)	--		20
Credit Score	30	9	02	34	9	02	86

DE: Discipline Elective

ID: Interdisciplinary

SB: Skill based (Practicals); Dissertation

CF: Compulsory foundation

EF: Elective Foundation

VB: Value Based

M.Sc. in Human Genetics (2021-2023)

Course Structure of the Programme

Semester-I

Course Code	Course Title	Course Type	Hours			Credit
			L	T	P	
MME.506	Cell Biology	Core	3	0	0	3
MME.507	Molecular Biology	Core	3	0	0	3
HGE.508	Basic and Clinical Biochemistry	Core	3	0	0	3
HGE.509	Biostatistics and Research Methodology	Compulsory Foundation	3	0	0	3
HGE.510	Concepts of Genetics	Compulsory Foundation	3	0	0	3
HGE.511	Basic and Clinical Biochemistry (Practical)	Skill based	0	0	2	1
HGE.512	Biostatistics and Research Methodology (Practical)	Skill based	0	0	2	1
HGE.513	Concepts of Genetics (Practical)	Skill based	0	0	2	1
Interdisciplinary Course-I (For other Departments)						
HGE.518	Introduction to Intellectual Property Rights	IDC	2	0	0	2
XXX.	Choose from IDC courses offered by other Departments	IDC	2	0	0	2
Total Credits			19	0	6	20

M.Sc. in Human Genetics (2021-2023)

Semester-II

Course Code	Course Title	Course Type	Hours			Credit
			L	T	P	
HGE.521	Human Cytogenetics and Human Biochemical Genetics	Core	3	0	0	3
MME.522	Essentials of Immunology	Core	3	0	0	3
HGE.523	Advanced Techniques in Human Genetics	Core	3	0	0	3
HGE.524	Human Anatomy and Physiology	Core	3	0	0	3
HGE.525	Human Anatomy and Physiology (Practical)	Skill Based	0	0	2	1
HGE.526	Clinical Genetics (Practical)	Skill Based	0	0	6	3
Discipline Elective Course-I (Any one of the following)						
HGE.527	Human Embryology and Developmental Genetics	DE	3	0	0	3
MME.527	Stem Cell and Regenerative Medicine	DE	3	0	0	3
MIC.525	Microbial Pathogenicity	DE	3	0	0	3
ZOL.553	Vascular Biology	DE	2	1	0	3
Discipline Elective Course-II (Any one of the following)						
HGE.528	Population Genetics and Genetic Epidemiology	DE	3	0	0	3
MME.528	Molecular and Cellular Oncology	DE	3	0	0	3
BCH.518	Secondary Metabolites and Xenobiotics Metabolism	DE	3	0	0	3
Total credits			18	0	8	22

M.Sc. in Human Genetics (2021-2023)

Semester-III

Course Code	Course Title	Course Type	Hours			Credit
			L	T	P	
HGE.551	Pharmacogenomics and Nutrigenomics	Core	3	0	0	3
HGE.552	Genetic Diseases and Therapies	Core	3	0	0	3
HGE.553	Recombinant DNA technology and therapeutics	Core	3	0	0	3
MME.554	Tools in Bioinformatics (Practical)	Skill Based	0	0	6	3
Discipline Elective Course-III (Any one of the following)						
HGE.555	Biosafety, Bioethics and Intellectual Property Rights	DE	3	0	0	3
MME.555	Evolution and Developmental Biology	DE	3	0	0	3
MIC.557	Pharmaceutical Microbiology	DE	3	0	0	3
CHM.563	Medicinal Chemistry	DE	3	0	0	3
ZOL.554	Neurobiology and Degeneration	DE	2	1	0	3
Foundation Courses						
HGE.556	Principles of Ecological Science	Value based	2	0	0	2
MME.557	Concepts of Bioinformatics	Discipline Enrichment	2	0	0	2
HGE.558	Innovation and Entrepreneurship	Compulsory Foundation	1	0	0	1
HGE.600	Research Proposal	Skill Based	0	0	8	4
Total Credits			17	0	14	24

M.Sc. in Human Genetics (2021-2023)

Semester-IV

Course Code	Course Title	Course Type	Hours			Credit
			L	T	P	
HGE.600	Dissertation	Skill Based	0	0	40	20
Total			0	0	0	20

MOOC Options: 40% credits can be obtained through MOOCs depending on availability of course with matching content.

Details of syllabus

Semester – I

Course Code: MME.506
Course Title: Cell Biology
Total Hours: 45

L	T	P	C
3	0	0	3

Learning Outcomes:

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

- Conceptualization of basic cellular mechanisms.
- Understanding structures and functions of various cellular organelles.
- Understanding the cell cycle regulation and its importance in disease biology.
- Conceptualize the mechanisms of inter- as well as intra-cellular communications.

Unit 1

12 Hours

Introduction to the cell: Models of membrane structure, Membrane proteins, Membrane carbohydrates, Membrane transport of small molecules, Membrane transport of macromolecules and particles. Structural organization and function of intracellular organelles: The lysosomes, Ribosomes, The peroxisomes, The Golgi apparatus, The endoplasmic reticulum, Mitochondria.

Unit 2

10 Hours

Protein secretion and sorting: Protein secretion, synthesis and targeting to mitochondria, chloroplast, 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.

Unit 3

14 Hours

The cytoskeleton: The nature of cytoskeleton, Intermediate filaments, Microtubules, Actin filaments, Cilia and centrioles, Organization of the cytoskeleton. Cell communication and cell signaling: Cell adhesions, Cell junctions and the extra cellular matrix, Cell-cell adhesion and communication, Cell matrix adhesion, Collagen the fibrous protein of the matrix, Non-collagen component of the extra cellular matrix.

Unit 4

9 Hours

Cell growth and division: Overview of the cell cycle and its control, molecular mechanisms for regulating mitotic and meiotic events, Amitosis, Cell cycle control, Checkpoints in cell cycle regulation.

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., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. (2010). 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. (2008). Cytology, Genetics and Evolution. Rastogi publications, Meerut, India.
4. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons. Inc. New Delhi, India.

M.Sc. in Human Genetics (2021-2023)

Course Code: MME.507
Course Title: Molecular Biology
Total Hours: 45

L	T	P	C
3	0	0	3

Learning Outcomes:

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

- Conceptualization of molecular mechanisms involved in cellular functioning.
- Understanding the molecular processes of DNA replication, transcription, and translation

Unit: 1

12 Hours

Nucleic acids, Genes and Genome organization: Chemical structure of DNA and base composition, Watson-Crick model, mitochondrial DNA, Chromosome Structure, Chromatin and the Nucleosome, Chromatin structure: euchromatin, heterochromatin, Constitutive and facultative heterochromatin, Regulation of chromatin structure and nucleosome assembly, typical structure of a eukaryotic genes including various regulatory elements.

Unit:2

12 Hours

DNA replication and repair: Mechanisms of DNA replication in eukaryotes, Enzymes and accessory proteins involved in DNA replication, Replication errors and proofreading, telomeres, DNA damage and repair mechanisms.

Unit: 3

11 Hours

Transcription and mRNA processing: Different forms of RNA: mRNA, tRNA, rRNA and other Types of RNA Eukaryotic transcription: Initiation, Elongation & Termination, general and specific transcription factors, Regulatory elements and mechanisms of transcription regulation, RNA processing and editing, post transcriptional gene regulation.

Unit: 4

10 Hours

Translation: Genetic code, eukaryotic translation, the translation machinery, mechanisms of chain initiation, elongation and termination, regulation of translation, co-and post- translational modifications of proteins.

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. Sambrook, J., Fritsch, E. F., & Maniatis, T. (2015). Molecular cloning: a laboratory manual. Cold Spring Harbor Laboratory Press New York.
2. Berk, A. Chris, A.K. & Krieger, M. (2011). Molecular Cell Biology. W.H. Freeman, USA.
3. Robertis, (2011). Cell and Molecular Biology. Lippincott Williams & Wilkins.
4. Karp, G. (2010). Cell and molecular biology: concepts and experiments. John Wiley & Sons.
5. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2017). Lewin's Genes XII. Jones & Bartlett Learning.
6. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., & Levine, M. (2003). Molecular Biology of the Gene Benjamin Cummings.
7. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2007). Molecular biology of the cell. Garland Science. New York, 1392.
8. Fasman, G.D. (1989). Practical Handbook of Biochemistry and Molecular Biology. CRC Press, Taylor and Francis Group, UK.

M.Sc. in Human Genetics (2021-2023)

Course Code: HGE.508
Course Title: Basic and Clinical Biochemistry
Total Hours: 45

L	T	P	C
3	0	0	3

Learning Outcomes:

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

- Study the importance of maintenance of pH, role of vitamins and minerals in metabolic processes.
- Compare the basic structural features of biomolecules namely carbohydrates, lipids, proteins, and vitamins.
- Elaborate the structure of different forms of DNA and RNA.
- Conceptualize the basic features of enzyme catalysis and regulation.

UNIT I

11 Hours

Clinical Biochemistry: Properties of water, Ionization of water, weak acids and weak bases, pH and buffers. Water and sodium balance, Interpretation of biochemical tests, Composition of blood, urine and cerebrospinal fluids, Vitamins and trace elements disorders. Liver and kidney function tests, Jaundice, diabetes mellitus, hypoglycemia, hypertension.

UNIT II

11 Hours

Carbohydrate Metabolism: Classification and functions, Epimers; Anomers; Mutarotation. Reactions of carbohydrates; General scheme of metabolism. Basic concepts, Glycolysis, Krebs cycle, Pentose phosphate pathway, Gluconeogenesis, Regulation of carbohydrate metabolism. Inborn errors of carbohydrate metabolism

Lipids: Classification and functions, Beta oxidation - Pathway and regulation. Role of acyl carnitine in fatty acyl transport. Cholesterol synthesis. Ketone bodies- Formation and utilization. Clinical features and laboratory findings in disorders of triglyceride, lipoprotein and cholesterol metabolism.

UNIT III

11 Hours

Proteins: Structure and function of proteins, Secondary, Tertiary and Quaternary structure, super secondary structures, Ramachandran plot. Oxygen binding proteins – Hemoglobin and myoglobin.

Nucleic Acids: Structure and functions, Nucleosides and nucleotides. Metabolism of purines and pyrimidines- Salvage and de novo pathways.

UNIT IV

12 Hours

Enzymes: Definition, Classifications and nomenclature, prosthetic groups, cofactors, Mechanism of enzyme action and properties of enzymes; Enzyme activity, Factors affecting rate of enzyme catalyzed reactions: pH, temperature, etc. ES complex formation; Michaelis-Menten equation; Determination of K_m and V_{max} and its significance; Turnover number; Enzyme inhibition: reversible and irreversible inhibition. Isoenzymes, catalytic antibodies, multienzyme complexes and ribozymes.

Transactional Modes: Lecture; Tutorial; Virtual classrooms; Lecture cum demonstration; Problem solving; Self-learning; Google Class; Microsoft teams; YouTube demonstrations etc.

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 Readings:

1. Berg, J.M., Tymoczko, J.L., Gatto Jr, J.R., Stryer, L. (2015) Biochemistry Eighth Edition, 2015, W.H. Freeman & Company. USA.
2. Brown, T.A. (2016). Gene Cloning and DNA Analysis: An Introduction, 7th Edition January 2016, Blackwell Publishing Professional. USA.
3. Nelson, D.L., Cox, M.M. (2017). Lehninger Principles of Biochemistry. Seventh Edition| 2017
4. Donald Voet, Charlotte W. Pratt, Judith G. Voet (2012) Principles of Biochemistry, International Student Version. John Wiley & Sons, Publisher

M.Sc. in Human Genetics (2021-2023)

5. Swaminathan, R. (2011). Handbook of clinical biochemistry. 2nd edition, World Scientific Publishing Company, New Jersey, USA
6. Palmer, T., Bonner, P.L. (2007) Enzymes: biochemistry, biotechnology and clinical chemistry. Woodhead Publishing Limited.
7. Price, N.C., Stevens, L. (2003) Fundamentals of enzymology: The cell and molecular biology of catalytic proteins. Oxford University Press, USA.
8. Swaminathan, R (2011) Handbook of Clinical Biochemistry, 2nd Edition, Publisher: World Scientific
9. Murphy M.J., Srivastava R., Deans, K. (2018) Clinical Biochemistry, 6th Edition. Elsevier's USA.
10. Devlin, T.M. (2010) Textbook of Biochemistry with clinical correlation. John Wiley and Sons Publishers.

Course Code: HGE.509
Course Title: Biostatistics and Research Methodology
Total Hours: 45

L	T	P	C
3	0	0	3

Learning Outcomes:

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

- Analyze and evaluate wide variety of statistical data
- Compose statistical data and summary statistics in graphical and tabular forms
- Apply suitable statistical tools to analyze data
- Write and communicate scientific reports, projects, and publications.

UNIT I

Hours: 11

Overview of Biostatistics: Basic concepts of statistical data and different types of tables; graphical representation of experimental data for publication; frequency distribution; measurement of central tendency and variation.

UNIT II

Hours: 11

Experimental design and analysis: Basics of sampling in biological studies; different types of sampling techniques; various steps in sampling; concept of data distribution in sampling; graphical representation of data; level of significance; hypothesis testing.

UNIT III

Hours: 11

Inferential Statistics: Chi-Square test: hypothesis testing, contingency, homogeneity; student's t-test: paired and unpaired, one tailed and two tailed; one-way and two-way analysis of variance (ANOVA); correlation and regression.

UNIT IV

Hours: 12

Study design & Technical writing: Best practices in research and technicality of research design; interpretation and report writing, e-Library; web-based literature search engines; evaluation-based development of scientific writing skill: synopsis, research paper, poster preparation and paper presentation and dissertation.

Transactional Modes: Lecture; Tutorial; Virtual classroom, Problem solving; Self-learning.

Internal assessment shall be through any of the following: Surprise Tests, student generated questions, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper.

Suggested Readings:

1. Rao, S.P.S.S. Richard, J. (2016). Introduction to biostatistics and research methods. 5th Ed. Phi Learning Pvt. Ltd. New Delhi.

M.Sc. in Human Genetics (2021-2023)

- Hoffman, J. (2015). Biostatistics for medical and biomedical practitioners. 1st Ed. Academic Press, London.
- Banerjee P.K (2014). Introduction to Biostatistics. S.Chand, New Delhi.
- Antonisamy, B. Christopher, S. Samuel, P.P. (2011). Biostatistics: Principles and Practice. Tata McGraw Hill. New Delhi.
- Daniel W.W (2011). Biostatistics: Basic Concepts and methodology for the health sciences. 9th Ed. John Wiley and Sons Inc, New Delhi.
- Norman, G. and Streiner, D. (2008). Biostatistics: The Bare Essentials. (with SPSS), 3rd Edition, Decker Inc. USA.
- Sokal, R.R. and Rohlf, F.J. (1994). Biometry: The Principles and Practices of Statistics in Biological Research. W.H. Freeman publishers, USA.

Course Code: HGE.510
Course Title: Concepts of Genetics
Total Hours: 45

L	T	P	C
3	0	0	3

Learning Outcomes:

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

- Evaluate the Mendelian and Non-Mendelian inheritance patterns
- Gather knowledge about gene expression regulation and sex determination
- Evaluate different chromosomal aberrations and ploidies
- Know the details of extra chromosomal inheritance patterns

UNIT I

11 Hours

Transmission Genetics: Mendel's laws of inheritance and its applications; concept of segregation, independent assortment and dominance; pedigree analysis; epistasis; crossing over and recombination; gene linkage and genetic mapping.

Sex determination: Sex determination in Human and Drosophila; X-chromosome inactivation; dosage compensation.

UNIT II

12 Hours

Chromosomal Mutations: Chromosomal aberrations: structural and numerical; evolutionary history of bread wheat; aneuploids—nullisomics, monosomics, and trisomics; somatic aneuploids; changes in chromosome structure; properties of chromosomes for detection of structural changes; mutations and its types; complementation and recombination; transposable elements in Pro- and Eukaryotes.

Genes and genome dynamics: Fine structure of gene; and analysis, Benzer's experiments.

UNIT III

11 Hours

Microbial Genetics: Genetic systems of Viruses and Bacteria; genetic analysis and mapping in Bacteria and Bacteriophages – conjugation, transformation and transduction; recombination and gene mapping; evolution of microbial genome.

UNIT IV

11 Hours

Extra-chromosomal inheritance: Chloroplast: variegation in Four O' Clock plants; mutations in Chlamydomonas; mitochondrial inheritance: poky in Neurospora, petites in yeast; molecular organization and gene products of chloroplast and mitochondrial DNA; infectious heredity: Kappa in Paramecium: Infective particles in Drosophila; endosymbiont theory.

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

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,

M.Sc. in Human Genetics (2021-2023)

case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, Karyotype analysis presentations and discussions.

Suggested Readings:

1. Klug WS and Cummings MR. Concepts of Genetics. Prentice-Hall.2014
2. Anthony, J.F. Miller, J.A. Suzuki, D.T., Richard, R.C., Gilbert, W.M. (1998). An introduction to Genetic Analysis. W.H. Freeman publication, USA.
3. Pierce BA. Genetics: A Conceptual approach. Freeman Publishers.
4. Hartle DL and Jones EW. Genetics: Analysis of Genes and Genomes. Jones & Bartlett.
5. Atherly, A.G., Girton, J.R., McDonald, J.F. (1999). The Science of Genetics. Saundern College publication.
6. Snusted, D.P., Simmons, M. J. (2010). Principles of Genetics. John Wiley & Sons, New
7. Griffith AF et al. An Introduction to Genetic Analysis. John Wiley & Sons.

Course Code: HGE.511
Course Title: Basic and Clinical Biochemistry (Practical)
Total Hours: 30

L	T	P	C
0	0	2	1

Learning Outcomes:

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

- Appreciate the importance of chemical safety and precautions in the biochemistry laboratory
- Prepare buffers and solutions with varied concentration.
- Quantitative estimation of biomolecules
- Qualitative estimation of biomolecules

Practicals:

1. Preparation of buffer solutions.
2. Estimation of proteins using Lowry's methods.
3. Quantitation estimation of Cholesterol.
4. Extraction of DNA, and purity check by electrophoresis.
5. Quantitative estimation of glucose.
6. Assay of enzyme activity in saliva.
7. Effect of temperature on enzyme activity.
8. Effect of pH on enzyme activity.
9. Liver function tests-SGOT and SGPT
10. Determination of urea

Transactional Modes: Hands-on Practicals; Demonstration; Virtual classrooms; Tutorial; Self-learning.

Internal assessment shall be through any of the following: Lab performance, Open book techniques, Notebook writing, homework assignments, term paper, presentations, and group discussions.

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.

M.Sc. in Human Genetics (2021-2023)

- Hofmann, A., Clokie, S. (2018). Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press, USA
- Murphy M.J., Srivastava R., Deans, K. (2018) Clinical Biochemistry, 6th Edition. Elsevier's USA.
- Swaminathan, R (2011) Handbook of Clinical Biochemistry, 2nd Edition, Publisher: World Scientific

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

Course Code: HGE.512
Course Title: Biostatistics and Research Methodology (Practical)
Total Hours: 30

L	T	P	C
0	0	2	1

Learning Outcomes:

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

- Analyze variety of statistical data using appropriate tools
- Apply suitable statistical equations to analyze data
- Perform data stratification and representation
- Write and communicate scientific reports, projects, and publications.

- Plotting different types of graphs using statistical data, using MS Excel.
- Plotting normal distribution graph
- Problem solving on calculation of variance: sampling; biological and experimental replication
- Chi-square tests
- Student's t-test
- ANOVA
- Regression and Correlation.
- Scientific writing skill development.

Transactional Modes: Laboratory based practicals; Virtual classrooms; 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 practicals)

- Final Examination = **40 Marks**
 - Subjective question = 10 Marks
 - Performing experiment = 20 Marks
 - Viva voce = 10 Marks

M.Sc. in Human Genetics (2021-2023)

Course Code: HGE.513
Course Title: Concepts of Genetics (Practical)
Total Hours: 30

L	T	P	C
0	0	2	1

Learning Outcomes:

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

- Analyze genetic linkage and epistasis
 - Evaluate different mutants of *Drosophila*
 - Demonstrate X inactivation in females
1. Monohybrid and dihybrid ratios, Multiple alleles, Epistasis – Problems.
 2. Inheritance patterns in Human– Numericals on Pedigree analysis- Autosomal patterns, X–linked patterns, Y–linked patterns.
 3. Segregation analysis in *Drosophila* (Monohybrid, Dihybrid)
 4. Analysis on Linkage
 5. Problems on Gene mapping
 6. Identification of inactivated X chromosome as Barr body and drumstick
 7. Studies of a Model organism: *E. coli*, *C.elegans*, *D. melanogaster* and *D. rerio*.

Transactional Modes: Hands-on practicals; Demonstration; Virtual classrooms; Tutorial; Self-directed learning.

Evaluation criteria for practical courses:

- Continuous Assessment = **60 Marks**
Based on performance 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

Course Code: HGE.518
Course Title: Introduction to Intellectual Property Rights
Total Hours: 30

L	T	P	C
2	0	0	2

Learning Outcomes:

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

- Understand the concept and genesis of IP
- Differentiate between plagiarism and fair use of copyright material
- Understand the Patent regime of India
- Conceptualize the other forms of IP namely Trademark, Industrial Design, Trade Secret, New varieties of plant

UNIT I

Brief history, current status and career opportunities in IP

8 Hours

M.Sc. in Human Genetics (2021-2023)

Introduction to IP, Genesis and development of concept of IPR; WIPO administered Treaties: Paris Convention, 1883, the Berne Convention, 1886, the TRIPS Agreement, 1994; the WIPO Convention, 1967; National Innovation and Startup Policy for Students and Faculty 2019, Career Opportunities in IP.

UNIT II

6 Hours

Copyright and Layout Design Protection

Copyright and related rights; Plagiarism; Fair Use of copyright material; Layout Design Protection.

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.

UNIT IV

8 Hours

Other forms of IP

Concept, Registration and term of protection: Trademark, Industrial Design, Trade Secret, Protection of New varieties of plant, Geographical Indications

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/>)

M.Sc. in Human Genetics (2021-2023)

Semester – II

Course Code: HGE.521
Course Title: Human Cytogenetics and Human Biochemical Genetics
Total Hours: 45

L	T	P	C
3	0	0	3

Learning Outcomes:

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

- Apply cytogenetic techniques for the identification of individual chromosomes
- Apply classical cytogenetic and molecular cytogenetic techniques for the identification of chromosomal disorders
- 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.

UNIT I

11 Hours

General features of Human Chromosome and Chromosome staining: Chromatin structure; nucleosome model; constitutive and facultative heterochromatin; centromeres, Telomere and its maintenance; nuclear organization region (NOR); chromosome nomenclature; sister chromatid exchanges (SCE); mosaicism; structure of human X and Y chromosome; ring chromosomes; human artificial chromosome.

UNIT II

12 Hours

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).

UNIT III

11 Hours

The concept of Biochemical Polymorphism: Concept of enzyme and protein polymorphism; molecular structure; Blood Group system: Biosynthesis and genetics of the ABH antigens; Rh antigens and MN antigens; quantitative and qualitative hemoglobin variants and its clinical affects

UNIT IV

11 Hours

Disorders due to abnormal variants of lysosomal enzymes, lipids and DNA nitrogenous bases: Disorders due to abnormal lysosomal enzymes: Tay-Sachs disease and Mucopolysaccharidoses; Disorders due to abnormal lipoprotein and lipid metabolism: hyper lipoproteinemia; Disorders due to abnormal purine metabolism: Lesch-Nyhan syndrome; disorders of pyrimidine metabolism: Orotic Aciduria.

Transactional modes: Lecture; Demonstration; Tutorial; Virtual classrooms; Lecture cum demonstration; Problem solving; Self-learning.

Internal assessment shall be through any of the following: Discussion on evolution of X and Y chromosomes, In Depth interview on banding techniques; Seminar on molecular cytogenetic techniques, Assignment on Flow cytometry; Surprise Tests, one sentence summary, Practice exercise on karyotype analysis, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, Seminars, term papers, discussions and presentations

Suggested Readings:

1. Gillham, N. (2011). Genes, Chromosomes and Disease. Pearson
2. Griffiths, A.J.F., Wessler, S.R. and Carroll, S.B. (2012). An Introduction to Genetic Analysis. W.H. Freeman Publication, USA.
3. Hein, S. and Mitelman, F. (2009). Cancer Cytogenetics. Wiley-Blackwell.
4. Korf, B.R and Irons, M.B. (2013). Human Genetics and Genomics. Wiley-Blackwell.

M.Sc. in Human Genetics (2021-2023)

5. Kumar, A. and Srivastava, M. (2012) A textbook of Molecular Cytogenetics, Narendra Publishing House, India
6. Purandare, H. and Chakravarty, A. (2000) Human Cytogenetic Techniques and Clinical Applications. Bhalani Publishing House, Mumbai, India.
7. Ram, M. (2010). Fundamental of Cytogenetics and Genetics. PHI Learning Pvt. Ltd.
8. Roy, D. (2009). Cytogenetics. Narosa Publishing House. New Delhi, India.
9. Tom, S and Read, A (2010). Human Molecular Genetics. Garland Science.
10. Shukla, A.N. (2009). Elements of enzymology. Discovery Publishing. New Delhi, India.
11. Voet, D. and Voet, J.G. (2008). Principles of Biochemistry. CBS Publishers & Distributors, New Delhi.

Course Code: MME.522
Course Title: Essentials of Immunology
Total Hours: 45

L	T	P	C
3	0	0	3

Learning Outcomes:

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

- Evaluate basic concepts of immune system.
- Gain knowledge about various key processes related to development of immune system.
- Understand the concept of immune-based diseases as either a deficiency of components or excess activity as hypersensitivity.
- Apply the knowledge how immune system is involved in diseases caused by internal or external factors.

Unit: 1

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.

Unit: 2

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 immune system: DC, NK, Monocytes etc.

Unit: 3

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.

Unit: 4

10 Hours

Immune System in Health and Diseases: Inflammation, hypersensitivity and autoimmunity, AIDS and immunodeficiencies, vaccine development.

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.

M.Sc. in Human Genetics (2021-2023)

- Charles, A. and Janeway, J.R. (2001). Immunobiology: The immune system in health and disease Blackwell Publishing, USA.
- Delves, P.J., Roitt, I.M. and Seamus, J.M. (2016). Roitt's Essential Immunology (Series–Essentials). Blackwell Publishers, USA.
- Elgert, K.D. (2015). Immunology: Understanding the immune system. Wiley-Blackwell, USA.
- Tizard. (2018). Immunology: An Introduction. Cengage Learning, Thompson, USA.
- Owen, Judith A; Punt, Jenni, Stranford, Sharon A. Kuby's Immunology (2013), W.H. Freeman and Company: New York, 2013

Course Code: HGE.523
Course Title: Advanced Techniques in Human Genetics
Total Hours: 45

L	T	P	C
3	0	0	3

Learning Outcomes:

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

- Analyze various cellular processes technically.
- Apply the knowledge to decipher the mechanisms of molecular and cell biology.
- Know specific technical aspects for variety of techniques used in biological experiments
- Conceptualize principles of different techniques used in life sciences

UNIT I

11 Hours

Biochemical Techniques: Sterilization techniques; spectrometry; colorimetry; Mass, UV, IR, NMR and atomic absorption spectrophotometry; centrifugation: principle and applications; ultracentrifugation; chromatography: principle, procedure and applications of thin layer chromatography (TLC), gel filtration and ion exchange, affinity chromatography, GC, GLC, HPLC, dHPLC and FPLC.

Assignment on application of specific techniques, Discussion on principles of techniques

UNIT II

11 Hours

Microscopy: Light microscopy; phase contrast microscopy; fluorescent microscopy; scanning electron microscopy (SEM/FESEM); transmission electron microscopy (TEM); micrometry and photomicrography; histochemistry; scanning-probe microscopy; atomic force microscopy; CLSM.

UNIT III

11 Hours

Nucleic acids: Isolation, purification and analysis of nucleic acids; electrophoresis: principle of gel electrophoresis, polyacrylamide gel electrophoresis (PAGE and SDS-PAGE), agarose gel electrophoresis, pulse field gel electrophoresis (PFGE) and 2-Dimensional gel electrophoresis; polymerase chain reaction (PCR): principle, types and applications; PCR based markers: RAPDs, SNPs; blotting techniques: southern, northern, western, dot blotting and hybridization; DNA fingerprinting.

UNIT IV

11 Hours

Flow Cytometry: Cell sorting; hybridoma technology: production of antibodies; histochemical and immuno techniques; immunochemical techniques; developing monoclonal and polyclonal antibodies; immunocytochemistry, radioimmunoassay (RIA); enzyme linked immunosorbent assay (ELISA) and autoradiography. Mutation analyses techniques: Restriction mapping, SSCP analyses, DNA sequencing-manual and automated methods. Cell and tissue culture techniques: Plants and animals.

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

Internal assessment shall be through any of the following: Interview on various microscopic techniques; Visit to CIL and compile a report; Case studies solved by DNA fingerprinting, Assignment; In Depth

M.Sc. in Human Genetics (2021-2023)

interviews, Analysis of DNA sequencing data, Surprise Tests, term paper, Seminars, discussions and presentations, drawing flow charts for the techniques.

Suggested Readings:

1. Brown, T.A. (2010). Gene cloning and DNA analysis: An Introduction. 6th Edition, Wiley-Blackwell Publisher, New York.
2. Goldsby, R.A., Kindt, T.J. and Osborne, B.A. (2008). Kuby Immunology. 6th Edition, W. H. Freeman & Company, San Francisco.
3. Gupta, P.K. (2005). Elements of biotechnology. Rastogi Publications, Meerut.
4. Gupta, S. (2005). Research methodology and statistical techniques, Deep & Deep Publications (P) Ltd. New Delhi.
5. Kothari, C.R. (2008.) Research methodology(s). New Age International (P) Ltd., New Delhi
6. Lewin, B. (2010). Genes X, CBS Publishers & Distributors. New Delhi.
7. Mangal, S.K. (2007). DNA Markers in Plant Improvement. Daya Publishing House, New Delhi.
8. Nelson, D. and Cox, M.M. (2009). Lehninger Principles of Biochemistry. W.H. Freeman and Company, New York.
9. Primrose. S.B. and Twyman, R. (2006). Principles of Gene Manipulation and Genomics. Blackwell Publishing Professional, U.K.
10. Sambrook, J. (2006). The Condensed Protocols from Molecular Cloning: A Laboratory Manual .Cshl Press. New York.
11. Sambrook, J. and Russell, D.W. (2000). Molecular Cloning: A Laboratory Manual (3 Vol-set). 3rd Edition, CSHL Press, New York.
12. Sawhney, S.K. and Singh, R. (2005). Introductory Practical Biochemistry. Narosa Publishing House, New Delhi.
13. Slater, A., Scott, N.W., and Fowler, M.R. (2008). Plant Biotechnology: The Genetic Manipulation of Plants. Oxford University Press, USA.
14. Wilson, K. and Walker, J. (2006). Principles and Techniques of Biochemistry and Molecular biology. 6th Edition, Cambridge University Press India Pvt. Ltd., New Delhi.
15. Sue Carson Heather Miller Melissa Srougi D. Scott Witherow (2019) Molecular Biology Techniques. Academic Press, USA

Course Code: HGE.524
Course Title: Human Anatomy and Physiology
Total Hours: 45

L	T	P	C
3	0	0	3

Learning outcome

- Understand anatomical and physiological functions of various tissues.
- Understand the clinical scenarios and be able to interpret physiological function.
- Recognize the cell structure and function, histology, gross anatomy and physiology of several organ systems.
- Understand and predict the body response to stimuli.
- Recognize the principle of homeostasis and control mechanisms

UNIT I

11 Hours

Muscular System: Structure and organization of muscles: skeletal, cardiac and smooth muscles; neuromuscular junction.

Cardiovascular System: Physiological anatomy of Heart; cardiac muscle, cardiac cycle; blood constituents; hematopoiesis; cardiovascular regulation.

UNIT II

12 Hours

M.Sc. in Human Genetics (2021-2023)

Digestive System: Anatomy of Gastrointestinal tract, physiology of salivary secretion, mouth and esophagus, epithelial barrier function; digestion and absorption in GIT; GIT secretions and accessory glands; BMR.

Urinary System: Physiological anatomy Kidney; urine formation; regulation of volume and concentration of body fluids, KFT.

UNIT III

11 Hours

Nervous System: Organization of nervous system, synapse, generation of action potential; vision; hearing and tactile response, degeneration and regeneration of peripheral nerves.

Thermoregulation and stress adaptation: Comfort zone; body temperature – physical, chemical and neural regulation; acclimatization.

UNIT IV

11 Hours

Respiratory System: Anatomical considerations; mechanism of respiration; neural and chemical regulation of respiration; Physiology of high altitude, hypoxia, PFT.

Reproduction: Physiology of reproductive system (male, female), pregnancy, physiology of fetus.

Transactional Modes: Lecture; Seminar; Tutorial; Virtual classrooms; Problem solving; Self-learning; group discussion.

Internal assessment shall be through any of the following: Assignment; In Depth interviews, Surprise Tests, term paper, Seminars, discussions, and presentations.

Suggested Readings:

1. Brody, T. (1998). Nutritional biochemistry. Academic Press, USA.
2. Devlin, T.M. (2005). Textbook of Biochemistry with clinical correlations. John Wiley & Sons Inc. USA.
3. Guyton. (2007). Textbook of medical physiology. 11th Edition. Elsevier India Pvt. Ltd. New Delhi.
4. Hill, R.W, Wyse, G. A. and Anderson, M. (2008). Animal physiology. Sinauer Associates Inc. USA.
5. Khurana. (2006). Textbook of medical physiology. Elsevier India Pvt. Ltd.
6. Murray, R.K. (2009). Harper's illustrated biochemistry. Jaypee Publishers, New Delhi, India.
7. Tyagi, P. (2009). A textbook of Animal Physiology. Dominant Publishers and distributors, New Delhi, India.
8. Silverthorne D, (2011) Human Physiology, Pearson; 6th edition.
9. Sherman V. (2013) Vander's Human Physiology. McGraw-Hill 13th edition.
10. Jain A.K. (2021). Textbook of physiology. Avichal Publishing Company-9th Edition.

Course Code: HGE.525
Course Title: Human Anatomy and Physiology (Practical)
Total Hours: 30

L	T	P	C
0	0	2	1

Learning Outcomes:

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

- Perform key hands-on experiments on human physiology
- Demonstrate several biophysical techniques regularly used in health sciences
- Get familiar with the basic principles of physiological experiments

1. Equipment in the laboratory - maintenance and use.
2. Hematology: Blood group typing, Observation of types of blood cells, Counting of WBCs and RBCs, Determination of hemoglobin

M.Sc. in Human Genetics (2021-2023)

3. Cardiovascular system: Studying characteristics of ECG, Measurement of blood pressure and pulse rate, Study the effect of exercise on blood pressure and pulse rate
4. Respiratory function: Estimation of Breathing rate and Breath holding capacity.
5. Muscle Physiology: Distinguish different types of muscles and Observation of types of muscular contraction.
6. Urinalysis: Detection of glucose and protein in Urine
7. Digestive system: Study the role of digestive enzymes

* Practical list can be modify depending upon the available faculty /facility.

Transactional Modes: Hands-on practicals; Demonstration; Virtual classrooms; **Tutorial;** 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 practicals)

- Final Examination = **40 Marks**

Subjective question = 10 Marks

Performing experiment = 20 Marks

Viva voce = 10 Marks

Course Code: HGE.526
Course Title: Clinical Genetics (Practical)
Total Hours: 45

L	T	P	C
0	0	6	3

Learning Outcomes:

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

- Interpret how genetic factors predispose to mendelian and adult onset diseases
 - Implications of these predispositions for diagnosis, prevention, and treatment.
 - Assess the clinical features of common chromosomal alterations.
 - Gain an insight into specific exposures that are likely to be teratogenic in humans
 - Appreciate the importance of genetic counseling to assert the birth of a children affected with genetic disorders
 - Application of appropriate molecular biology techniques for diagnosis, disease prediction and prevention.
1. Genetic assessment and drawing pedigree.
 2. Genetic counseling
 3. Common chromosomal disorders-case studies
 4. Teratogens and dysmorphology
 5. DNA and RNA isolation, quantification, gel electrophoresis (agarose/PAGE),
 6. PCR-RFLP
 7. RT-PCR
 8. ELISA

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

M.Sc. in Human Genetics (2021-2023)

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. 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.

Discipline Elective -I

Course Code: HGE.527
Course Title: Human Embryology and Developmental Genetics
Total Hours: 45

L	T	P	C
3	0	0	3

Learning Outcomes:

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

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

UNIT I

12 Hours

Basic concepts of development: Gametogenesis; fertilization; embryogenesis: gastrulation and implantation of embryo; fetal membrane and placenta; potency, commitment, specification, induction, competence, determination, and differentiation. Role of Sry, Sox9 and WNT4 and DAX1 in early gonad differentiation

UNIT II

11 Hours

Gene expression regulation in development: Basics of gene expression regulation during early embryogenesis; homeotic genes, P granules, role of key developmental genes: polycomb gene, SOX, HOX.

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.

UNIT IV

11 Hours

Post-natal Development, Aging and senescence: Environmental and genetic factors during maturations, Sex linked changes, Deciduous and primary teeth, Clinical death.

Teratology: Teratogens, introduction to toxicogenomic.

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

M.Sc. in Human Genetics (2021-2023)

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). Essential 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 Embryology). 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

Course Code: MME.527
Course Title: Stem Cell and Regenerative Medicine
Total Hours: 45

L	T	P	C
3	0	0	3

Learning Outcomes:

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

- Understand basics of cell culture
- Understand basic stem cell biology.
- Gain conceptual knowledge about requirements for tissue engineering.
- Know regenerative medicine and its potential applications.

Unit: 1

11 Hours

Basics of cell culture and media, Culturing primary cells and cell lines, suspension and adherent cultures, cell growth, growth inhibition and apoptotic studies, Embryo culture, transplantation and teratogens, teratomas, stem cell culture, organ culture.

Unit: 2

12 Hours

Stem Cells: Stem cells and their properties, classification of stem cells, in-vitro culture techniques, isolation, identification and characterization of stem cells, stem cells in various organs and in disease conditions.

Unit: 3

11 Hours

Tissue Engineering: Principles of tissue culture, tissue and organ culture, extracellular matrices, bioreactors, ethical issues related to stem cell therapies, stem cell banks, bone marrow transplantation.

Unit: 4

11 Hours

Regenerative Medicine: Modes of tissue and organ delivery, tissue Engineering and transplantation techniques, immuno isolation techniques, regeneration of bone and cartilage, Islet cell transplantation and bio-artificial pancreas, lung regeneration

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.

M.Sc. in Human Genetics (2021-2023)

- Lanza, R., Klimanskaya, I. (2018). Essential Stem Cells Methods. Academic Press.
- Mao, J. J. & (2017). Translational approaches in tissue engineering and regenerative medicine. Artech House.
- Lanza, R. (2017). Principles of Tissue Engineering, 3rd Edition. Academic Press
- 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.
- 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.

Discipline Elective-II

Course Code: HGE.528
Course Title: Population Genetics and Genetic Epidemiology
Total Hours: 45

L	T	P	C
3	0	0	3

Learning Outcomes:

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

- Conceptualize the basic concepts in population genetics and apply statistics relevant to the study of genomic diversity
- Examine the major genetic and ecological processes underlying evolution and explain the process driving speciation
- Perform different epidemiological studies to identify the cause-effect relationship in variety of human traits/diseases
- Design genetic studies and perform association and linkage analysis on any relevant data.

UNIT I

11 Hours

Population dynamics and basics of epidemiology: Dynamics and conditions of the Hardy-Weinberg law; selection coefficient and fitness; heterozygous advantages; inbreeding and its consequences; mutation pressure and estimation of rates; genetic load; dynamics of migration and genetic drifts.

UNIT II

11 Hours

Evolution and Speciation: Emergence of evolutionary thoughts Lamarck; Darwinism – concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; spontaneity of mutations; the evolutionary synthesis; Mechanism of evolution: Adaptive radiation; isolating mechanisms; speciation; allopatricity and sympatricity; convergent evolution; sexual selection; co-evolution; Evolution of Homo sapiens

UNIT III

11 Hours

Fundamentals of epidemiological studies: Different types of Experimental and observational studies; basic parameters of epidemiology: frequency, occurrence, prevalence, incidence; association; causation, variation; Association studies: candidate gene association and genome-wide association studies (GWAS); systematic review and meta-analysis.

UNIT IV

11 Hours

Genetic variation and complex trait inheritance: Basics of genetic variations; genetic markers – SNP, CNV, Ins/dels, VNTR, STR, microsatellite; concepts of tag markers and haplotypes, linkage disequilibrium; quantitative genetic analysis; QTL and eQTL.

M.Sc. in Human Genetics (2021-2023)

Transactional Modes: Lecture; Demonstration; Tutorial; Case study; Virtual classrooms; seminar presentation; 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. Bhasker, H.V. and Kumar S (2008). Genetics. Campus Books International, New Delhi, India.
2. Cavalli-Sforza, L.L. and Bodmer, W.F. (2013). The Genetics of Human Populations. Dover Publications.
3. Hamilton M.B. (2009). Population Genetics. Wiley-Blackwell, UK.
4. Hedrick P.W.(2011). Genetics of Populations. Jones and Bartlett Publishers, Massachusetts.
5. Jobling, M., Hollox, E., Hurler, M., Kivisild, T. and Tyler-Smith, C. (2013). Human Evolutionary Genetics. Garland Science.
6. Knight, J.C. (2009). Human Genetic Diversity –Functional consequences for Health and Disease. Oxford University Press, USA.
7. Krebs, J.E, Goldstein, E.S. and Kilpatrick, S.T. (2013) Lewin’s Essential Genes. Jones and Bartlett learning, USA.
8. Nielsen, R. and Slatkin, M. (2013). An Introduction to Population Genetics: Theory and Applications. Sinauer Associates, Inc.
9. Relethford, J.H. (2012). Human Population Genetics. John Wiley & Sons.
10. Snusted, D.P., Simmons, M. J. (2010). Principles of Genetics. John Wiley & Sons, New York.
11. Palmer LJ, Burton PR & Smith GD (2011). An introduction to genetic epidemiology (Policy Press, University of Bristol)
12. Dawn TM (2011). Genetic Epidemiology (Springer)
13. Austin M (2013). Genetic Epidemiology: Methods and Applications, 1st Edition (CABI Publishing).

Course Code: MME.528
Course Title: Molecular and Cellular Oncology
Total Hours: 45

L	T	P	C
3	0	0	3

Learning Outcomes:

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

- Understand fundamentals of cancer.
- Gain knowledge about genetics and signal transduction involved in tumorigenesis.
- Learn about various tools used for diagnostic purposes.
- Understand basics principles of anticancer therapeutics as well as about recent developments of the field.

Unit: 1

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.

Unit: 2

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.

Unit: 3

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

M.Sc. in Human Genetics (2021-2023)

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.

Unit: 4

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 other new anticancer therapies.

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 Stanford 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. Weinberg, Robert A. (2015). 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

Semester – III

Course Code: HGE.551
Course Title: Pharmacogenomics and Nutrigenomics
Total Hours: 45

L	T	P	C
3	0	0	3

Learning Outcomes:

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

- 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.
- Have an understanding about the nutritional requirements and the role of gut microbiota in human nutrition.
- Be aware of the effect of genetic polymorphisms in variable response to micronutrients and will understand the regulation of transcription factors by the nutrients.
- Get aware of the genetic markers involved in the regulation of metabolomics and the role of these markers in health and disease.

UNIT I

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, trastuzumab; heredity disorders with altered drug response: porphriavariiegata, hemoglobinopathies, Grigler-najjar syndrome; concept of pharmacogenomics; progress in understanding the genomic basis for adverse drug reactions; ethnic diversity in pharmacogenomics studies and challenges posed by ethnicity.

UNIT II

11 Hours

Nutritional Biochemistry: Essential and non-essential nutrients; micro and macro nutrients; measurement of calorie values of foods; recommended dietary allowances; basal metabolic rate (BMR); malnutrition; malabsorption and interventional strategies. Concept of gut microbiota in human nutrition.

UNIT III

11 Hours

Nutrigenomics in determining health: Diet and gene expression; nutritional status in early life and metabolic programming; nutrients as regulators of activity and transcription factors; modulating the risk of obesity and vitamin D deficiency through nutrigenomics.

UNIT IV

12 Hours

Biomarkers and recent advances in Nutrigenomics: Genetic and nutritional control of lipid metabolism, metabolomics; effect of diet on epigenetic processes, concept of oral and gut microbiome and its implications in health and disease; therapeutic approaches through microbiota transplantation.

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

Internal assessment shall be through any of the following: Literature survey on current medicines based on pharmacogenomics, In-depth interview on ADRs. Group activity to calculate BMI, Preparation of a list of essential micro and macronutrients, Surprise Tests, case analysis, classroom assignments, homework assignments, term paper, Seminars, term papers, discussions, and presentations.

Suggested Readings:

1. Altman RB, Flockhart D and Goldstein DB (2012). Principles of Pharmacogenetics and Pharmacogenomics. Cambridge University Press.
2. Ferguson, L,R.(2013) Nutrigenomics and Nutrigenetics in Functional Foods and Personalized Nutrition. CRC Press.

M.Sc. in Human Genetics (2021-2023)

3. Tollefsbol T (2011). The New Molecular and Medical Genetics. Elsevier Inc
4. Simopoulos A.P. and Ordovas J.M. (2004). Nutrigenetics and Nutrigenomics Karger Publishers
5. Rimbach, G and Fuchs, J (2005) Nutrigenomics (Oxidative Stress and Disease). CRC press
6. Yui-Wing Francis Lam Stuart Scott (2018) Pharmacogenomics: Challenges and Opportunities in Therapeutic Implementation, Elsevier, Netherlands

Course Code: HGE.552
Course Title: Genetic Diseases and Therapies
Total Hours: 45

L	T	P	C
3	0	0	3

Learning Outcomes:

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

- Understand the genetic causes of monogenic disorders
- Understand the genetic basis of common multifactorial diseases.
- Analyze the consequences of altered epigenetic processes in causing genetic disorders.
- Apply the principal of genetics and biostatistics for genetic disorders risk assessment

UNIT I

11 Hours

Monogenic Disorders: Cystic fibrosis; Huntington's disease; Duchenne Muscular dystrophy; X-linked rickets. Multifactorial Diseases: Diabetes type 2; Cancers; Hypertension; Obesity; Neurodegenerative diseases.

UNIT II

11 Hours

Genomic Imprinting and Human Diseases: Uniparental disomy & genomic imprinting: Syndromes: Prader-Willi & Angelman syndrome; Beckwith-Wiedemann syndrome & Silver Russell Syndrome; Role of Imprinting brain development and behavior.

UNIT III

11 Hours

Genetic Screening: Pre symptomatic testing for genetic diseases and malignancy, carrier detection; prenatal and postnatal screening; Assisted reproductive techniques and Pre-implantation diagnosis; Genetic Counseling.

UNIT IV

12 Hours

Therapies for genetic disorders and multifactorial diseases: Stem cell therapies: stem cell types, cord blood cells, bone marrow transplantation; current stem cell therapies; gene therapies: methods; diseases suitable for gene therapies: hemoglobinopathies, cystic fibrosis, muscular dystrophies, cancer; challenges in gene therapy; regulatory requirements.

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.

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 & Bartlett.
3. Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. (2014). Lewin's Genes XI. Jones and Bartlett India Pvt. Ltd.

M.Sc. in Human Genetics (2021-2023)

4. Lodish, H., Berk, A., Chris, A. K., Krieger, M. (2008), Molecular Cell Biology. W.H. Freeman, USA.

Course Code: HGE.553
Course Title: Recombinant DNA Technology and Therapeutics
Total Hours: 45

L	T	P	C
3	0	0	3

Learning Outcomes:

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

- Demonstrate cloning and expression vectors in E.Coli in recombinant DNA techniques
- Get familiar with vectors for Eukaryotes
- Learn conventional methods used in recombinant DNA technology
- Learn therapeutics aspect of recombinant DNA technologies

UNIT I

11 Hours

Basics of Genetic Engineering: Isolation and purification of nucleic acids; restriction and DNA modifying enzymes; restriction modification systems; cloning vectors: plasmids, phages, lambda vectors, cosmids, PAC, BAC, YAC; selection and screening of clones.

UNIT II

11 Hours

Construction of DNA libraries: Genomic and cDNA libraries; screening of genomic and expression libraries.

Analysis of gene expression: Real-time-PCR; digital PCR; RNA sequencing analysis; EST analysis; promoter analysis; TSS mapping; cDNA and oligos array; serial analysis of gene expression (SAGE).

UNIT III

11 Hours

Expression Vectors: Animal virus derived vectors-Sv-40, vaccinal/bacculo, retroviral vectors and pichia vectors system; Expression vectors and Protein purification methods, Inclusion bodies and methodologies to reduce its formation.

UNIT IV

12 Hours

Techniques and Applications of recombinant DNA technology: Sites specific mutagenesis; Gene Editing through; CRISPR/CAS system, Genetically modified microbes (Recombinant bacteria) for the production of commercial scale production of proteins, pharmaceuticals; transgenic animals; RNA based therapeutics.

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, home work assignments, term paper, Seminars, term papers, discussions and presentations

Suggested Readings:

1. R.W. Old & S.B. Primrose (2007) Principles of Gene Manipulation 7th Edition Blackwell science.
2. Bernard R. Glick & Jack J. Pasternak. (2010) Molecular Biotechnology 4th Edition ASM Press Washington.
3. James Watson, Micheal Gilman Jan Witkowsk (2007) Recombinant DNA 3rdedition . CSHL, New York.
4. CokinRateldge and Bjorn Christiansen, (2006) Basic Biotechnology 3rdEdition Cambridge University press.
5. John E. Smith. (2009) Biotechnology 5th Edition by Cambridge University press.
6. Molecular Biology of Gene 6th Edition by Watson CSHL Press New York.
7. Sambrook& Russell Molecular cloning , CSHL Press, New York.
8. David & Freifelder John & Barlett (2008) Molecular biology 2nd Edition, Narosa publishing, New Delhi.

Related Weblinks:

M.Sc. in Human Genetics (2021-2023)

1. <http://www.genengnews.com/ontheweb.asp>
2. <http://www.ige-india.com/>
3. <http://www.icgeb.org/~bsafesrv/>
4. <http://www.livescience.com/32648-whats-genetic-engineering.html>

Course Code: MME.554
Course Title: Tools of Bioinformatics (Practical)
Total Hours: 60

L	T	P	C
0	0	6	3

Learning Outcomes:

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

- Analyze publicly available and experimental genomics data
 - Perform in-silico prediction of protein structures and interactions
 - Perform in-silico functional annotation of genetic findings
 - Demonstrate physical property of biomolecules in silico
1. Access to sequence databases (downloading DNA/RNA/Protein sequences).
 2. Performing sequence alignment using various tools (BLAST, MSA)
 3. Pipeline of RNA-seq analysis.
 4. Submission of SRA and TSA database.
 5. Genome wide association study and DNA microarray-data analysis.
 6. Understanding the evolutionary relationship using molecular phylogeny analysis.
 7. Prediction of Protein structure using sequence database
 8. Practical insights of tertiary structure prediction and comparative modelling
 9. Protein-protein and protein-ligand docking
 10. Evaluation of techniques for 3-D structure determination like X-ray, NMR, MS/MS analysis using case study.
 11. Structure-based drug design and virtual screening of the drug.
 12. Quantitative structure activity relations, Cheminformatics and pharmacophore mapping in therapeutic development.

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.

M.Sc. in Human Genetics (2021-2023)

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.

Discipline Elective-III

Course Code: HGE.555
Course Title: Biosafety, Bioethics, and Intellectual Property Rights
Total Hours: 45

L	T	P	C
3	0	0	3

Learning Outcomes:

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

- Interpret the bioethical issues concerning biotechnological advancements like recombinant DNA technology, cloning, gene manipulation.
- Implement biosafety while carrying out research.
- Distinguish different types of Intellectual Property Rights.
- Describe the ways of protecting traditional knowledge from Biopiracy.

UNIT I

11 Hours

Biosafety: Good laboratory practices; Risk and safety assessment from genetically engineered organisms; special procedures for r-DNA based products; biological containment (BC) and physical containment (PC); CDC biosafety levels; biohazard management.

UNIT II

11 Hours

Bioethics: Ethical considerations during research, Use of Animals for clinical research, Embryonic and adult stem cell research, assisted reproductive technologies, cloning, MTP and Euthanasia; the element of informed consent; ethical issues of the human genome project.

UNIT III

11 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.

UNIT IV

12 Hours

Patent system: 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).

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:

M.Sc. in Human Genetics (2021-2023)

1. Clarke, A (2012). Genetic Counseling: Practice and Principles. Taylor & Francis
2. Fleming, D.O. and Hunt, D.L. (2006). Biological Safety: Principles and Practices. American Society for Microbiology, USA.
3. Mahop, M.T. (2010). Intellectual Property, Community Rights and Human Rights: The Biological and Genetic Resources of Developing Countries. Routledge.
4. Shannon, T.A. (2009). An Introduction to Bioethics. Paulist Press, USA.
5. Thompson J and Schaefer, B.D (2013). Medical Genetics: An Integrated Approach. McGraw Hill.
6. Vaughn, L. (2009). Bioethics: Principles, Issues, and Cases. Oxford University Press, UK.
7. WHO. (2005). Laboratory Biosafety Manual. World Health Organization.
8. Ahuja, V.K. (2017). Law relating to Intellectual Property Rights. LexisNexis, India. 3rd Edition.
9. Mahop, M.T. (2010). Intellectual Property, Community Rights and Human Rights: The Biological and Genetic Resources of Developing Countries. Routledge, USA.
10. Neeraj, P. and Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.
11. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.

Course Code: MME.555
Course Title: Evolution and Developmental Biology
Total Hours: 45

L	T	P	C
3	0	0	3

Learning Outcomes:

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

- Gain knowledge on concept related to origin of life.
- Develop understanding regarding molecular evolution and original of first cell.
- Know about concepts related to developmental processes.
- Understand pathology related to mechanisms of development and differentiation.

Unit: 1

11 Hours

Origin of Life: History of evolutionary ideas, Modern evolution theory, Natural Selection, Adaptation, The origin of species.

Unit: 2

11 Hours

Paleontology and Molecular Evolution: The evolutionary time scale, Major events in the evolutionary time scale, Intimate partnership, Stages in primate evolution, Human evolution, Neutral evolution, Molecular divergence and molecular clocks, Gene duplication and divergence.

Unit: 3

12 Hours

Basic Concepts of Development: Potency, Commitment, Specification, Induction, Competence, Determination and Differentiation, Morphogenetic gradients, Cell fate and cell lineages, Stem cells, Genomic equivalence and the cytoplasmic determinants, Imprinting, Mutants and transgenics in analysis of development.

Unit: 4

11 Hours

Gametogenesis, Fertilization, embryology and neurulation: Production of gametes, Cell surface molecules in sperm-egg recognition; embryonic development and formation of germ layers in humans, fetal development, sex determination, neural tube formation.

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

M.Sc. in Human Genetics (2021-2023)

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 Reading:

1. Darwin, C. (1956). The Origin of Species: By means of natural selection or the preservation of favoured races in the struggle for life (No. 575.0162). Oxford University Press.
2. Dawkins, R. (1996). The blind watchmaker: Why the evidence of evolution reveals a universe without design. WW Norton & Company.
3. Futuyma, D.J. (2017). Evolution. Sinauer Associates Inc. USA.
4. Wilt, F. H., & Hake, S. (2004). Principles of developmental biology. W.W. Norton & Company, New York, USA.
5. Hall, B.K., & Hallgrímsson, B. (2017). Strasburger's Evolution. Jones and Bartlett Publishers, India.
6. Lewin, R. (2014). Human Evolution - An Illustrated Introduction. Wiley-Blackwell, USA.
7. Scott, F., & Gilbert, S.F. (2017). Developmental Biology. Sinauer Associates, Inc. USA.
8. Slack, J.M.W. (2015). Essential Developmental Biology, Wiley-Blackwell, USA.

Foundation Courses

Course Code: HGE.556
Course Title: Principles of Ecological Science
Total Hours: 30

L	T	P	C
2	0	0	2

Learning Outcomes:

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

- Improve their knowledgebase about basics of ecological science
- Improve student's aptitude for research and development on ecological succession and dynamics
- Contribute in conservation science

UNIT I

6 Hours

Environmental components: Physical environment; biotic environment; biotic and abiotic interactions. Concept of habitat and niche; resource partitioning; character displacement. Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.

UNIT II

8 Hours

Biological components of environment: Characteristics of a population; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemec extinctions, age structured populations; Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis; Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.

UNIT III

8 Hours

Ecosystem and Ecological Succession: Ecosystem: structure and function; energy flow and mineral cycling (C, N, P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial and aquatic. Ecological Successions: Types; mechanisms; changes involved in succession; concept of climax.

UNIT IV

8 Hours

Applied Ecology and Conservation Biology: Environmental pollution; biodiversity: status, monitoring and documentation; biodiversity management approaches; Principles of conservation and its management; Indian case studies on conservation/management strategy: Project Tiger, Biosphere reserves.

M.Sc. in Human Genetics (2021-2023)

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. Smith, Robert Leo, et al. "Elements of ecology." (2015): E9.
2. Recknagel F. 2002 Ecological Informatics: Understanding Ecology by Biologically- Inspired Computation, Springer, New York.
3. Odum E.P. 1983 Basic Ecology. Saunders International Edition, Japan
4. Michael Begon, 2020 Ecology: From Individuals to Ecosystems 5th Edition

Course Code: MME.557
Course Title: Concepts of Bioinformatics
Total Hours: 30

L	T	P	C
2	0	0	2

Learning Outcomes:

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

- Analyze publicly available and experimental genomics data
- Perform in-silico prediction of protein structures and protein-protein interaction
- Perform in silico functional annotation of genetic findings
- Demonstrate the physical property of biomolecules in silico.

Unit I

6 Hours

Concept of biological databases: Nucleotide Sequence Databases, GenBank, DDBJ, EMBL, Sequence Flat file and submission process, Protein sequence databases, UniProt in detail, Mapping databases, Genomic databases, Data mining.

UNIT II

8 Hours

Inferring relationships: Concept of global Vs. local sequence alignments, Dotplots, Scoring matrices, Pairwise sequence alignment, BLAST, Position-Specific scoring and PSI-BLAST, MegaBLAST, BL2SEQ, BLAT, FASTA Vs BLAST, Protein multiple sequence alignments, Basics of Sequence assembly and finishing.

UNIT III

8 Hours

Sequence analysis: Gene Prediction methods, Promoter analysis, RNA secondary structure thermodynamics, refining multiple sequence alignment based on RNA secondary structure predictions, SNP discovery methods and databases, Genotyping, International haplotype map project, 1000 genomes project.

Unit IV

8 Hours

Analysis for protein sequences: Predicting features of individual residues, Neural networks, Theory of Protein structure prediction, Protein structure databases, PDB in detail, Pathway and molecular interaction databases.

Transactional Modes: Lecture; Demonstration; 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

M.Sc. in Human Genetics (2021-2023)

Suggested Readings:

1. Baxevanis, A.D. and Ouellette, B.F.F. (2005). Bioinformatics: A Practical guide to the Analysis of Genes and Proteins. Wiley-Interscience, USA.
2. Hall, B.G. (2011). Phylogenetic Trees Made Easy: A How-To Manual. Sinauer Associates, Inc. USA.
3. Lesk, A.M. (2008). Introduction to Bioinformatics. Oxford University Press, UK.
4. Zvelebil, M. and Baum, J. (2007). Understanding Bioinformatics, Garland Science, New York, USA.
5. Ramsden, J. (2010). Bioinformatics: An Introduction (Computational Biology). Springer, India.
6. Ye, S.Q. (2008). Bioinformatics: A Practical approach. Chapman & Hall/CRC, UK.
7. Mount, D. (2012). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press.
8. Graur, D., Li, W. H. (2000). Fundamentals of Molecular Evolution. Sinauer Associates.
9. Tisdall, J. (2001). Beginning Perl for Bioinformatics. O'Really Publishers.

Course Code: HGE.558
Course Title: Innovation and Entrepreneurship
Total Hours: 15

L	T	P	C
1	0	0	1

Learning Outcomes:

On the completion of this course, the learners will:

- Understand the basic concepts of entrepreneur, entrepreneurship, and its importance.
- Aware of the issues, challenges, and opportunities in entrepreneurship.
- Develop capabilities of preparing proposals for starting small businesses.
- Know the availability of various institutional supports for making a new start-up.

Unit I

4 Hours

Entrepreneurial Structure; Nature, Characteristics, functions and its role in economic development Entrepreneurship- problems and prospects in India. Entrepreneurial Behavior and Skills. Entrepreneurial traits and skills; Types of entrepreneurial ventures; enterprise and society in Indian context; Importance of women entrepreneurship

Unit II

4 Hours

Role of industries/entrepreneur's associations and self-help groups; Funding opportunities for start-ups. Basic start-up problems; Preliminary contracts with the vendors, suppliers, bankers, principal customers; Contents of business plan/ project proposal.

Unit III

4 Hours

Promotion of a venture – Why to start a small business; How to start a small business; opportunity analysis, external environmental analysis, legal requirements for establishing a new unit, raising of funds, and establishing the venture

Blending University Research and Entrepreneurship culture, National Innovation and startup policy for students and faculty 2019

Unit IV

3 Hours

Opportunities and challenges associated with establishing entrepreneurship in the field of Genetics and Molecular Medicine, Success stories

Suggested Readings:

1. Arora, Renu (2008). Entrepreneurship and Small Business, Dhanpat Rai & Sons Publications.
2. Chandra, Prasaan (2018). Project Preparation, Appraisal, Implementation, Tata Mc-Graw Hills.
3. Desai, Vasant (2019). Management of a Small-Scale Industry, Himalaya Publishing House.
4. Jain, P. C. (2015). Handbook of New Entrepreneurs, Oxford University Press.

M.Sc. in Human Genetics (2021-2023)

5. Srivastava, S. B. (2009). A Practical Guide to Industrial Entrepreneurs, Sultan Chand & Sons.
6. National Innovation and startup policy for students and faculty 2019, Government Policy document <http://rmkcet.ac.in/RMK/NISP%20policy.pdf>

Course Code: HGE.599
Course Title: Research Proposal
Total Hours: 60

L	T	P	C
0	0	8	4

Learning Outcomes:

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

- Apply genetic and genomics technique for research
- Construct study design
- Interpret result of a genetic experiment
- Present oral and written scientific communication skills

The objective of dissertation part-I would be to ensure that the student learns the nuances of the scientific writing. Herein the student shall have to write his synopsis including an extensive review of literature with simultaneous identification of scientifically sound (and achievable) objectives backed by a comprehensive and detailed methodology.

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

M.Sc. in Human Genetics (2021-2023)

Semester IV

Course Code: HGE.600
Course Title: Dissertation
Total Hours: 300

L	T	P	C
0	0	40	20

Learning Outcomes:

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

- Apply genetic and genomics technique for research
- Construct study design
- Interpret result of a genetic experiment
- Present oral and written scientific communication skill

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)

M.Sc. in Human Genetics (2021-2023)

Examination pattern for 2021-22 session

Core, Discipline Elective, Compulsory Foundation, Value Added and Interdisciplinary Courses			Discipline Enrichment Course		Entrepreneurship Course	
	Marks	Evaluation	Marks	Evaluation	Marks	Evaluation
Internal Assessment	25	Various	-	-	-	-
Mid-semester test (MST)	25	Subjective	50	Objective	25	Objective
End-semester test (EST)	50	Subjective (70%) Objective (30%)	50	Objective	25	Subjective

Dissertation Proposal (Third Semester)			Dissertation (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)

Evaluation pattern similar to fourth semester dissertation will apply for internship where supervisor will award 50% marks and external co-supervisor, HoD and senior-most faculty will award 50% marks.