Silicon University

Curriculum Structure & Detailed Syllabus

Master of Science (Molecular Medicine)

(Two-Year Post-Graduate Program)

Silicon University, Odisha

Silicon Hills, Patia, Bhubaneswar - 751024

https://silicon.ac.in

Effective From Academic Year 2024-25

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Approval History

ACM#	Date	Resolutions
SU-1	27/04/2024	The curriculum structure of M.Sc.(Molecular Medicine) was approved in principle by the Academic Council.
SU-2	17/08/2024	The curriculum structure and detailed syllabus of M.Sc.(Molecular Medicine) was approved by the Academic Council.

Program Outcomes

Graduates Attributes (GAs) form a set of individually assessable outcomes that are the components indicative of the graduate's potential to acquire competence to practice at the appropriate level.

PO1. Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.

PO2. Develop various methods of molecular biology techniques to detect the changes in the DNA and associate them with various disease conditions.

PO3. Design novel and innovative DNA based platforms for clinical application and early detection of diseases like Cancer, Infertility, and Life style Disorders.

PO4. Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.

PO5. Integrate the tools of Biochemistry, Molecular Biology, Immunology and Genetics to develop panels and sytems to explain the diseases at the molecular level and determine possible treatments or management.

PO6. Function effectively as an individual or as a member of a multidisciplinary team with professional and managerial skills.

PO7. Work with professional context with intellectual integrity, ethics and social responsibility.

PO8. Communicate effectively and present technical information in oral and written reports supported by diagrams and models for easy visualization.

PO9. Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.

PO10. Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

Program Specific Outcomes (PSOs)

PSO1. Acquire the necessary skill sets in the domain of Molecular Life Sciences and develop core competence to apply in various branches of healthcare at molecular level.

PSO2. Implement the skills and practical knowledge gained from real world medical cases of various diseases and develop expertise to make informed decisions.

PSO3. Utilize the expertise in various cutting edge domains of molecular and DNA based techniques & tools for a rewarding career and zest for entrepreneurship or higher studies.

Program Educational Objectives (PEOs)

PEO1. Build a successful career in super-specialised discpline of molecular medicine domain based on individual preference and skill sets.

PEO2. Work independently or in a diverse team with effective communication in interdisciplinary environment, and demonstrate leadership in industry and academia.

PEO3. Engage in lifelong learning and career development through analysis, discussion, professional studies, literature study, and continued research.

Course Categories & Definitions

L	Lecture
T	Tutorial
P	Practical / Laboratory / Sessional
WCH	Weekly Contact Hours
UCR	University Core Course
UMC	University Mandatory Course (0-Credit)
PCR	Program Core Course
PEL	Program Elective Course
OEL	Open Elective Course
HNS	Honours (Choice-based) Course
MNR	Minor (Choice-based) Course
OOC	Open Online Course (on NPTEL / Swayam / Other)
INT	Summer Internship
PSI	Practice School / Industry Internship
PRJ	Project Work
SEC	Skill Enhancement Course
VAC	Value Addition Course

Contents

Part I

Curriculum Structure

Curriculum Structure

Semester I								
Category	**Code**	**Course Title**	**WCH** L-T-P			**Credits** L-T-P		
THEORY								
PCR	MM5001	Biochemical & Molecular Basis of Life	3	0	0	3	0	0
PCR	MM5002	Microbial Genetics	3	0	0	3	0	0
PCR	MM5003	Genetics & Molecular Basis of Diseases	3	0	0	3	0	0
PCR	MM5004	Stem Cell & Development Biology	3	1	0	3	1	0
PCR	MM5005	Infection Biology & Immunology	3	1	0	3	1	0
PRACTICAL								
PCR	MM5006	Cytogenetics Lab	0	0	2	0	0	1
PCR	MM5007	Molecular Biology - I Lab	0	0	4	0	0	2
UCR	HS5003	Communication & Soft Skills	0	0	2	0	0	1
		SUB-TOTAL	**15**	**2**	**8**	**15**	**2**	**4**
		TOTAL	**25**			**21**		

Semester II								
Category	**Code**	**Course Title**	**WCH** L-T-P			**Credits** L-T-P		
THEORY								
PCR	MM5008	Epigenetics & Diseases	3	0	0	3	0	0
PCR	MM5009	Molecular Endocrinology	3	0	0	3	0	0
PCR	MM5010	Molecular Oncology	3	1	0	3	1	0
PEL		Program Elective - I	3	0	0	3	0	0
PEL		Program Elective - II	3	0	0	3	0	0
PRACTICAL								
PCR	MM5011	Clinical Pathology Lab	0	0	4	0	0	2
PCR	MM5012	Molecular Biology - II Lab	0	0	4	0	0	2
PCR	MM5013	Molecular Cytogenetics Lab	0	0	2	0	0	1
PCR	MM5014	PCR & Multiplexing Lab	0	0	2	0	0	1
		SUB-TOTAL	**15**	**1**	**12**	**15**	**1**	**6**
		TOTAL	**28**			**22**		

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Semester III								
Category	**Code**	**Course Title**	**WCH** L-T-P			**Credits** L-T-P		
THEORY								
PCR	MM6001	Research Methodology	3	0	0	3	0	0
PCR	MM6002	Genetic Counselling	3	0	0	3	0	0
PEL		Program Elective - III	3	0	0	3	0	0
PEL		Program Elective - IV	3	0	0	3	0	0
PRACTICAL								
PCR	MM6003	DNA Sequencing Lab	0	0	6	0	0	3
PCR	MM6004	Case Reporting & Interpretation Lab	0	0	2	0	0	1
PRJ	IP4003	Capstone Project	0	0	10	0	0	5
INT	IP4001	Summer Internship	0	0	0	0	0	1
		SUB-TOTAL	**12**	**0**	**18**	**12**	**0**	**10**
		TOTAL	**30**			**22**		

Semester IV								
Category	**Code**	**Course Title**	**WCH** L-T-P			**Credits** L-T-P		
THEORY								
OOC	MM6005	MOOC	0	0	0	3	0	0
PRACTICAL								
PRJ/PSI	IP4002	Project Work / Industry Internship	0	0	24	0	0	12
VAC	VA0001	Yoga / NCC / NSS	0	0	2	0	0	0
		SUB-TOTAL	**0**	**0**	**26**	**3**	**0**	**12**
		TOTAL	**26**			**15**		

		GRAND TOTAL (4 SEMESTERS)	**109**	**80**

Note:

1. Courses offered under each elective are given in “List of Electives” on Page 4.
2. MOOC - Massive Open Online Course (on NPTEL / Swayam / Other).
3. Approved list of courses for MOOC (self study) shall be published by the department. Students are advised to complete the same before the end of 4th semester.
4. Students opting for Project Work shall undergo the same under the guidance of a faculty member.
5. Students selected for Industry Internship shall be attached to a faculty member as mentor.
6. The Value Addition Course (Yoga / NSS / NCC) may be assigned in a different semester depending on available capacity.

List of Electives

Code	Elective # and Subjects
	Program Elective-I
MM5015	Embryology & IVF
MM5016	Computational Bioinformatics
MM5017	Bioethics & IPR
	Program Elective-II
MM5018	Advanced Cytogenetics
MM5019	Preventive Health Management
MM5020	Epidemiology & Biostatistics
	Program Elective-III
MM6006	Tissue Engineering
MM6007	R&D Management
MM6008	DNA Fingerprinting & Forensics
	Program Elective-IV
MM6009	Functional & Lifestyle Medicine
MM6010	Omics & Diseases
MM6011	Nutritional Genetics

Note:

1. The department shall offer subjects under each program elective depending on available capacity.
2. Unless adequate number of students choose an elective subject offered by the department, the subject shall not be offered and the students shall be assigned with a different elective subject.

Part II

Detailed Syllabus

Category	Code	Biochemical & Molecular Basis of Life	L-T-P	Credits	Marks
PCR	MM5001		3-0-0	3	100

Objectives	The objective of this course is to understand the fundamental concepts of molecular mechanisms that governs the basis of life at the cellular and molecular level with familiarity on concepts of DNA and physiological functions.
Pre-Requisites	Basic concepts of cell, DNA, and biochemistry is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on case studies and practical examples.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Genomic Structure and its Stability**: Central dogma of molecular biology, DNA Topology - Linking numbers, Supercoiling, Topoisomerases, Denaturation & renaturation, Melting temperature, Hyperchromicity, Renaturation kinetics, Cot analysis, Repetitive DNA sequences, C-value paradox, Protein-DNA-complexes in prokaryotes & eukaryotes, Chromatin structure, Nucleosomes, Histones, Nucleoproteins & their functions.	**8 Hours**
Module-2	**Transfer of Genetic Information**: RNA as the genetic material, RNA to DNA by reverse transcription & back to RNA in simple genomes; Types of RNA - Secondary structure, Complex tertiary structure, Catalytic RNA or ribozymes, Discovery of mRNA, Discovery of transfer RNA, Nature of ribosomal RNA & other small RNAs, Crick's adaptor hypothesis, RNA structure conservation through evolution; Genetic code, Synthesis of amino acids by triplet bases; Start & stop codons, Concept of genomics & proteomics in mutations & diseases.	**10 Hours**
Module-3	**DNA Replication and its Regulation in Prokaryotes and Eukaryotes**: Biochemistry of DNA synthesis; Mechanism of DNA Replication - Function of polymerase, Replication fork & regulatory steps in the initiation, DNA Replication - Elongation & termination steps, Fidelity, Nucleosome modification & remodeling.	**9 Hours**
Module-4	**Recombination and Transposition**: Homologous recombination, Double-strand break repair model, Gene conversion, Site specific recombination; Transposition - Mechanism of transposition by DNA transposons, Poly-A retrotransposons, Virus-like retrotransposons and retroviruses, Biological roles of transposition.	**9 Hours**
Module-5	**Mutation and Repair**: Types of mutations, Mutagens, Point mutations, Frame shift mutations, Insertion, Deletion, Inversion, Transposable elements as inducers of insertion and deletion, Replication errors, DNA repair mechanisms, High fidelity and error prone repair, DNA repair by recombination.	**6 Hours**
	Total	**42 Hours**

Text Books:

T1. J. D. Watson, N. H. Hopkins, J. W. Roberts, J. A. Steitz, and A. M. Weiner, ***The Molecular Biology of the Gene - Vol I & II***, 4th Edition, Benjamin Cummings, 1987.
T2. B. E. Tropp, ***Molecular Biology : Genes to Proteins***, 4th Edition, Jones and Bartlett, 2011.

Reference Books:

R1. B. Lewin, ***Genes IX***, 9th Edition, Jones and Bartlett, 2007.
R2. R. J. Brooker, ***Genetic Analysis and Principles***, 6th Edition, McGraw-Hill, 2017.

Online Resources:

1. https://ocw.mit.edu/courses/7-01sc-fundamentals-of-biology-fall-2011/pages/molecular-biology/
2. https://molbiomadeeasy.files.wordpress.com/2013/09/fundamental_molecular_biology.pdf

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Describe the structural aspects of DNA and RNA as a fundamental basis of life.
CO2	Explain the flow of genetic information from DNA to RNA and from RNA to protein.
CO3	Identify different diseases that are initiated due to replication error.
CO4	Explain the molecular mechanism of recombination and jumping genes.
CO5	Analyze the effect of mutagenesis on DNA base sequence leading to diseases.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO2	Develop various methods of molecular biology techniques to detect the changes in the DNA and associate them with various disease conditions.
PO3	Design novel and innovative DNA based platforms for clinical application and early detection of diseases like Cancer, Infertility, and Life style Disorders.
PO4	Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.
PO5	Integrate the tools of Biochemistry, Molecular Biology, Immunology and Genetics to develop panels and sytems to explain the diseases at the molecular level and determine possible treatments or management.
PO9	Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	3	1	1	1				2	2	2	1	1
CO2	2	2	1	1	1				2	2	1	1	1
CO3	2	2	1	1	1				2	1	1	1	1
CO4	2	2	1	1	1				2	1	1	1	1
CO5	3	3	2	2	2				3	2	2	2	2

Category	Code	Microbial Genetics	L-T-P	Credits	Marks
PCR	MM5002		3-0-0	3	100

Objectives	The objective of this course is to study the fundamental concepts, theories and basis of microbial genomics, plasmids, bacterial transposition, bacteriophage genetics, microbial gene transfer, gene expression and genetic engineering.
Pre-Requisites	Basic concepts of microbial cell biology and genetics is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on case studies and practical examples.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Principles of Genetics & Microbiology**: Essential of prokaryotic genetics, Nomenclature, Nucleic acids, Proteins - Chemical and physical structure, Enzymes, Bacterial growth, Counting, Preparation of media, Metabolic regulation and Phage structures, Life cycle and counting phages.	**8 Hours**
Module-2	**Molecular Aspects & Maintenance of Prokaryotic Gene Expression**: Gene expression, Regulation of gene expression, Lactose operon, Tryptophan operon, Lambda genetic switch, DNA damage and repair, Mutagenesis, Mutations and mutants, Recombination and mapping.	**9 Hours**
Module-3	**Bacterial and Phage Genetics**: Plasmids - Types, Detection, Purification and transfer, Transposable elements, Bacterial transformation, Bacterial conjugation, Genetics of T4 phage, Lysogeny & lytic growth of lambda phage, Transduction and strain construction.	**9 Hours**
Module-4	**Applications of Microbial Genetics**: Genetic engineering, Vectors, Enzymes, Recombinant molecules, Restriction mapping, Genetic strategies of vaccine development, Approaches to drug development for microbial strains.	**8 Hours**
Module-5	**Microbial Genomics**: Genome, Biology and evolution of the *Mycobacterium tuberculosis* complex, *Pseudomonas aeruginosa*, *Candida albicans*, *Leishmania donovani*, Adenovirus, HIV, Reading microbial gene & protein sequences, Tools and resources, NCBI Database.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. S. R. Maloy, J. E. Cronan, and D. Friefelder, ***Microbial Genetics***, 2nd Edition, Jones & Bartlett, 1994.
T2. U. N. Streips and R. E. Yasbin, ***Modern Microbial Genetics***, 2nd Edition, Wiley–Liss Pubs, 2002.
T3. N. Trun and J. Trempy, ***Fundamental Bacterial Genetics***, 1st Edition, Wiley-Blackwell, 2004.

Reference Books:

R1. R. J. Brooker, ***Genetic Analysis and Principles***, 6th Edition, McGraw-Hill, 2017.
R2. K. W. Adolph, ***Microbial Gene Techniques: Methods in Molecular Genetics, Vol.6***, Academic Press, 1995.

Online Resources:

1. https://nptel.ac.in/courses/102103074: By Dr. V. Trivedi, IIT Guwahati
2. https://nptel.ac.in/courses/102103013: By Dr. U. Bora, IIT Guwahati
3. https://www.scienceprofonline.com/vmc/microbial-genetics-main.html
4. https://accesspharmacy.mhmedical.com/content.aspx?bookid=1551&sectionid=94105826

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Explain the pathogenesis and life-cycle of few known viruses and bacteria.
CO2	Describe the flow of genetic information and the function of molecular switch.
CO3	Compare different natural methods that introduce variation among microbes.
CO4	Explore the design of various RDT tools and techniques for vaccine & drug development.
CO5	Identify the online databases for microbial genome biology, evolution and analysis.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO2	Develop various methods of molecular biology techniques to detect the changes in the DNA and associate them with various disease conditions.
PO3	Design novel and innovative DNA based platforms for clinical application and early detection of diseases like Cancer, Infertility, and Life style Disorders.
PO4	Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.
PO5	Integrate the tools of Biochemistry, Molecular Biology, Immunology and Genetics to develop panels and sytems to explain the diseases at the molecular level and determine possible treatments or management.
PO9	Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	1	1	1	1				2	1	1	1	1
CO2	2	1	1	1	1				3	1	1	1	1
CO3	2	1	1	1	1				3	2	1	1	1
CO4	3	3	3	3	2				3	3	2	1	2
CO5	3	2	2	3	1				3	2	2	2	2

Category	Code	Genetics & Molecular Basis of Diseases	L-T-P	Credits	Marks
PCR	MM5003		3-0-0	3	100

Objectives	The objective of this course is to study the relevance, fundamental concepts, theories and molecular mechanisms by which disease genes function and their disease processes affecting specific cell types, tissues or organ systems.
Pre-Requisites	Basic concepts of microbial cell, molecular biology, and biochemistry is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on case studies and practical examples.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Introduction**: Disease and disorder, Types and subtypes, Classification, Communicable and non-communicable diseases, Factors and mechanisms.	**6 Hours**
Module-2	**Genetic Disorders**: Types, Single-gene diseases – Sickle cell anemia, Thalassemia; Multifactorial genetic disorders – Diabetes, Alzheimer disease; Chromosomal abnormalities – Male Pseudo-hermaphrodite (MPH), Female Pseudo-hermaphrodite (FPH), True Hermaphrodites (TH), Mixed gonadal dysgenesis (MGD) and Persistent Mullerian Duct Syndrome (PMDS); Mitochondrial genetic disorders, Metabolic genetic disorder – Inborn errors of metabolism, Phenylketonuria, Homocystinuria.	**9 Hours**
Module-3	**Molecular Basis of Infectious & Non-Communicable Diseases**: Principles of infectious diseases, Man-microbe interaction, Molecular basis of bacterial pathogenesis – Virulence factors, Adhesins, Pathogenicity island, Protein and DNA secreting systems in pathogenicity and disease, Modulation of host signaling system in response to infection; Molecular & cellular basis of viral infections, Key examples, Molecular biology of oncoviruses, Mechanisms of carcinogenesis; Molecular parasitology - Molecular aspects of parasite biology, Genetics & biochemistry, Mechanisms of pathogenesis, Parasite adaptations for survival, Challenges for drug & vaccine development; Molecular basis of non-communicable diseases - Diabetes, Coronary artery diseases, Hypertension, Cancer, and Neuronal disorders.	**10 Hours**
Module-4	**Molecular Basis of Metabolic Disorders**: Introduction to metabolic disorders and metabolic profiling, Genetics and epigenetics in metabolic disorders, Diagnosis of metabolic disorders and therapy.	**9 Hours**
Module-5	**Novel Therapies for Diseases**: Tyrosine kinase inhibitor, Monoclonal antibody, Chemo & radio, Gene Therapies, Small peptides; Limitations, Ethical and biosafety issues in gene therapies, RNA therapy.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. L. B. Jorde, J. C. Carey, M. J. Bamshad, and R. L. White, ***Medical Genetics***, 3rd Edition, Elsevier, 2006.
T2. C. Gaultier (Ed.), ***Genetic Basis for Respiratory Control Disorders***, Springer, 2008.

Reference Books:

R1. R. J. Epstein, ***Human Molecular Biology: An Introduction to Health and Disease***, Cambridge University Press, 2003.
R2. H. H. Kesslar, ***Molecular Diagnostics of Infectious Diseases***, 3rd Illustrated Edition, De Gruyter, 2014.

Online Resources:

1. https://dth.ac.in/medical/course-inner.php?id=230: by Dr. Girisha KM, Manipal university
2. https://dth.ac.in/medical/course-inner.php?id=228: : By Dr. Girisha KM, Manipal university
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6293117/

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Describe the fundamental concept of molecular basis of diseases.
CO2	Identify various types of genetic disorders and possible treatment if any.
CO3	Explain the molecular mechanisms behind communicable and non-communicable diseases.
CO4	Design tools and techniques for the diagnosis of metabolic disorders.
CO5	Compare the novel therapies for various disease and their limitations.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO2	Develop various methods of molecular biology techniques to detect the changes in the DNA and associate them with various disease conditions.
PO3	Design novel and innovative DNA based platforms for clinical application and early detection of diseases like Cancer, Infertility, and Life style Disorders.
PO4	Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.
PO5	Integrate the tools of Biochemistry, Molecular Biology, Immunology and Genetics to develop panels and sytems to explain the diseases at the molecular level and determine possible treatments or management.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	1	1	1	1				2	1	1	1	1
CO2	3	1	1	2	3				3	3	2	2	2
CO3	3	1	1	2	3				3	3	2	2	2
CO4	3	1	1	2	3				3	3	2	2	2
CO5	3	1	1	2	3				3	3	2	2	2

Category	Code	Stem Cell & Development Biology	L-T-P	Credits	Marks
PCR	MM5004		3-1-0	4	100

Objectives	The objective of this course is to study the fundamental concepts of human developmental biology and stem cell genetics including stem cell pathways, types, differentiation, disorders and applications.
Pre-Requisites	Basic concepts of human physiology and development is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on case studies and practical examples.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Stem Cells**: Introduction, Signaling pathway, Totipotency, Pluripotency, Source of stem cells, Genetic basis of stem cells, Embryonic, Adult stem cells, Hematopoietic stem cells, Cancer stem cells and properties.	**10 Hours**
Module-2	**Applications**: Neurodegenerative disorders, Cardiac disorders, Experimental and clinical therapy using stem cells, Potentials and issues associated with stem cells - Ethical issues and regulation of stem cell research, Stem cell therapeutics.	**12 Hours**
Module-3	**Developmental Genetics**: Gametogenesis, Early development, Morphogenetic processes, Developmental pathways, Organogenesis, Development of nervous system.	**10 Hours**
Module-4	**Regulation of Embryonic Development**: Stages of development, Body cavities, Mesenteries, Respiratory and Cardiovascular system, Alimentary and Urogenital system, Skeletal and muscular system, Development of Limbs, Nervous system, Human birth defects.	**12 Hours**
Module-5	**Gonadal Development, Disease and Applications**: Sex chromosomes, Differentiation, Hormonal changes, Reproductive aging, Infertility, Assisted Reproductive Technologies (ART), Prenatal genetic screening, Diagnostics (PGS & PGD) and advances.	**12 Hours**
	Total	**56 Hours**

Text Books:

T1. K. L. Moore, ***The Developing Human: Clinically Oriented Embryology***, 11th Edition, Saunders, 2019.
T2. J. M. W. Slack, ***Essential Developmental Biology***, 3rd Edition, Wiley-Blackwell, 2012.
T3. K. E. Orwig and B. P. Hermann, ***Stem Cell Biology and Regenerative Medicine***, Humana Press, 2011.

Reference Books:

R1. R. Kirschstein and L. R. Skirboll, ***Stem Cells: Scientific Progress and Future Research Directions***, NIH Report, 2001.
R2. G. B. Schaefer and J. Thompson, ***Medical Genetics: An Integrated Approach***, 1st Edition, McGraw-Hill, 2013.
R3. A. Milunsky and J. M. Milunsky, ***Genetic Disorders and the Fetus: Diagnosis, Prevention & Treatment***, 8th Edition, Willey-Blackwell, 2021.
R4. Selected papers from various scientific journals.

Online Resources:

1. https://nptel.ac.in/courses/102106084: By Prof. K. Subramaniam, IIT Madras
2. https://pubmed.ncbi.nlm.nih.gov/32135011/

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Describe the concepts of different types of stem cells.
CO2	Explain the functioning of stem cells from health-care perspectives and ethical issues.
CO3	Articulate the concepts of developmental genetics and their relevance in health-care.
CO4	Correlate the mechanisms of embryonic developmental process and birth defects.
CO5	Analyze the significance of genetic changes that affect gonadal development.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO2	Develop various methods of molecular biology techniques to detect the changes in the DNA and associate them with various disease conditions.
PO3	Design novel and innovative DNA based platforms for clinical application and early detection of diseases like Cancer, Infertility, and Life style Disorders.
PO4	Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.
PO5	Integrate the tools of Biochemistry, Molecular Biology, Immunology and Genetics to develop panels and sytems to explain the diseases at the molecular level and determine possible treatments or management.
PO9	Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	1	1	1	1				2	2	2	2	2
CO2	3	2	2	3	2				3	3	2	2	3
CO3	3	2	1	2	2				2	2	2	2	2
CO4	3	2	1	2	2				2	2	2	2	2
CO5	3	2	2	3	3				3	3	2	3	3

Category	Code	Infection Biology & Immunology	L-T-P	Credits	Marks
PCR	MM5005		3-1-0	4	100

Objectives	The objective of this course is to study the fundamental concepts, theories and basis of Infection biology and immunology, molecular basis of infectious diseases, and applications of clinical immunology & antibody engineering.
Pre-Requisites	Basic concepts of microbiology and immunology is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on case studies and practical examples.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Immunity & Compliment System**: Introduction, Organization of human immune system, Cell mediated immune mechanism, Induction and mediators of immune response, Complement system and MHC.	**10 Hours**
Module-2	**Molecular Basis of Infectious Diseases**: Bacterial pathogenesis – Role of virulence factors, Protein and DNA secreting systems in pathogenicity and disease; Modulation of host signaling system in response to infection; Molecular and cellular basis of viral infections: Key examples of RNA and DNA virus of humans causing diseases.	**12 Hours**
Module-3	**Infection Biology**: Infectious diseases – General principles of microbial interactions with humans that result in infection and diseases; Examples of bacterial, viral, fungal and parasitological pathogens with special emphasis on developing countries.	**12 Hours**
Module-4	**Antibody Engineering**: Introduction, Vectors, Cloning of antibody DNA, Expression of phage antibodies, Growth of phage antibodies, Selection of antibody variants, Analysis of phage derived antibodies, Chimeric antibodies – Introduction, Properties and construction models.	**12 Hours**
Module-5	**Clinical Immunology**: Transplantation immunology, Transfusion immunology – Blood group antigens and multiple alleles system of human blood groups, Immunodeficiency status -– Primary and secondary immune techniques and applications.	**10 Hours**
	Total	**56 Hours**

Text Books:

T1. A. A. Salyers, B. A. Wilson, D. D. Whitt, and M. Winkler, ***Bacterial Pathogenesis: A Molecular Approach***, 3rd Edition, ASM Press, 2011.

T2. K. J. Ryan (Ed.), ***Medical Microbiology: An Introduction to Infectious Diseases***, 3rd Edition, Appleton & Lange, 1995.

T3. S. J. Martin, D. R. Burton, I. M. Roitt, and P. J. Delves, ***Roitt's Essential Immunology***, 13th Edition, Wiley-Blackwell, 2017.

T4. J. Punt, S. Stranford, P. Jones, and J. A. Owen, ***Immunology***, 8th Edition, W. H. Freeman & Co., 2018.

Reference Books:

R1. Anonymous, ***Emerging Infectious Diseases, Vol. 14***, CDC Press, 2008.
R2. H. H. Kesslar (Ed.), ***Molecular Diagnostics of Infectious Diseases***, 3rd Revised Edition, De Gruyter, 2014.
R3. M. R. G. O'Gorman and A. D. Donnenberg, ***A Handbook of Human Immunology***, 2nd Edition, CRC Press, 2008.
R4. Selected papers from various scientific journals.

Online Resources:

1. https://nptel.ac.in/courses/102105083: by Prof. A. Ganguly and Prof. S. K. Ghosh, IIT Kharagpur
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6456699/pdf/fimmu-10-00684.pdf

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Explain the basic concepts and theories of immunology.
CO2	Discuss the details of the molecular basis of infectious diseases.
CO3	Describe the relevance and basic concepts of infection biology.
CO4	Compare different antibody engineering techniques and their applications in health-care.
CO5	Describe the molecular principles and mechanisms in clinical immunology and its applications.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO2	Develop various methods of molecular biology techniques to detect the changes in the DNA and associate them with various disease conditions.
PO3	Design novel and innovative DNA based platforms for clinical application and early detection of diseases like Cancer, Infertility, and Life style Disorders.
PO4	Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.
PO5	Integrate the tools of Biochemistry, Molecular Biology, Immunology and Genetics to develop panels and sytems to explain the diseases at the molecular level and determine possible treatments or management.
PO9	Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	1	1	1	2				2	1	2	1	1
CO2	2	2	2	1	2				2	1	2	1	1
CO3	2	1	1	1	2				1	1	2	1	1
CO4	2	2	3	2	2				2	3	3	3	2
CO5	2	2	2	2	2				2	2	2	2	2

Category	Code	Cytogenetics Lab	L-T-P	Credits	Marks
PCR	MM5006		0-0-2	1	100

Objectives	The objective of this course is to understand the relevance, fundamental concepts and practical applications of cytogenetics through experiments.
Pre-Requisites	Basic concepts of cell biology and genetics are required.
Teaching Scheme	Regular laboratory experiments conducted under supervision of the teacher.

Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test / Project	Viva-voce	Total
10	30	15	30	15	100

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Good Laboratory Practices and Laboratory Ethics.
2	Sterilization techniques.
3	Medium preparation.
4	Culture setup, Culture termination and slide preparation from human peripheral blood sample.
5	Culture setup, Culture termination and slide preparation from human bone marrow sample.
6	Human Chromosome staining and Banding techniques- GTG, R-banding.
7	Calculation of mitotic index using mitogen induced human lymphocytes.
8	Human chromosome and their analysis- Eye karyotyping.
9	Human chromosome identification through Paper karyotyping.
10	Human chromosome and their analysis through Software.
11	Cytokinesis-block micronucleus (CBMN) assay.
12	Dose response curve and estimation through CBMN Assay.
13	Chemical mutagenesis and chromosomal aneuploidy.
14	Sister chromatid exchange (SCE) assay.

Text Books:

T1. M. S. Arsham, M. J. Barch, H. J. Lawce, ***The AGT Cytogenetics Laboratory Manual***, 4th Edition, Wiley-Blackwell, 2017.

Reference Books:

R1. U. Dutta , ***Essentials of Cytogenetic and Molecular Cytogenetic Laboratory Testing***, Cambridge Scholars Publishing, 2022.

Online Resources:

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7073234/
2. https://www.vanderbilt.edu/viibre/CellCultureBasicsEU.pdf

P.T.O

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Adapt to good laboratory practice and lab ethics.
CO2	Prepare various kinds of growth medium for culture.
CO3	Conduct experiments with culture setup, termination & slide preparation from different types of samples.
CO4	Identify human chromosomes and banding pattern manually or using software.
CO5	Estimate dose response using CBMN assay.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO2	Develop various methods of molecular biology techniques to detect the changes in the DNA and associate them with various disease conditions.
PO3	Design novel and innovative DNA based platforms for clinical application and early detection of diseases like Cancer, Infertility, and Life style Disorders.
PO4	Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.
PO5	Integrate the tools of Biochemistry, Molecular Biology, Immunology and Genetics to develop panels and sytems to explain the diseases at the molecular level and determine possible treatments or management.
PO7	Work with professional context with intellectual integrity, ethics and social responsibility.
PO9	Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1						3		1		1	1	1
CO2	2	1	1						1	1	1	1	1
CO3	3	2	2	3	2				3	1	3	2	2
CO4	3	2	2	3	2				3	1	3	2	3
CO5	3	2	2	3	2				3	1	3	2	2

Category	Code	Molecular Biology-I Lab	L-T-P	Credits	Marks
PCR	MM5007		0-0-4	2	100

Objectives	The objective of this laboratory course is to provide hands-on exposure on basic microbiology and microbial genetics tools and techniques.
Pre-Requisites	Basic concepts of Microbiology and Molecular biology are required.
Teaching Scheme	Regular laboratory experiments conducted under supervision of the teacher.

Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test / Project	Viva-voce	Total
10	30	15	30	15	100

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Media Preparation: General Purpose, Selective & Differential.
2	Plating Techniques: Streak plate, Pour Plate, Spread Plate.
3	Preservation of micro-organisms: Sub-culturing, Glycerol.
4	Identification of micro-organisms by Staining methods (Gram and Acid Fast).
5	Use of microscope: Setting at 10X, 40X, 100X (oil immersion) magnification.
6	Microbial culture in LB media.
7	Plasmid Isolation From microbial culture.
8	Restriction Mapping & Restriction Digestion (Single & double digestion).
9	Gel elution of digested product followed by Ligation.
10	Competent cells preparation and transformation by CaCl2 method.
11	Recombinant selection (Blue white screening or antibiotic resistance).
12	Induction and expression of given protein.
13	siRNA based gene silencing.
14	Introduction to CRISPR-Cas9 gene editing.

Text Books:

T1. J. G. Cappuccino and N. Sherman, ***Microbiology: A Laboratory Manual***, 10th Edition, Pearson Education, 2014.

T2. A. Hofmann and S. Clokie, ***Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology***, 8th Edition, Cambridge University Press, 2018.

Reference Books:

R1. J. Sambrook, M. R. Green, ***Molecular Cloning: A Laboratory Manual Vol. I, II & III***, 4th Edition, Viva Books, 2013.

R2. J. Harley, ***Laboratory Exercises in Microbiology***, 10th Edition, McGraw-Hill, 2016.

Online Resources:

1. http://www.molecularcloning.com/index.php

P.T.O

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Prepare different growth media for microbial culture.
CO2	Identify different organization and shape of microbes under microscope.
CO3	Isolate plasmid from broth culture.
CO4	Design experiments for restriction digestion, ligation and bacterial transformation.
CO5	Develop methods for induced protein expression.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO2	Develop various methods of molecular biology techniques to detect the changes in the DNA and associate them with various disease conditions.
PO3	Design novel and innovative DNA based platforms for clinical application and early detection of diseases like Cancer, Infertility, and Life style Disorders.
PO4	Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.
PO5	Integrate the tools of Biochemistry, Molecular Biology, Immunology and Genetics to develop panels and sytems to explain the diseases at the molecular level and determine possible treatments or management.
PO9	Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	1	1	1	1				1	1	2	1	1
CO2	2	1	2	2	2				3	2	2	2	2
CO3	3	3	2	1	2				2	3	2	2	2
CO4	3	3	2	2	2				3	3	3	2	2
CO5	3	3	3	2	2				3	3	3	3	3

Category	Code	Communication & Soft Skills	L-T-P	Credits	Marks
UCR	HS5003		0-0-2	1	100

Objectives	The objectives of this laboratory course are to develop effective communication and soft skills, such as negotiation, assertiveness, teamwork, leadership, presentation, writing e-mails, business letters, and reports, etc.
Pre-Requisites	Knowledge of English and basic communication skills is required.
Teaching Scheme	Regular laboratory classes pair through and/or team activities with regular assessments, presentations, discussions, role-playing, audio-visual supplements, writing activities, business writing practices and vocabulary enhancement.

Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test / Project	Viva-voce	Total
10	30	15	30	15	100

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Introduction to the course and diagnostic test
2	Personality development and soft skills for professionals
3	Group Discussion (GD): Mock GD 1
4	Group Discussion (GD): Mock GD 2
5	Verbal Ability
6	Writing a compelling resume and cover letter
7	Personal Interview FAQs
8	Mock Personal Interview (PI)
9	Assertive communication and negotiation skills
10	Teamwork and leadership skills
11	Powerpoint Presentation 1
12	Powerpoint Presentation 2
13	Writing business letters, email etiquette
14	Preparing Analytical Reports

Text Books:

T1. M. A. Rizvi, ***Effective Technical Communication***, 2nd Edition, Tata McGraw-Hill, 2017.
T2. M. Raman and S. Sharma, ***Technical Communication: Principles and Practice***, 3rd Edition, Oxford University Press, 2015.

Reference Books:

R1. S. John, ***The Oxford Guide to Writing and Speaking***, 3rd Edition, Oxford University Press, 2013.
R2. S. Kumar and P. Lata, ***Communication Skills***, 2nd Edition, Oxford University Press, 2015.
R3. B. K. Das, K. Samantray, R. Nayak, S. Pani, and S. Mohanty, ***An Introduction to Professional English and Soft Skills***, 2nd Edition, Cambridge University Press, 2012.

Online Resources:

1. https://nptel.ac.in/courses/109/106/109106094/: By Prof. A. Iqbal, IIT Madras
2. https://nptel.ac.in/courses/109/104/109104031/: By Dr. T. Ravichandran, IIT Kanpur

3. https://www.coursera.org/specializations/business-english
4. https://ocw.mit.edu/courses/comparative-media-studies-writing/21w-732-5-introduction-to-technical-communication-explorations-in-scientific-and-technical-writing-fall-2006/download-course-materials/

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Communicate assertively and make successful negotiations in business situations.
CO2	Improve skills like verbal ability, GD, PI & writing resumes for career success.
CO3	Develop effective team work abilities and take leadership in real-life situations.
CO4	Demonstrate & apply various techniques of effective oral presentation.
CO5	Compose effective business correspondences such as e-mail, business letters, and reports.

Program Outcomes Relevant to the Course:

PO6	Function effectively as an individual or as a member of a multidisciplinary team with professional and managerial skills.
PO7	Work with professional context with intellectual integrity, ethics and social responsibility.
PO8	Communicate effectively and present technical information in oral and written reports supported by diagrams and models for easy visualization.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1						2	1	1		1			1
CO2						1	1	1			1		1
CO3						3	1	1		1	1		1
CO4						3	1	3		1	1		1
CO5						1	2	1		1	1	1	1

Category	Code	Epigenetics & Diseases	L-T-P	Credits	Marks
PCR	MM5008		3-0-0	3	100

Objectives	The objective of this course is to learn the fundamental concepts and mechanism of epigenetic basis of disease.
Pre-Requisites	Basic concepts of genetics and genetic function is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on case studies and practical examples.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Introduction to Epigenome**: Nuclear organization, Chromatin structure and nucleosome model, Histone proteins and modification, Methylation and acetylation mechanisms, Nucleosome positioning and architecture, Nuclear topology, Nucleosome I and Nucleosome II.	**10 Hours**
Module-2	**Genome Imprinting**: Epigenetic memory, Histone marks, Epigenetic stress, Protein-protein interaction, Protein and nucleic acid interaction, Enhancers, Super enhancers.	**8 Hours**
Module-3	**The Histone Code**: Histone modifying enzymes and class, Dosage compensation in species, Maintenance of epigenetic marks, Polycomb proteins, Heterochromatin and gene control elements.	**9 Hours**
Module-4	**Epigenetic Basis of Disease**: Epigenetics basis of cancer, Other lifestyle disorders, Diabetes, Obesity, Cardiac ailments, Neurodegenerative disorder, Epigenetic reversal and therapeutics.	**8 Hours**
Module-5	**Epigenetic Programming and Stem Cell Development**: *In vitro* modification of lineage development in stem cell, Epigenetics and ageing.	**7 Hours**
	Total	**42 Hours**

Text Books:

T1. T. O. Tollefsbol (Ed.), ***Epigenetics in Human Disease***, 2nd Edition, Elsevier, 2018.
T2. C. D. Allis, M-L. Caparros, T. Jenuwein, and D. Reinberg, ***Epigenetics***, 2nd Edition, CSHL Press, 2015.

Reference Books:

R1. D. S. Moore, ***The Developing Genome: An Introduction to Behavioral Epigenetics***, 3rd Edition, Oxford University Press,2017.

Online Resources:

1. https://scholarship.claremont.edu/pitzer_fac_pub/194/
2. https://science.umd.edu/classroom/BSCI411/Liu/epigenetic.pdf
3. https://nptel.ac.in/courses/102104056: by Prof S. Ganesh, IIT Kanpur

P.T.O

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Describe DNA organization in the nucleus and structural basis of nucleosome complex.
CO2	Discuss genetic memory and concept of imprinting and DNA-Protein interaction.
CO3	Explain the concepts of Histone-Core Complex and regulation of genome.
CO4	Categorize various diseases at the epigenetics level.
CO5	Correlate the fundamental basis of ageing with respect to stem cells and epigenetics.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO2	Develop various methods of molecular biology techniques to detect the changes in the DNA and associate them with various disease conditions.
PO3	Design novel and innovative DNA based platforms for clinical application and early detection of diseases like Cancer, Infertility, and Life style Disorders.
PO4	Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.
PO5	Integrate the tools of Biochemistry, Molecular Biology, Immunology and Genetics to develop panels and sytems to explain the diseases at the molecular level and determine possible treatments or management.
PO9	Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	1	1	1	1				2	2	2	1	2
CO2	3	2	2	1	1				3	2	2	1	2
CO3	2	1	1	1	1				3	2	2	1	2
CO4	3	2	2	2	2				3	3	2	2	2
CO5	3	2	2	3	2				3	3	2	3	3

Category	Code	Molecular Endocrinology	L-T-P	Credits	Marks
PCR	MM5009		3-0-0	3	100

Objectives	The objective of this course is to study the concepts related to the molecular aspects of hormonal regulation and diseases like diabetes, cardiovascular and other life-style disorders linked with endocrine dysfunction.
Pre-Requisites	Basic concepts of cell, human physiology, and biochemistry are required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on case studies and practical examples.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Hormonal Axis**: Primary hormonal axis and its regulation, Molecular basis of metabolism and hormonal control, Pituitary and its functional control on other glands, Environmental and behavioral association of endocrine functions.	**8 Hours**
Module-2	**Molecular Metabolism & Diabetes**: Diabetes as a complex disorder, Molecular and metabolic aspect of insulin resistance, Genetics and hereditary mechanism of familial diabetes, Juvenile adult and geriatric presentation, Epigenetic regulation of diabetes.	**10 Hours**
Module-3	**Endocrine Regulation**: Endocrine regulation and early genome imprinting, Cardiovascular diseases and endocrine dysregulation, Obesity pathophysiology of hormonal imbalances, Life style disorders linked with endocrine dysfunction, Hypertensive cardiometabolic syndrome.	**9 Hours**
Module-4	**Cortisol Rhythmicity**: Hypothalamus, Pituitary, Thyroid, Pancreas Adrenal Cortex and their individual role in genetic regulation and feedback mechanism, Sleep pathology and the role of circadian rhythm, Cortisol rhythmicity and adaptive stress.	**9 Hours**
Module-5	**Molecular Basis of Stress**: Psychoneuroimmunology and stress regulation, Endocrine tumors and their management, Reproductive endocrinology and infertility, Life style changes and restoring endocrine homeostasis.	**6 Hours**
	Total	**42 Hours**

Text Books:

T1. F. F. Bolander Jr., ***Molecular Endocrinology***, 3rd Edition, Academic Press, 2012.
T2. O-K. Park-Sarge, T. E. Curry, ***Molecular Endocrinology: Methods and Protocols***, Humana Press, 2012.

Reference Books:

R1. I. Y. Pandya and V. K. Verma, ***Molecular and Applied Endocrinology***, 1st Edition, Manglam Publications, 2020.
R2. J. Waxman, ***Molecular Endocrinology of Cancer, Vol. 1 & 2***, 1st Edition, Cambridge University Press, 2011.

P.T.O

Online Resources:

1. https://nptel.ac.in/courses/121105009: by Prof. R. Guha, IIT Kharagpur
2. https://www.endocrine.org/topics

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Explain the various hormonal axes in human system.
CO2	Articulate the regulatory role of hormonal system in diabetes.
CO3	Correlate the association of endocrine dysfunction with various lifestyle disorders.
CO4	Explain the role of hormones in sleep and stress regulation.
CO5	Discuss various hormonal controls in stress, tumor, and infertility.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO2	Develop various methods of molecular biology techniques to detect the changes in the DNA and associate them with various disease conditions.
PO3	Design novel and innovative DNA based platforms for clinical application and early detection of diseases like Cancer, Infertility, and Life style Disorders.
PO4	Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.
PO5	Integrate the tools of Biochemistry, Molecular Biology, Immunology and Genetics to develop panels and sytems to explain the diseases at the molecular level and determine possible treatments or management.
PO9	Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	1	1	2	1				1	1	2	1	1
CO2	3	1	2	2	2				3	2	2	2	2
CO3	3	1	2	2	2				3	3	2	2	2
CO4	3	2	2	2	2				3	3	3	2	2
CO5	3	2	2	2	2				3	3	3	3	3

Category	Code	Molecular Oncology	L-T-P	Credits	Marks
PCR	MM5010		3-1-0	4	100

Objectives	The objective of this course is to study the molecular concept and processes of cancer formation at the cellular and molecular level.
Pre-Requisites	Basic concepts of cell, DNA, and biochemistry are required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on case studies and practical examples.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Cell Cycle and Cancer**: Basic concepts, Cell cycle and cancer - Cell cycle checkpoints, G1/S checkpoint, G2/M checkpoint, Cyclins and Cyclin dependent kinases; CDK Inhibitors - p16, p21 and p27; Gate keeper and Tumor suppressor genes, Rb, p53.	**11 Hours**
Module-2	**Oncogenes and Proto-Oncogenes**: Multi-step tumorigenesis, Transformation, Driver mutations, Subsequent pathogenic and non-pathogenic genetic changes in cancer cells, Genome instability, Gene amplification, Receptor signaling pathways.	**13 Hours**
Module-3	**Cell Signalling in Cancer**: Cell signaling pathways, Tumor heterogeneity, G protein/signal transduction, Tyrosine and Serine/Threonine kinases and transcription factors; DNA methylation, Telomerase and immortality.	**12 Hours**
Module-4	**Genome Integrity and Cancer**: Apoptosis and autophagy, Tumor immunology, Tumor Infiltrating Cells (TICS), DNA damage and repair in cancer, Tumor mutation burden, Tumor metabolism, Metastasis and systemic disease.	**12 Hours**
Module-5	**Precision Oncology**: Targeting various cancer specific biomarkers, Emerging trends in immuno-oncology and advanced therapeutics, Hereditary and non-hereditary cancers, Lifestyle and cancers in 21st century health care domain.	**8 Hours**
	Total	**56 Hours**

Text Books:

T1. R. A. Weinberg, ***The Biology of Cancer***, 2nd Edition, Garland Publishing, 2013.
T2. L. Picorino, ***Molecular Biology of Cancer Mechanisms: Targets and Therapeutics***, 5th Edition, Oxford University Press, 2021.

Reference Books:

R1. S. Pelengaris and M. Khan, ***The Molecular Biology of Cancer: A Bridge from Bench to Bedside***, 2nd Edition, Wiley Blackwell, 2013.
R2. M. H. Bronchud (Ed.), ***Principles of Molecular Oncology***, 2nd Edition, Springer, 2003.

Online Resources:

1. https://nptel.ac.in/courses/102108086: By Prof. S. Laloraya, IISc Bangalore
2. https://learninglink.oup.com/access/pecorino5e-student-resources#tag_all-chapters
3. https://oncologypro.esmo.org/education-library

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Correlate the alterations in cell cycle regulation related to cancer.
CO2	Categorize various oncogenes and their roles in cancer progression.
CO3	Describe the signaling pathways that have significant impact on cancer.
CO4	Explain the integrity of genome and cellular metabolism of cancer cell.
CO5	Design various tools and techniques that are used to treat cancer.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO2	Develop various methods of molecular biology techniques to detect the changes in the DNA and associate them with various disease conditions.
PO3	Design novel and innovative DNA based platforms for clinical application and early detection of diseases like Cancer, Infertility, and Life style Disorders.
PO4	Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.
PO5	Integrate the tools of Biochemistry, Molecular Biology, Immunology and Genetics to develop panels and sytems to explain the diseases at the molecular level and determine possible treatments or management.
PO9	Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	1	1	2				2	2	2	2	1
CO2	3	2	1	2	2				3	3	2	2	2
CO3	3	2	2	3	2				3	3	3	2	2
CO4	3	2	2	3	2				3	3	3	2	3
CO5	3	2	2	3	3				3	3	3	3	3

Category	Code	Embryology & IVF	L-T-P	Credits	Marks
PEL	MM5015		3-0-0	3	100

Objectives	The objective of this course is to study sperm & ova production, changes in fertilization, embryo & fetal developmental period, assisted *in-vitro* fertilization techniques, testing for pre-implantation samples, and laws & guidelines.
Pre-Requisites	Knowledge and concepts of developmental biology are required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on case studies and practical examples.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Causes of Male and Female Infertility**: Gametogenesis, Spermatogenesis - Formation of spermatids, Multiplication, Growth, and Maturation phases; Spermiogenesis - Formation of head of spermatozoa, Changes in nucleus, Acrosome formation, Tail formation; Other events - Structure of sperm cell and abnormalities, Oogenesis - Multiplication phase, Growth phase; Previtellogenesis - Growth of nuclear substance, Vitellogenesis, Cortical differentiation; Maturation of egg - Menstrual cycle, Structure of Ovum.	**9 Hours**
Module-2	**Fertilization and Early Embryonic Differentiation**: Acrosome reaction, Fertilization, Post fertilization changes – Zygote, Morula, Blastula, Cleavage and Gastrulation, Formation of three germ layers (Ectoderm, Endoderm, Mesoderm and their derivatives), Genetic basis of differentiation and regulation by cascades of gene expression.	**7 Hours**
Module-3	**Human Embryology**: Implantation and placentation (Placental types), Human embryo development - first, second, and third trimester; Teratogenesis, Birth defects, Epigenetics.	**7 Hours**
Module-4	**Assisted Reproductive Techniques**: History, Prevalence and overview of Assisted Reproductive Technology (ART); Semen analysis, Types of sperm abnormalities, Management and sperm retrieval techniques; Ovulation induction - Oocyte retrieval, In-vitro maturation, In-vitro fertilization - ICSI, GIFT, ZIFT etc., Vitrification, Embryo biopsy, Embryo hatching.	**9 Hours**
Module-5	**Genetics in Infertility, Regulatory Laws & Guidelines**: Molecular and genetic assessment, Pre-implantation Genetic Testing for – Aneuploidy (PGTA), Monogenic disorders (PGT-M), Structural Rearrangements (PGT-SR); Proteomics and metabolomics, Genetic analysis - Karyotyping, PCR, FISH, NGS, CGH; Gamete banking - Preserving male & female gametes as per regulatory guidelines, Cryopreservation of gametes & embryos, Ethics, Regulatory laws & Guidelines - Ethical practices, National & International guidelines for ART, Laws regulating gamete donors & surrogacy.	**10 Hours**
	Total	**42 Hours**

P.T.O

Text Books:

T1. V. Singh, ***Textbook of Clinical Embryology***, 2nd Edition, Elsevier, 2017.
T2. A. Weissman, C. M. Howeles, D. K. Gardner, and Z. Shoham, ***Textbook of Assisted Reproductive Technologies: Laboratory and Clinical Perspectives***, 3rd Edition, Informa Healthcare, 2009.
T3. R. D. Pai, N. Palshetkar, H. Pai, and K. R. Shah, ***Textbook of IUI and ART***, 1st Edition, Jaypee Brothers Medical Publishers, 2016.

Reference Books:

R1. T. W. Sadler, ***Langman's Medical Embryology***, South Asian Edition, Wolters Kluwer, 2019.
R2. K. L. Moore, T. V. N. Persud, and M. G. Torchia, ***Before We Are Born – Essential of Embryology & Birth Defects***, 10th Edition, Elsevier, 2020.
R3. K. Elder and B. Dale, ***In-Vitro Fertilization***, 4th Edition, Cambridge University Press, 2020.
R4. J. Harper, ***Preimplantation Genetic Diagnosis***, 2nd Edition, Cambridge University Press, 2009.

Online Resources:

1. https://www.mayoclinic.org/tests-procedures/in-vitro-fertilization/about/pac-20384716
2. https://www.sart.org/patients/a-patients-guide-to-assisted-reproductive-technology/general-information/assisted-reproductive-technologies/
3. https://www.sart.org/patients/a-patients-guide-to-assisted-reproductive-technology/resources/glossary/

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Describe human reproductive system and various aspects of gametogenesis and oogenesis.
CO2	Identify genes that are regulating human embryonic differentiation.
CO3	Explain the development of human in each trimester of gestational period.
CO4	Discuss the technologies of assisted reproduction and their application in medicine.
CO5	Follow ethics, laws, and guidelines in assisted reproductive technologies.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO2	Develop various methods of molecular biology techniques to detect the changes in the DNA and associate them with various disease conditions.
PO3	Design novel and innovative DNA based platforms for clinical application and early detection of diseases like Cancer, Infertility, and Life style Disorders.
PO4	Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.
PO5	Integrate the tools of Biochemistry, Molecular Biology, Immunology and Genetics to develop panels and sytems to explain the diseases at the molecular level and determine possible treatments or management.
PO7	Work with professional context with intellectual integrity, ethics and social responsibility.
PO9	Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

P.T.O

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	2	2	2				2	2	2	2	2
CO2	3	3	2	2	2				2	3	2	2	2
CO3	3	3	2	3	3		2		3	3	3	3	3
CO4	3	3	2	3	3		2		3	3	3	3	3
CO5	3	3	3	3	3		3		3	3	3	3	3

Category	Code	Computational Bioinformatics	L-T-P	Credits	Marks
PEL	MM5016		3-0-0	3	100

Objectives	The objective of this course is to study the concepts, theories, and applications of computational bioinformatics including various biological databases used in bioinformatics, virtual PCR & primer designing, pharmacogenomics and computer assisted drug designing.
Pre-Requisites	Basic knowledge of computational biology is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving and practical examples.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Introduction**: Generation & types of computers, Hardware & software, Input & output, Evolution of computers, Major developments in Bioinformatics and Computational Biology, Nature and scope, Sequence Alignment - Local and global, Pair-wise and multiple, BLAST, Databases - Types & organization, Nucleotide sequence databases, Protein sequence databases, Mapping databases, Genomic databases, Data mining.	**8 Hours**
Module-2	**Chromosome-Genome-Genes Databases**: Bio-molecules - DNA, RNA, Protein and amino acids, Chargaff's rules, Codon bias, GC content, DNA and Protein sequencing, Human Genome Project, Bioinformatics databases - Nucleotide sequence databases, Primary nucleotide sequence databases - EMBL, Gene Bank, DDBJ; Secondary nucleotide sequence databases – Protein sequence databases, UniProt, Mapping databases, Genomic databases - Introduction and application, Tools - UCSC *In-Silico* PCR, *In-Silico* PCR amplification, Tools - Primer 3, Primer Blast, Genscript.	**10 Hours**
Module-3	**Proteins and Databases**: Protein structure and function, Protein primary structure, Amino acid residues, Secondary, Tertiary, Quaternary structure of protein, Protein sequence databases - SwissProt/ TrEMBL, PIR, Sequence motif databases - Pfam, PROSITE, Protein structure databases, Protein Data Bank - SCOP, CATH, KEGG, Chembank, Sequence, Structure and function relationship.	**7 Hours**
Module-4	**Pharmacogenomics**: Importance of Drug Design, Molecular modeling, Visualization tools, Structure-based drug design, Docking, Ligand based drug design, Qualitative Structure Activity Relationship (QSAR), SNP, Mutation, Drug target selection, Target screening & validation, Assessment of therapeutic utility, Mutant analysis, Genomics in antimicrobial drug discovery & toxicology, Universal mutation database, dbSNP, PharGKB.	**9 Hours**
Module-5	**DNA Sequencing Tools**: Annotations, Target validation, Interpretation and clinical correlation.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. D. Higgins and W. Taylor, ***Bioinformatics: Sequence, Structure, and Databanks: A Practical Approach***, Oxford University Press, 2000.

T2. J. Xiong, ***Essential Bioinformatics***, Cambridge University Press, 2006.

Reference Books:

R1. S. C. Rastogi, N. Mendiratta, and P. Rastogi, ***Bioinformatics: Concepts, Skills and Applications***, 2nd Edition, CBS Publishers, 2006.

Online Resources:

1. https://nptel.ac.in/courses/102106065: by Prof. M. M. Gromiha, IIT Madras
2. https://ocw.mit.edu/courses/6-047-computational-biology-fall-2015/pages/lectures_slides/

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Describe the fundamentals of computers and development of bioinformatics.
CO2	Explain the Chromosome-Genome-Genes databases, virtual PCR, and primer designing.
CO3	Utilize various online database related to protein sequence and structure prediction.
CO4	Apply different approaches of drug designing, target screening, and validation.
CO5	Correlate DNA sequence data with clinical significance.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO2	Develop various methods of molecular biology techniques to detect the changes in the DNA and associate them with various disease conditions.
PO3	Design novel and innovative DNA based platforms for clinical application and early detection of diseases like Cancer, Infertility, and Life style Disorders.
PO4	Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.
PO5	Integrate the tools of Biochemistry, Molecular Biology, Immunology and Genetics to develop panels and sytems to explain the diseases at the molecular level and determine possible treatments or management.
PO9	Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	2	2	2				2	2	2	2	2
CO2	2	2	2	2	2				2	2	3	2	2
CO3	2	2	2	2	2				3	3	3	2	2
CO4	2	2	2	3	3				3	3	3	3	3
CO5	2	2	2	3	3				3	3	3	3	3

Category	Code	Bioethics & IPR	L-T-P	Credits	Marks
PEL	MM5017		3-0-0	3	100

Objectives	The objective of this course is to study the bioethical aspects in clinical research, various types of Intellectual Property Rights (IPR) and their importance in medical research & publication.
Pre-Requisites	Basics of biology and principles of Research & Innovation at UG level is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on case studies and practical examples.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Introduction**: Definition of property, Types of property, Historical development of property rights, Discovery enabled science & innovation, Basic concepts of Intellectual Property Rights, Laws, Forms of IPR - Patent, Copyright, Trademark, Industrial design, Geographical Indication, Trade Secret, General Agreement on Tariffs & Trade (GATT), Trade-Related Aspects of IPR (TRIPS), Importance of IPR in Science & Technology.	**8 Hours**
Module-2	**IPR Laws**: Rights of patent, Patent infringement & remedies, Indian Patent Act 1970 and TRIPS, Changes in Indian patent system as post-TRIPS effect, Draft of National Intellectual Property Policy, 2003 and 2005 Amendments, Content of patent, Specification & procedure for patent, Obtaining patent, Geographical Indication, WTO, Patenting biological products, Cartagena Protocol; Business of IPR & its influence on economy, Brand building and value creation through IPR; Convention on biodiversity, Budapest treaty; Case Studies on Patents - Basmati, Neem, Haldi; Emerging issues in IPR, Recent case studies on cancer drugs - Novartis and Cadilla cases in India.	**9 Hours**
Module-3	**Bio-Ethics**: Historical need of ethics, World war atrocities on war prisoners, Holocaust and Nazi regime, Concept of ethics committee and research protocol, Importance of consent form and different types of clinical trials, Helsinki guidelines, Nuremberg code abortion, Partial-birth abortion, Wrongful birth, Wrongful conception, Wrongful life, Assisted reproduction and surrogate mother concept, Cloning & stem-cell research, Issues in human genetics, Regulation of human-subject research, Human organ transplantation, Ethical issues in GMOs.	**9 Hours**
Module-4	**Euthanasia**: Concept and practice in various societies, Fetal-maternal decision making, The "right to die" – Patients with decisional capacity, Children & newborns, Physician-assisted suicide and active euthanasia, Ethical issues related to clinical trial, Gene therapy and stem cell guidelines in India.	**8 Hours**

Cont'd. . .

Module-#	Topics	Hours
Module-5	**Bio-Safety**: History, Principles, Risks, Regulatory agencies, Health and safety practices, Applying bio-safety principles, Emergency procedures, Bio-safety levels, Biological Containment Practices - Primary containment, Secondary containment, Biological containment; Guidelines for research involving Recombinant DNA molecules, Difference between biological and chemical safety measures, Long-term effects of health hazards, Biosafety Level I, II and III; Experiments involving whole animals and plants, Case studies of common accidents involved in research, Animal handling and safety measures, GMP issues and common mistakes in laboratory practice.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. R. S. Rao, ***Lectures on Intellectual Property Rights***, LexWorth-Gogia Law Agency, 2020.
T2. J. F. Kilner, D. B. Uustal, and C. C. Hook, ***Cutting-Edge Bioethics: A Christian Exploration of Technologies and Trends***, 2nd Edition, Scott & Paul Cox, 2002.
T3. V. S. Krishna, ***Bioethics and Biosafety in Biotechnology***, 1st Edition, New Age International, 2007.

Reference Books:

R1. D. Goel and S. Parashar, ***IPR, Biosafety and Bioethics***, 1st Edition, Pearson Education, 2013.
R2. Sibi G., ***Intellectual Property Rights, Bioethics, Biosafety and Entrepreneurship in Biotechnology***, 1st Edition, Wiley India, 2021.

Online Resources:

1. https://nptel.ac.in/courses/129105005: by Prof. N. S. Bhattacharya, IIT Kharagpur
2. https://depts.washington.edu/bhdept/ethics-medicine
3. https://www.genome.gov/10001744/online-bioethics-resources

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Describe the concepts of IP and value with distinction of physical property.
CO2	Discuss the business aspects of various forms of IPR and international standings.
CO3	Explain the importance of human ethics and various aspects of legal rights.
CO4	Realize the concepts of Euthanasia or assisted death and its principles.
CO5	Analyze different levels of biosafety and containment of dangerous materials in research.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO7	Work with professional context with intellectual integrity, ethics and social responsibility.
PO9	Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

P.T.O

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1						3		2	1	2	1	1
CO2	1						3		2	1	2	1	1
CO3	1						3		3	1	2	1	1
CO4	1						3		3	1	2	1	1
CO5	1						3		3	1	2	1	1

Category	Code	Advanced Cytogenetics	L-T-P	Credits	Marks
PEL	MM5018		3-0-0	3	100

Objectives	The objective of this course is to study various human genetic disorders related to numerical and structural abnormalities in chromosome, and various advanced cytogenetic techniques and their applications.
Pre-Requisites	Knowledge of cell biology and basic cytogenetics is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on case studies and practical examples.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Human Cytogenetics**: Origins and developments of human cytogenetics, Cell culture, Cell cycle and DNA condensation, Applications of microscopy, Optical resolution.	**6 Hours**
Module-2	**Human Chromosomes**: Structure and features of human chromosome - Chromatin structure, Nucleosome model, Constitutive & facultative heterochromatin, Centromeres, Telomere & its maintenance, Nuclear organization region (NOR); Classification of Non-banded & banded chromosomes - Identification & definition of chromosome landmark, region, and bands, Principle & application of R-banding, G-banding, High resolution banding, C-banding, NOR banding, Q–banding; Chromosome Nomenclature - International System for Human Cytogenomic Nomenclature (ISCN), Karyotype designation, Uncertainty in chromosome or band designation, Order of chromosomal abnormalities in karyotype, Normal variable chromosome feature, Numerical and structural chromosome abnormalities.	**10 Hours**
Module-3	**Advanced Molecular Cytogenetic Techniques**: Fluorescence *In-Situ* Hybridization (FISH), Probe classification, Probe designing, Labeling techniques - Haptens and Fluorochromes; Chromosome Painting - Interphase FISH, Extended Chromatin Fiber FISH (Fiber FISH), Multiplex FISH (mFISH), mBand, Combined Binary Ratio Labeling (COBRA) FISH, Spectral Color Banding (SCAN), Karyotyping (SKY), Comparative Genomic Hybridization (CGH), Cross Species (RX) FISH, Spectral & Reverse chromosome painting.	**9 Hours**
Module-4	**Specialized Cytogenetic Techniques**: Principle and application, Premature chromosome condensation, Sister Chromatid Exchanges (SCE), Fragile X, Micronucleus assay, Telomere FISH, Optical genome mapping.	**7 Hours**
Module-5	**Profiling of Common Chromosomal Disorders**: Case Studies; Numerical Chromosomal Disorders - Down Syndrome, Patau Syndrome, Edward Syndrome; Sex Chromosome Aneuploidies - Turner Syndrome, Klinefelter Syndrome, Jacobs Syndrome, Triple X Syndrome; Structural Chromosomal Disorders - Cri-du-Chat Syndrome, Pallister-Killian Syndrome; Mosaicism - Mosaic Down Syndrome, Mosaic Turner Syndrome; Hematological Disorders - Myelodysplastic Syndrome, Multiple Myeloma, Acute Leukemia.	**10 Hours**
	Total	**42 Hours**

Text Books:

T1. L. B. Jorde, J. C. Carey, M. J. Bamshad, and R. L. White, ***Medical Genetics***, 3rd Edition, Mosby, 2006.
T2. R. L. Nussbaum, R. R. McInnes, H. F. Willard, A. Hamosh, and M. W. Thompson, ***Genetics in Medicine***, 8th Edition, Saunders/Elsevier, 2016.

Reference Books:

R1. M. S. Arsham, M. J. Barch, H. J. Lawce, ***The AGT Cytogenetics Laboratory Manual***, 4th Edition, Wiley-Blackwell, 2017.

Online Resources:

1. https://www.future-science.com/doi/10.2144/000112811
2. https://onlinecourses.swayam2.ac.in/cec20_bt17/preview: by Prof. N. B. Ramachandra, University of Mysore

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Describe the clinical implications of human cytogenetics.
CO2	Identify unique features of chromosomes in accordance to ISCN guidelines.
CO3	Apply various advanced molecular cytogenetic techniques for clinical purposes.
CO4	Design specialized cytogenetic techniques to identify genetic defects.
CO5	Identify the clinical features and indications of various chromosomal disorder.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO2	Develop various methods of molecular biology techniques to detect the changes in the DNA and associate them with various disease conditions.
PO3	Design novel and innovative DNA based platforms for clinical application and early detection of diseases like Cancer, Infertility, and Life style Disorders.
PO4	Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.
PO5	Integrate the tools of Biochemistry, Molecular Biology, Immunology and Genetics to develop panels and sytems to explain the diseases at the molecular level and determine possible treatments or management.
PO6	Function effectively as an individual or as a member of a multidisciplinary team with professional and managerial skills.
PO9	Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	2	3	2	2			2	3	2	2	2
CO2	3	2	2	3	2	3			3	3	3	3	3
CO3	3	2	2	3	2	3			3	3	3	3	3
CO4	3	2	2	3	2	3			3	3	3	3	3
CO5	3	2	2	3	2	3			3	3	3	3	3

Category	Code	Preventive Health Management	L-T-P	Credits	Marks
PEL	MM5019		3-0-0	3	100

Objectives	The objective of this course is to study the lifestyle factors that influence human health, implement preventive methods, early detection, control and management of life-style diseases concerning public health.
Pre-Requisites	Knowledge of human health, physiology, disease and epidemiology is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on case studies and practical examples.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Human Health and Risks**: Factors influencing human heath, Occurrence and prevalence of major lifestyle disorders, Life style risk factors - Genetic, Environmental, Socio-demographic, Self-management, Medical conditions.	**9 Hours**
Module-2	**Preventive Methods and Awareness**: Right decisions, Dietary habits, Maintaining weight, Smoking habit and prescription drug use, Workout and physical activities, Resting habit, Regular check-ups; Role of preventive medicine in development of social medicine, Community health, Community medicine.	**8 Hours**
Module-3	**Early Detection Methods for Diseases**: Detection methods - Routine blood test, Molecular genetic study, Familial history and screening, Wellness screening programs; Future scope in detection techniques of lifestyle diseases - Real-time monitoring of cardiovascular activity, Blood pressure, Oxygen saturation level, Sleeping pattern.	**10 Hours**
Module-4	**Management of Major Lifestyle Disorders**: Lifestyle management, Stress management, Diet management, Sleep health management, Cardiac health management, Avoidance of risky substance, Counseling.	**7 Hours**
Module-5	**Guidelines for Disease Prevention and Control**: Implementation and preventive methods, National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases & Stroke (NPCDCS) - Operational guidelines, A guide to implementation research in the prevention and control of non-communicable diseases - WHO, National Center for Chronic Disease Prevention and Health Promotion (NCCDPHP).	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. K. Park, ***Park's Textbook of Preventive & Social Medicine***, 26th Edition, Banarsidas Bhanot Publishers, 2021.

Reference Books:

R1. B. Gossard, ***Disease Prevention & Treatment***, 5th Edition, Life Extension Media, 2013.

Online Resources:

1. https://www.sdcollegeambala.ac.in/wp-content/uploads/2022/01/compjune21-32.pdf
2. https://www.godigit.com/health-insurance/lifestyle/what-are-lifestyle-diseases
3. https://main.mohfw.gov.in/sites/default/files/Operational%20Guidelines%20of%20NPCDCS%20%28Revised%20-%202013-17%29_1.pdf
4. https://www.cdc.gov/chronicdisease/about/prevent/index.htm
5. https://apps.who.int/iris/bitstream/handle/10665/252626/9789241511803-eng.pdf
6. https://www.frontiersin.org/articles/10.3389/fpubh.2020.574111/full

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Identify different lifestyle risk factors that lead to human disease.
CO2	Explain various preventive methods for public health and create awareness.
CO3	Apply various detection and screening techniques for major lifestyle disorders.
CO4	Discuss major lifestyle disorders with proper guidance to the patients.
CO5	Describe various guidelines for prevention and management of public health.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO2	Develop various methods of molecular biology techniques to detect the changes in the DNA and associate them with various disease conditions.
PO3	Design novel and innovative DNA based platforms for clinical application and early detection of diseases like Cancer, Infertility, and Life style Disorders.
PO4	Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.
PO5	Integrate the tools of Biochemistry, Molecular Biology, Immunology and Genetics to develop panels and sytems to explain the diseases at the molecular level and determine possible treatments or management.
PO6	Function effectively as an individual or as a member of a multidisciplinary team with professional and managerial skills.
PO7	Work with professional context with intellectual integrity, ethics and social responsibility.
PO9	Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	2	2		2	2	2	2	1
CO2	3	2	1	2	2	2	2		3	2	2	2	1
CO3	3	2	2	2	2	2	2		3	2	2	2	1
CO4	3	2	1	2	2	3	2		3	3	2	2	1
CO5	3	2	1	2	2	3	3		3	3	2	2	1

Category	Code	Epidemiology & Biostatistics	L-T-P	Credits	Marks
PEL	MM5020		3-0-0	3	100

Objectives	The objective of this course is to study the factors that influence the genotype frequency, estimate the prevalence & risks of traits in a population, genetic variation and speciation, and population health & disease susceptibility.
Pre-Requisites	Basic concepts of biology and mathematics is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on case studies and practical examples.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Population Dynamics & 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, Selection coefficient and fitness, Dynamics of migration and genetic drifts.	**7 Hours**
Module-2	**Epidemiological Studies**: Experimental and observational, Cohort studies, Association Studies - Candidate gene association and genome-wide association studies (GWAS), Systematic review and meta-analysis, General approaches to access the genetic basis of disease, Heritability; Basic Parameters of Epidemiology - Frequency, Occurrence, Prevalence, Incidence, Association, Variation.	**10 Hours**
Module-3	**Biostatistics**: Introduction, Probability - Concepts, Scale, Measurement, Laws, Conditional probability, Bayes' Theorem; Distributions – Random variable, Expected value, Variance, Discrete distribution, Continuous distribution; Statistical Methods - Estimation & hypothesis testing, Properties of good estimation, Point & Interval estimation, Mean proportion, Variance, Rates, Chi-square test, T-test, ANOVA; Correlation - Pearson's correlation, Partial correlation, Multiple correlation, Spearman rank correlation, Regression - Linear regression, Multiple linear regression, Logistic regression.	**10 Hours**
Module-4	**Genetic Variation & Complex Trait Inheritance**: Basics of genetic variations; Genetic Markers – SNP, CNV, Ins/dels (INDELs), VNTR, STR, Microsatellite; Concepts of tag markers and haplotypes, Linkage disequilibrium, Quantitative genetic analysis, QTL and eQTL.	**8 Hours**
Module-5	**Case Studies**: SNP Analysis, Single variant, Multiple variant analysis, Systemic analysis.	**7 Hours**
	Total	**42 Hours**

Text Books:

T1. M. B. Hamilton, ***Population Genetics***, 2nd Edition, Wiley-Blackwell, 2021.
T2. T. Glover and K. Mitchell, ***An Introduction to Biostatistics***, Waveland Press, 2015.

Reference Books:

R1. D. L. Hartel and A. G. Clarke, ***Principles of Population Genetics***, 4th Edition, Sinave Associates, 2007.
R2. M. J. Khoury, T. H. Becaty, and B. H. Cochen, ***Fundamentals of Genetic Epidemiology***, Oxford University Press, 1993.
R3. W. W. Daniel and C. L. Cross, ***Biostatistics: A Foundation for Analysis in the Health Sciences***, 11th Edition, Wiley Press, 2018.
R4. J. M. Bland, ***An Introduction to Medical Statistics***, 4th Edition, Oxford University Press, 2015.

Online Resources:

1. https://nptel.ac.in/courses/102106051: by Prof. M. Doble, IIT Madras
2. https://www.britannica.com/science/epidemiology
3. https://www.cdc.gov/genomics/resources/books/genepi2.htm
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4041482/

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Describe the concepts of population genetics with respect to genomic diversity.
CO2	Conduct epidemiological studies to identify the cause-effect relationship in human traits/diseases.
CO3	Apply statistical tools in biostatistics various domains of life sciences & human health.
CO4	Explain the fundamentals of genetic variations, linkage analysis and quantitative genetics.
CO5	Discuss different types of single gene disorders and their association in population.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO4	Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.
PO5	Integrate the tools of Biochemistry, Molecular Biology, Immunology and Genetics to develop panels and sytems to explain the diseases at the molecular level and determine possible treatments or management.
PO6	Function effectively as an individual or as a member of a multidisciplinary team with professional and managerial skills.
PO9	Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3			2	1	2			2	2	1	1	1
CO2	3			2	1	2			2	2	1	1	1
CO3	2			2	1	3			3	2	2	1	1
CO4	3			2	1	3			3	2	2	2	2
CO5	3			2	1	3			3	2	2	2	2

Category	Code	Clinical Pathology Lab	L-T-P	Credits	Marks
PCR	MM5011		0-0-4	2	100

Objectives	The objective of this laboratory course is to provide hands-on exposure on basics of tissue physiology, cellular morphology and different aspects of pathological techniques, and understanding diagnosable differences between tumor cells and normal cells by different staining techniques.
Pre-Requisites	Basics of cell biology and biochemistry is required.
Teaching Scheme	Regular laboratory experiments conducted under supervision of the teacher.

Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test / Project	Viva-voce	Total
10	30	15	30	15	100

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Human tissue identification, grossing and processing of the tissue.
2	Embedding & preparation of blocks.
3	Section cutting, use & care of microtome.
4	Stain and reagent preparation.
5	Coated slide preparation.
6	Hematoxylin & Eosin staining, Giemsa staining, Leishman staining, Pap staining.
7	Immunohistochemistry (IHC).
8	AFB staining (TB) in smear/ tissue section.
9	Small, medium, and large biopsy processing.
10	Identification of tumor, stage and grading.
11	Cut margin profiling.
12	Microscopy.
13	Tissue banking.
14	Multiple markers screening and tissue array of unknown primary tumor.

Text Books:

T1. H. Sharma, ***Practical Manual of Histology***, 1st Edition, CBS Publishers, 2020.
T2. F. Lin and J. Prichard, ***Handbook of Practical Immunohistochemistry***, 2nd Edition, Springer, 2016.

Reference Books:

R1. H. Mohan, ***Pathology Practical Book***, 2nd Edition, Jaypee Brothers Medical Publishers, 2010.
R2. P. Kumar NS, ***Manual of Practical Pathology***, 2nd Edition, CBS Publishers, 2022.
R3. S. Renshaw, ***Immunohistochemistry: Methods Express Series***, Scion Publishing, 2007.

Online Resources:

1. https://apps.pathology.jhu.edu/team-path-md/external-path-education-resources/free-online-education-tools/
2. https://histology.medicine.umich.edu/full-slide-list

P.T.O

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Identify different types of human tissue.
CO2	Prepare tissue block and slides using advance automatic histopathology instruments.
CO3	Examine different disease tissue after application of appropriate staining procedure.
CO4	Perform immunohistochemistry experiments and image analysis.
CO5	Identify human pathogens present in different types of human samples.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO2	Develop various methods of molecular biology techniques to detect the changes in the DNA and associate them with various disease conditions.
PO3	Design novel and innovative DNA based platforms for clinical application and early detection of diseases like Cancer, Infertility, and Life style Disorders.
PO4	Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.
PO5	Integrate the tools of Biochemistry, Molecular Biology, Immunology and Genetics to develop panels and sytems to explain the diseases at the molecular level and determine possible treatments or management.
PO6	Function effectively as an individual or as a member of a multidisciplinary team with professional and managerial skills.
PO9	Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	2			2	3	3	3	3
CO2	3	3	3	3	3	2			2	3	3	3	3
CO3	3	3	3	3	3	2			3	3	3	3	3
CO4	3	3	3	3	3	2			3	3	3	3	3
CO5	3	3	3	3	3	2			3	3	3	3	3

Category	Code	Molecular Biology-II Lab	L-T-P	Credits	Marks
PCR	MM5012		0-0-4	2	100

Objectives	The objective of this laboratory course is to provide practical exposure on reagent preparation & related calculation, learn the methods of nucleic acid isolation using different laboratory techniques, and different analytical instruments necessary for molecular biology experiments.
Pre-Requisites	Basic concepts on cell culture and molecular biology is required.
Teaching Scheme	Regular laboratory experiments conducted under supervision of the teacher.

Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test / Project	Viva-voce	Total
10	30	15	30	15	100

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Reagent preparation, pH adjustment, Calculations for different solution preparation (Normality, Molarity, percentage & dilution).
2	Genomic DNA isolation from Human Peripheral blood using PCI method.
3	DNA isolation from tissue by silica membrane-based spin columns.
4	Total RNA isolation from Human Peripheral Blood using TRIzol method.
5	RNA isolation from Blood using spin columns.
6	Quantification & purity assessment of Nucleic acids using UV spectrophotometer or Nanodrop.
7	Agarose gel electrophoresis of nucleic acid and visualization under UV Transilluminatoror Gel Doc system, and result interpretation.
8	Estimation of protein by Bradford method.
9	Separation of protein using SDS-PAGE and Estimation of molecular weight.
10	Detection and characterization of proteins using western blotting.
11	Cell free DNA isolation from plasma sample using spin columns & quantification using fluorometer.
12	Reverse Transcription using Reverse Transcriptase and cDNA synthesis and Estimation.
13	Detection of SNP in some of the disease phenotype and conformation in gel.
14	Isolation of mitochondrial DNA and quantification.

Text Books:

T1. J. Sambrook and M. R. Green, ***Molecular Cloning: A Laboratory Manual, Vol. I, II & III***, 4th Edition, Viva Books, 2013..
T2. R. Beynon and J. Easterby, ***Buffer Solutions: The Basics***, 1st Edition, Taylor & Francis, 2003.
T3. S. Magdeldin, ***Gel Electrophoresis: Principles and Basics***, InTechOpen, 2012.

Reference Books:

R1. F. Hildebrandt and P. Igarashi, ***Techniques in Molecular Medicine***, Springer, 2014.
R2. D. S. Witherow and H. B. Miller, ***Molecular Biology Techniques: A laboratory Manual***, 3rd Edition, Academic Press, 2011.

Online Resources:

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7073234/
2. https://www.vanderbilt.edu/viibre/CellCultureBasicsEU.pdf

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Prepare different molecular biology reagents and use relevant instruments.
CO2	Preform nucleic acid isolation from various type of biological samples.
CO3	Assess quality of nucleic acids for downstream processes.
CO4	Analyze PCR products of given DNA samples after gel electrophoresis.
CO5	Develop expertise for handling different spectrophotometric & electrophoretic instruments.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO2	Develop various methods of molecular biology techniques to detect the changes in the DNA and associate them with various disease conditions.
PO3	Design novel and innovative DNA based platforms for clinical application and early detection of diseases like Cancer, Infertility, and Life style Disorders.
PO4	Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.
PO5	Integrate the tools of Biochemistry, Molecular Biology, Immunology and Genetics to develop panels and sytems to explain the diseases at the molecular level and determine possible treatments or management.
PO9	Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	1	1	1	1				2	1	1	1	1
CO2	3	3	3	3	3				3	3	2	2	3
CO3	3	2	1	2	2				2	2	2	2	2
CO4	3	3	3	3	3				3	3	3	3	3
CO5	3	3	3	3	3				3	3	3	3	3

Category	Code	Molecular Cytogenetics Lab	L-T-P	Credits	Marks
PCR	MM5013		0-0-2	1	100

Objectives	The objective of this laboratory course is to provide practical exposure on the relevance, fundamental concepts and practical applications of Molecular Cytogenetics.
Pre-Requisites	Basic concepts on molecular biology, genetics and immunology is required.
Teaching Scheme	Regular laboratory experiments conducted under supervision of the teacher.

Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test / Project	Viva-voce	Total
10	30	15	30	15	100

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Good Laboratory Practices and Laboratory Ethics.
2	Reagent Preparation.
3	Microscopy - Light and Compoundmicroscopy.
4	Microscopy - Inverted and Fluorescence microscopy.
5	Cell harvesting from human peripheral blood/bone marrow sample.
6	Interphase FISH-Pre-hybridization process, Hybridizations process, Post-hybridization process, Imaging and analysis.
7	Chromosome preparation for metaphase FISH.
8	Interphase FISH- Hematological malignancy.
9	Metaphase FISH-Pre-hybridization process, Hybridizations process, Post-hybridization process, Imaging and analysis.
10	Estimation of tumor percentage through histopathology analysis.
11	Solid Tumor FISH-Pre-hybridization process, Hybridizations process, Post-hybridization process, Imaging and analysis.
12	Detection of structural and numerical anomalies by FISH.
13	Telomere FISH and genome instability.
14	Microarray (demonstration)- Genomic DNA estimation, DNA quantification, Restriction digestion, probe labelling and purification, Hybridization & Post-hybridization wash, Array analysis.

Text Books:

T1. M. S. Arsham, M. J. Barch, H. J. Lawce, ***The AGT Cytogenetics Laboratory Manual***, 4th Edition, Wiley-Blackwell, 2017.

Reference Books:

R1. D. L Spector and R. D. Goldman, ***Basic Methods in Microscopy Protocols and Concepts from Cells: A Laboratory Manual***, Cold Spring Harbor Laboratory, 2006.

P.T.O

Online Resources:

1. https://www.mdpi.com/1420-3049/26/13/3874
2. https://www.molecularinstruments.com/hcr-rnafishprotocols
3. https://cap.objects.frb.io/documents/practical-guide-specimen-handling.pdf
4. https://www.ualberta.ca/biological-sciences/media-library/mbsu/microarray/amersham-microarray-handbook.pdf

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Follow lab ethics and GLP properly when conducting experiments.
CO2	Prepare reagents for various experiments.
CO3	Apply advanced cytogenetic tools and techniques in molecular diagnostics.
CO4	Solve various advanced cytogenetic case scenarios.
CO5	Illustrate and outline the fundamentals of digital Karyotyping.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO2	Develop various methods of molecular biology techniques to detect the changes in the DNA and associate them with various disease conditions.
PO3	Design novel and innovative DNA based platforms for clinical application and early detection of diseases like Cancer, Infertility, and Life style Disorders.
PO4	Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.
PO5	Integrate the tools of Biochemistry, Molecular Biology, Immunology and Genetics to develop panels and sytems to explain the diseases at the molecular level and determine possible treatments or management.
PO9	Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	1	1	1	1				1	1	2	1	1
CO2	2	1	2	2	2				3	2	2	2	2
CO3	3	3	2	1	2				2	3	2	2	2
CO4	3	3	2	2	2				3	3	3	2	2
CO5	3	3	2	2	2				3	3	3	3	3

Category	Code	PCR & Multiplexing Lab	L-T-P	Credits	Marks
PCR	MM5014		0-0-2	1	100

Objectives	The objective of this laboratory course is to provide hands-on exposure on design of primers for genes of interest, troubleshooting & optimizing PCR experiments, analysis of RT-PCR data, and various bioinformatics tools.
Pre-Requisites	Basic concepts on molecular biology & PCR is required.
Teaching Scheme	Regular laboratory experiments conducted under supervision of the teacher.

Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test / Project	Viva-voce	Total
10	30	15	30	15	100

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Primer designing using online bioinformatics tools (Primer3, Primer BLAST, Primo Pro, UCSC In-Silico PCR).
2	PCR experiment setup for gene of interest and gel analysis after amplification.
3	Gradient PCR for optimization of Annealing Temperature of primers.
4	PCR experiment setup for SNP detection in Beta-Thalassemia and interpretation.
5	Multiplex PCR setup to detectmutations in Y–Chromosome microdeletion.
6	Synthesis of cDNA from mRNA using Reverse transcriptase enzyme andquantification.
7	Detection of Philadelphia chromosome (BCR-ABL) using Taqman Assay in RT-PCR.
8	Detection of HLA-B27 mutation in given sample using SYBR green technique in RT-PCR
9	Detection of SNP in K-RAS gene by RT-PCR.
10	Data interpretation of RT-PCR experiments and copy number calculation.
11	Pre-natal aneuploidy screening from cell free DNA.
12	Concept of MLPA based screening.

Text Books:

T1. R. Jenkins, S. Maddocks, ***Understanding PCR: A Practical Bench-Top Guide***, 1st Edition, Academic Press, 2016.
T2. K. Kadri, ***Polymerase Chain Reaction (PCR): Principle and Applications***, (Chapter 9 of Synthetic Biology), IntechOpen, 2019.

Reference Books:

R1. B. D. M. Theophilus and R. Rapley, ***PCR Mutation Detection Protocols: v.187 (Methods in Molecular Biology)***, Humana Press, 2002.
R2. S. B. Primrose, ***Molecular Biotechnology***, 2nd Edition, Wiley–Blackwell, 1991.

Online Resources:

1. https://www.gene-quantification.de/real-time-pcr-handbook-life-technologies-update-flr.pdf
2. https://www.intechopen.com/chapters/65252

P.T.O

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Design primers for PCR experiment and optimize Tm of primers.
CO2	Detect mutation using Taq Man Multiplex PCR technique.
CO3	Prepare reagents for Reverse Transcription PCR experiments.
CO4	Analyze RT-PCR data and calculate copy number.
CO5	Detect Mutation using SYBR Green technique.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO2	Develop various methods of molecular biology techniques to detect the changes in the DNA and associate them with various disease conditions.
PO3	Design novel and innovative DNA based platforms for clinical application and early detection of diseases like Cancer, Infertility, and Life style Disorders.
PO4	Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.
PO5	Integrate the tools of Biochemistry, Molecular Biology, Immunology and Genetics to develop panels and sytems to explain the diseases at the molecular level and determine possible treatments or management.
PO9	Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	3	3	3				2	2	3	3	3
CO2	3	3	3	3	3				2	2	3	3	3
CO3	3	3	3	3	3				3	3	3	3	3
CO4	3	3	3	3	3				3	3	3	3	3
CO5	3	3	3	3	3				3	3	3	3	3

Category	Code	Research Methodology	L-T-P	Credits	Marks
PCR	MM6001		3-0-0	3	100

Objectives	The objective of this course is study the relevance, concepts, theories and approaches for planning, execution, report submissions and research publications to enable the students to conduct research in the real-world scenarios.
Pre-Requisites	Basic understanding of research and statistics is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on case studies and practical examples.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Introduction**: Meaning and importance of research, General principles of Research, Types of Research, Research process, Critical thinking, Formulating hypothesis and development of research plan, Selection criteria, Graphical representation of data, Level of significance, Interpretation of results and discussion; Sampling in biological studies - Sampling techniques, Steps, Data distribution in sampling.	**7 Hours**
Module-2	**Literature Survey**: Sources of literature – Pubmed, The Genome Database, Online Mendelian Inheritance of Man (OMIM), MedGen, ClinVar, Protein Database, SNP Database and Online Journals; Types of literature - Original articles, Reviews, Case report letter to the editor, Short notes, Case reports, Magazines, Periodicals, Books and Proceedings.	**8 Hours**
Module-3	**Statistical Methods**: Chi-Square test - Hypothesis testing, Contingency, Student's t-test - paired and unpaired, One-tailed and two-tailed, One-way and two-way analysis of variance (ANOVA); Correlation and regression.	**10 Hours**
Module-4	**Publication**: Preparation of research reports, Project reports, Scientific report writing, Structure and ethics of scientific presentations, Documentation of references, Reference Manager - End Note, Mendeley; Citation Index, Journal Citation Index, Impact factor, H-index; Citation Tools - SCOPUS, Web of Science (WOS), Google Scholar, Pubmed, and Indian Citation Index (ICI); Plagiarism Tools – Turnitin, iThenticate, Academic Plagiarism Checker, Duplichecker, Plagiarisma.net and Plagscan.	**9 Hours**
Module-5	**Research Funding**: World Health organization (WHO), National Institute of Health (NIH), Department of Science & Technology (DST), Department of Biotechnology (DBT), Indian Council for Medical Research (ICMR), Department of Atomic Energy (DAE); Structure of Research Proposals - Origin, Objectivities, Previous Findings, Methodology, Budget and expected outcome.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. S. Gupta, ***Research Methodology and Statistical Techniques***, Deep & Deep Publications, 2005.
T2. C. R. Kothari and G. Garg, ***Research Methodology: Methods and Techniques***, 4th Edition, New Age International, 2019.

Reference Books:

R1. N. Gurumani, ***Research Methodology: For Biological Sciences***, 1st Edition, MJP Publishers, 2021.
R2. S. K. Sharma, ***Research Methodology & Biostatistics: A Comprehensive Guide for Health Care Professionals***, 1st Edition, Elsevier India, 2017.

Online Resources:

1. https://nptel.ac.in/courses/121106007: by Dr. P. Haridoss et. al., IIT Madras
2. https://nptel.ac.in/courses/127106134: by Dr. M. V. Murhekar, ICMR-NIE
3. https://nptel.ac.in/courses/127106227: by Prof. S. Banerjee, IISER Kolkata

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Describe the terminologies, methods, techniques, tools, and methodologies of research.
CO2	Explore various sources of research papers and conduct comprehensive literature survey.
CO3	Apply different statistical techniques to analyze the research data.
CO4	Publish research papers with proper citations & references without plagiarism.
CO5	Write scientifically sound research proposals for funding of research projects.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO2	Develop various methods of molecular biology techniques to detect the changes in the DNA and associate them with various disease conditions.
PO3	Design novel and innovative DNA based platforms for clinical application and early detection of diseases like Cancer, Infertility, and Life style Disorders.
PO4	Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.
PO5	Integrate the tools of Biochemistry, Molecular Biology, Immunology and Genetics to develop panels and sytems to explain the diseases at the molecular level and determine possible treatments or management.
PO6	Function effectively as an individual or as a member of a multidisciplinary team with professional and managerial skills.
PO7	Work with professional context with intellectual integrity, ethics and social responsibility.
PO8	Communicate effectively and present technical information in oral and written reports supported by diagrams and models for easy visualization.
PO9	Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	2	3	2			3	2	2	2	2	2
CO2	3	2	2	3	2			3	3	3	2	2	2
CO3	3	2	2	3	2			3	2	2	2	2	2
CO4	3	2	2	3	2			3	3	3	3	2	3
CO5	3	2	2	3	2	3	3	3	3	3	3	3	3

Category	Code	Genetic Counselling	L-T-P	Credits	Marks
PCR	MM6002		3-0-0	3	100

Objectives	The objective of this course is to study the concepts and applications of genetic counseling through case-studies and integrate & apply them in practice.
Pre-Requisites	Basic concepts of cell biology and genetics is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on case studies and practical examples.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Principles of Genetic Counseling**: Definition and goals, Philosophy and ethos of genetic services and counseling, Voluntary utilization of services, Equal access, Client education, Complete disclosure of information, Non-directive counseling, Confidentiality and protection of privacy.	**8 Hours**
Module-2	**Components of Genetic Counseling**: Indications and purpose, Information gathering and interviewing techniques - Medical genetic evaluation, Basic Components of Medical History - Past medical history & family history, Pedigree construction and analysis, Risk assessment, Establishing diagnosis, Options, Psycho-social aspects of genetic counselling. **Genetic Screening**: Population screening for genetic disease, Presymptomatic testing for genetic diseases and malignancy, Carrier detection.	**9 Hours**
Module-3	**Inheritance Pattern and Risk Estimation**: Inheritance pattern of genetic disorders - Consanguinity - Inbreeding co-efficient, Occurrence and risk estimation, Empirical risk - Sensitivity & specificity of screening and diagnostic tests.	**8 Hours**
Module-4	**Counseling Context & Situations**: Counseling in common Mendelian and multifactorial disorders -Pediatrics and adult onset disease; Reproductive issues, Infertility issues, RPL & BOH; **Cancer Genetic Counseling**: Prenatal genetic counseling - Purpose, Indications, Noninvasive and Invasive techniques - USG, Maternal serum screening, NIPT, CVS, Amniocentesis, Cordocentesis; ICMR Guidelines - Fetal rights - PC-PNDT Act 1994, The ART Regulation Act, 2021.	**10 Hours**
Module-5	**Database Guided Interactive Genetic Counseling**: Databases annotation for genetic counseling cases – POSSUMweb, OMIM, MedGen, Atlas of Genetics and Cytogenetics in Oncology and Haematology.	**7 Hours**
	Total	**42 Hours**

Text Books:

T1. W. R. Uhlmann, J. L. Schuette, and B. M. Yashar, ***A Guide to Genetic Counseling***, 2nd Edition, Wiley-Blackwell, 2009.

T2. L. B. Jorde, J. C. Carey, M. J. Bamshad, and R. L. White, ***Medical Genetics***, 3rd Edition, Mosby, 2006.

T3. R. L. Nussbaum, R. R. McInnes, H. F. Willard, A. Hamosh, and M. W. Thompson, ***Genetics in Medicine***, 8th Edition, Saunders/Elsevier, 2016.

Reference Books:

R1. R. J. M. Gardner, G. R Sutherland, and L. G. Shaffer, ***Chromosome Abnormalities and Genetic Counseling***, 4th Edition, Oxford University Press, 2011.
R2. P. S. Harper, ***Practical Genetic Counseling***, 7th Edition, Hodder Headline Group,2010.
R3. P. M. Veach, ***A Practical Guide to Clinical Supervision in Genetic Counseling***, Oxford University Press, 2023.
R4. K. A. Schneider, ***Counseling About Cancer: Strategies for Genetic Counseling***, 3rd Edition, Wiley-Blackwell, 2011.

Online Resources:

1. https://dth.ac.in/medical/courses/pathology/8/2/index.php: by Prof. Girisha KM, Manipal Academy of Higher Education
2. https://pubmed.ncbi.nlm.nih.gov/29617718/
3. https://pubmed.ncbi.nlm.nih.gov/34309119/

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Describe the fundamental roles & responsibilities of a genetic counselor.
CO2	Apply the principles of evaluation & screening for proper genetic counseling.
CO3	Assess inheritance pattern of genetic disorders and estimate the risks of genetic diseases.
CO4	Conduct patient counseling in different contexts & situations as per guidelines & laws.
CO5	Explain & apply annotation of databases for varied genetic counseling cases.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO2	Develop various methods of molecular biology techniques to detect the changes in the DNA and associate them with various disease conditions.
PO3	Design novel and innovative DNA based platforms for clinical application and early detection of diseases like Cancer, Infertility, and Life style Disorders.
PO4	Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.
PO5	Integrate the tools of Biochemistry, Molecular Biology, Immunology and Genetics to develop panels and sytems to explain the diseases at the molecular level and determine possible treatments or management.
PO7	Work with professional context with intellectual integrity, ethics and social responsibility.
PO8	Communicate effectively and present technical information in oral and written reports supported by diagrams and models for easy visualization.
PO9	Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

P.T.O

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	2	3	2		2	2	3	3	3	3	2
CO2	3	2	3	3	3		2	2	3	3	3	3	2
CO3	3	3	3	3	3		2	1	3	3	3	3	3
CO4	3	3	3	3	3				3	3	3	3	3
CO5	3	2	2	2	2				3	3	3	3	3

Category	Code	Tissue Engineering	L-T-P	Credits	Marks
PEL	MM6006		3-0-0	3	100

Objectives	The objective of this course is to study cellular differentiation, functioning of genes & genetics, and applications of tissue engineering in experimental research and health care.
Pre-Requisites	Basic concepts of cell biology and genetics is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on case studies and practical examples.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Introduction**: Cells and tissues, Types, Growth factors and signaling, Extracellular matrix structure, Function, Cell adhesion, Migration, Classical culture methods, Cryopreservation, Dedifferentiation, Organ culture, Ethical issues in tissue engineering, Regulatory issues.	**8 Hours**
Module-2	**Engineering at the Genetic and Molecular Level**: Tissue and organ differentiation, Control of organogenesis, Cytokine signalling, Stem cells, Plasticity, Engineering at tissue (bone, cartilage, muscle, neural, adipose, skin, dental) and organ level, Artificial liver, pancreas, bladder, cell based regenerative medicine for heart disease.	**10 Hours**
Module-3	**Tools in Tissue Engineering**: Biomaterials, Scaffold structure and fabrication, Hydrogels, Mineralized collagen, Micromass culture technology, Bioreactors in tissue engineering, Microenvironmental determinants of stem cell fate.	**8 Hours**
Module-4	**Transplantation & Immune System**: Functional aspects in biological engineering, Perfusion effects and hydrodynamics, Innate and adaptive immune responses, Toll like receptors, Potential targets for therapeutic interventions, Tissue engineered models for *in-vitro* and *in-vivo* studies.	**8 Hours**
Module-5	**Clinical Applications**: Evidence based applications in tissue engineering and regenerative medicine, Tissue engineering applications in neurology, Maxillofacial surgery, Dental implantology, General and plastic surgery, Cardiovascular substitutes, Endocrinology and hematology.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. B. Palsson, J. A. Hubbell, R. Plonsey, and J. D. Bronzino, ***Tissue Engineering - Principles and Applications***, 1st Edition, CRC Press, 2019.

T2. H. Mori and H. Matsuda, ***Cardiovascular Regeneration Therapies Using Tissue Engineering Approaches***, Springer Verlag, 2005.

T3. J. P. Fisher, A. G. Mikos, and J. D. Bronzino, ***Tissue Engineering***, 1st Edition, CRC Press, 2013.

T4. K. E. Orwig and B. P. Hermann, ***Male Germline Stem Cells: Developmental and Regenerative Potential (Stem Cell Biology and Regenerative Medicine)***, Humana Press, 2011.

Reference Books:

R1. R. Kirschstein and L. R. Skirboll, ***Stem Cells: Scientific Progress and Future Research Directions***, NIH Report, 2001.
R2. W. W. Minuth, R. Strehl, and K. Schumacher, ***Tissue Engineering – Essentials for Daily Laboratory Work***, Wiley GmbH, 2005.
R3. J. R. Morgan and M. L. Yarmush, ***Methods in Molecular Medicine: Tissue Engineering Methods and Protocols. Vol.18***, Humana Press, 1998.

Online Resources:

1. https://nptel.ac.in/courses/102106036: by Dr. S. Swaminathan, IIT Madras
2. https://ocw.mit.edu/courses/hst-535-principles-and-practice-of-tissue-engineering-fall-2004/pages/lecture-notes/
3. https://www.verywellhealth.com/tissue-engineering-4580368
4. https://www.biologydiscussion.com/biotechnology/tissue-engineering/tissue-engineering-4-aspects-with-diagram/10577

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Discuss the fundamentals, relevant concepts and ethical aspects of tissue engineering.
CO2	Illustrate the mechanistic basis of tissue engineering at genetic and molecular level.
CO3	Demonstrate various tools used in tissue engineering technology.
CO4	Relate the roles of transplantation and immune system response in tissue engineering.
CO5	Apply the clinical tools & techniques of tissue engineering in different domains.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO2	Develop various methods of molecular biology techniques to detect the changes in the DNA and associate them with various disease conditions.
PO3	Design novel and innovative DNA based platforms for clinical application and early detection of diseases like Cancer, Infertility, and Life style Disorders.
PO4	Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.
PO5	Integrate the tools of Biochemistry, Molecular Biology, Immunology and Genetics to develop panels and sytems to explain the diseases at the molecular level and determine possible treatments or management.
PO7	Work with professional context with intellectual integrity, ethics and social responsibility.
PO9	Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	2	2	2		2		2	3	3	2	2
CO2	3	3	3	2	3				2	3	3	2	3
CO3	2	3	3	2	2				2	3	3	2	2
CO4	3	3	3	3	2				2	3	3	2	2
CO5	3	2	3	3	3				3	3	2	3	3

Category	Code	R&D Management	L-T-P	Credits	Marks
PEL	MM6007		3-0-0	3	100

Objectives	The objective of this course is to inculcate effective R&D team building, organization and performance evaluation, issues related to commercialization of innovations, developing innovative business models and management.
Pre-Requisites	Basic concepts of research methodology is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on case studies and practical examples.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Fundamentals of R&D Management**: Basic concepts of discovery and innovation products, Stages of R&D product cycle and management needs, Laboratory scale up and components of manufacturing large scale production, Concepts of quality, Reproducibility and financial planning, Managing micro and macro level of experimental output and process layout.	**8 Hours**
Module-2	**R&D Project Success Criteria and Factors**: Identification of relevance to International, National, and Societal needs, Causes of failure and success, The goal and methods matrix, Three dimensions of project success requirements, Market globalization, Avoiding duplication and infringement, Search strategies, Managing short-term and long-term perspectives.	**6 Hours**
Module-3	**Resource Optimization**: Various aspects of project financing, Planning and costs in R&D, Funding agencies, Cost evaluation models, Cost control, Time management, Quality management, Stage Gate Process, Team Management - Team size, Functional team, Lightweight team, Heavyweight team, Autonomous team, Team leadership, Team administration, Differentiating performers, achievers, and non-performers, Optimization of technical and non-technical resources.	**10 Hours**
Module-4	**Strategy Development for Implementation**: Product/market matrix, Understanding and addressing the development gaps in research-reproducibility, Scale-up, Manufacturing challenges, Regulatory aspects, Ownership issues, Material transfer aspects in case of biotech and pharmaceuticals, Types of association, R&D, Contract research, Commercial production etc., Strategies for research commercialization - Joint ventures, Licensing, Transfer of technology (ToT) and Strategic alliances (MOUs).	**10 Hours**
Module-5	**Contemporary Management**: Adapting to the global standards and statutory requirements with a scheme of continuous evaluation process, Value creation and entry barrier with IP fencing, Reinvention and market fitment as per changing demographics and societal need, Harnessing new and contemporary products to meet the challenge of incumbency, Bridging the commercial gap of R&D funding by diversification of products.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. M. A. Schilling, ***Strategic Management of Technological Innovation***, 7th Edition, McGraw-Hill, 2023.
T2. R. Basu, ***Managing Projects in Research and Development***, Gower Publishing Company, 2015.

Reference Books:

R1. P. Gilbert, N. Bobadilla, L. Gastaldi, M. Le Boulaire, and O.Lelebina, ***Innovation, Research and Development Management***, John Wiley & Sons, 2018.
R2. P. Bamfield, ***Research and Development Management***, Wiley-VCH, 2003.
R3. K. B. Akhilesh, ***R & D Management (Management for Professionals)***, 1st Edition, Springer, 2016.

Online Resources:

1. https://nptel.ac.in/courses/109103153: by Prof. R. Bedamatta, IIT Guwahati

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Describe stages of R&D product cycle and management.
CO2	Identify different success criteria and factors in R&D project management.
CO3	Evaluate various aspects of R&D project financing, including cost, team and quality.
CO4	Develop various strategies for the effective management of R&D projects.
CO5	Apply modern approaches for effective planning, monitoring, and management of a business.

Program Outcomes Relevant to the Course:

PO3	Design novel and innovative DNA based platforms for clinical application and early detection of diseases like Cancer, Infertility, and Life style Disorders.
PO6	Function effectively as an individual or as a member of a multidisciplinary team with professional and managerial skills.
PO7	Work with professional context with intellectual integrity, ethics and social responsibility.
PO8	Communicate effectively and present technical information in oral and written reports supported by diagrams and models for easy visualization.
PO9	Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1						3	3	2		2	1	2	2
CO2			1			3	3	2	1	2	1	2	2
CO3			1			3	3	3	1	2	1	2	2
CO4						3	3	3		2	1	2	2
CO5						3	3	3		3	1	2	2

Category	Code	DNA Fingerprinting & Forensics	L-T-P	Credits	Marks
PEL	MM6008		3-0-0	3	100

Objectives	The objective of this course is to study the concepts, relevance, and applications of DNA fingerprinting techniques in forensic investigations.
Pre-Requisites	Basic concepts of cell biology and genetics is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on case studies and practical examples.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Forensic Science**: Introduction, Definition, History, Progress and scope of forensic science in India; Need, Concepts and significance, Branches of forensic science, Organizational set-up of a forensic laboratory at central & state levels, Mobile forensic laboratory.	**6 Hours**
Module-2	**Biological Material**: Sources and types of biological sample, Collection and handling of biological material, Identification and characterization of biological evidence, Storage of biological material; **Tools & Techniques in Forensic Science**: Basic principles, Types and applications of microscopy, Spectroscopy, Chromatography, Electrophoresis, Enzyme-Linked Immunosorbent Assay (ELISA), Radio Immuno Assay (RIA), X–rays and x-Ray based techniques in forensic science.	**9 Hours**
Module-3	**DNA Fingerprinting**: Basic principles of DNA as biological blueprint of life, Historical perspective, Extraction of DNA for analysis and its quantization, Sample & preservative requirements, Procedure & considerations for evaluating DNA evidence.	**9 Hours**
Module-4	**Tools & Techniques in DNA Fingerprinting**: Repetitive DNA, DNA fingerprinting & Polymerase Chain Reaction, Sequence polymorphisms, Short Tandem Repeats (STR) and role of fluorescent dyes, Nature of STR loci, Restriction Fragment Length Polymorphism (RFLP) & genetic markers used in RFLP, Typing procedure, Interpretation of results & individualization of evidence.	**9 Hours**
Module-5	**Applications & Developments**: Applications of DNA fingerprinting, Latent fingerprinting vs. DNA fingerprinting, Forensic DNA typing, Y chromosome analysis, Mitochondrial DNA sequence analysis, Touch DNA & parentage testing, Principles of heredity & genetics of paternity, Use of fibers & hairs in forensic identification, Limitations & challenges.	**9 Hours**
	Total	**42 Hours**

Text Books:

T1. W. Goodwin, A. Linacre, and S. Hadi, ***An Introduction to Forensic Genetics***, 2nd Edition, 2011.
T2. S. Basu, ***The History of Forensic Science in India***, 1st Edition, Routledge, 2021.

Reference Books:

R1. J. Schober, R. Li, and S. Norman, ***Forensics Biology***, 2nd Edition, Taylor & Francis, 2021.
R2. A. Snow, ***Forensic DNA Technology***, Kaufman Press, 2022.

Online Resources:

1. https://mrsancheta.weebly.com/chap7dna-fingerprinting.html
2. https://www.csir.res.in/dna-fingerprinting-technology-its-success-and-future

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Describe the background and basic concepts of Forensic Science.
CO2	Identify, collect, and store unique biological samples for use in forensic analysis.
CO3	Describe the background and basic concepts of DNA Fingerprinting.
CO4	Differentiate the specialized techniques in DNA fingerprinting and their applications.
CO5	Analyze data collected from different experiments related to DNA fingerprinting.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO2	Develop various methods of molecular biology techniques to detect the changes in the DNA and associate them with various disease conditions.
PO3	Design novel and innovative DNA based platforms for clinical application and early detection of diseases like Cancer, Infertility, and Life style Disorders.
PO4	Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.
PO5	Integrate the tools of Biochemistry, Molecular Biology, Immunology and Genetics to develop panels and sytems to explain the diseases at the molecular level and determine possible treatments or management.
PO9	Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	2	2	2				2	2	3	2	2
CO2	3	3	3	3	3				3	3	3	3	3
CO3	3	2	2	2	3				2	2	3	3	2
CO4	3	3	3	3	3				3	3	3	3	3
CO5	3	3	3	3	3				3	3	3	3	3

Category	Code	Functional & Lifestyle Medicine	L-T-P	Credits	Marks
PEL	MM6009		3-0-0	3	100

Objectives	The objective of this course is to provide knowledge in the domain of life style disorders and causative factors at functional level.
Pre-Requisites	Basic concepts of metabolism, physiology, and gene function are required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on case studies and practical examples.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Health & Diet**: Definition of health and the foundations for good health, Lifestyle medicine, Reasons for development, Importance of lifestyle based studies, Energy requirements and energy balance – Energy intake and expenditure, Regulation of energy consumption, Energy reservoirs in the body, Carbohydrates, Glycemic index, Metabolic implications of fructose, Dietary fiber, Protein.	**10 Hours**
Module-2	**Lifestyle Disorders & Nutritional Habit**: Importance of nutrition and micro nutrients in special population, Saturated fat, Unsaturated fat, Trans-fat, Omega-3, Nutritional recommendations for common illnesses - Heart disease, Diabetes, Hypertension, Osteoporosis, Malignancies, Types of diets - Mediterranean, DASH and others. Nutrition dilemmas double edge sword.	**8 Hours**
Module-3	**Regulation of Food Consumption**: Factors mediating the sensation of hunger and satiety on the level of the central nervous system, Central and peripheral mechanisms involved in the regulation of food consumption, Genetic study on increase consumption of fast food, Snack foods, Sugary beverages and fructose, Impairment in the regulation of food consumption, Study of Nutrigenomics in personalized setting.	**9 Hours**
Module-4	**The Physical Activity Pyramid**: Physical activity pyramid including practical experience, Principles of prescribing physical activity to healthy people, General information on prescribing physical activity in disease situations for special populations, Self-evaluation – By heart rate reserve, BORG scale, Metabolic coefficient MET – ergometry, Molecular effects of energy management.	**8 Hours**
Module-5	**Time Cycle & Circadian Rhythm**: Time cycle, Circadian rhythm, Caloric restriction, Genetic balance of hormones and enzymes, Functional impact assessment, Epigenetic regulation of life style disorders due to multiple factors in daily routine, Acute and chronic impact, Biological aging and control mechanisms.	**7 Hours**
	Total	**42 Hours**

Text Books:

T1. J. M . Rippe, ***Manual of Lifestyle Medicine***, 1st Edition, CRC Press, 2021.
T2. A. A. Moosavi-Movahedi, ***Rationality and Scientific Lifestyle for Health***, Springer, 2021.

Reference Books:

R1. L. S. Sidossis and S, N. Kales, ***Textbook of Lifestyle Medicine***, 1st Edition, Wiley Blackwell, 2022.
R2. M. Hiramatshu, T. Yoshikawa, and L. Packer, ***Molecular Interventions in Lifestyle Related Diseases***, Taylor & Francis, 2006.

Online Resources:

1. https://wexnermedical.osu.edu/integrative-health/resources/mindfulness-practices
2. https://my.clevelandclinic.org/departments/functional-medicine/medical-professionals/resources

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Describe the impact of food habit on health and lifestyle diseases.
CO2	Explain recommended foods for common lifestyle disorder.
CO3	Discuss various mechanisms that are involved in the regulation of food consumption.
CO4	Explain the principles of prescribing physical activity to healthy people and in disease situation.
CO5	Describe time cycle with respect to circadian rhythm and caloric restriction.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO2	Develop various methods of molecular biology techniques to detect the changes in the DNA and associate them with various disease conditions.
PO3	Design novel and innovative DNA based platforms for clinical application and early detection of diseases like Cancer, Infertility, and Life style Disorders.
PO4	Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.
PO5	Integrate the tools of Biochemistry, Molecular Biology, Immunology and Genetics to develop panels and sytems to explain the diseases at the molecular level and determine possible treatments or management.
PO9	Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	2	2	2				2	2	3	2	2
CO2	3	2	2	2	2				2	2	3	2	2
CO3	3	2	2	3	3				3	3	3	3	3
CO4	3	2	2	3	3				3	3	3	3	3
CO5	3	2	3	3	3				3	3	3	3	3

Category	Code	Omics & Diseases	L-T-P	Credits	Marks
PEL	MM6010		3-0-0	3	100

Objectives	The objective of this course is to provide knowledge of the importance of complex and dynamic networks of molecules and their alteration leads to diseases.
Pre-Requisites	Basic concepts of cell biology and genetics is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on case studies and practical examples.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Introduction**: A historical perspective on the development of omics technologies and its role in disease diagnosis, Functional annotation and omics, Omics platforms and their general application – Genomics, Transcriptomics, Proteomics, Metabolomics; *In silico* disease annotation and development of tools for functional validation with real world diseases, Integrative omics.	**7 Hours**
Module-2	**Genomics**: Genome mapping and sequencing, Next Generation Sequencing technologies, 3rd and 4th Generation Sequencing, Introduction to different tools and algorithms, Data repositories and databases, Choice of sequencing platforms, Applications of genomics using case studies.	**8 Hours**
Module-3	**Transcriptomics**: Introduction, Typical wet lab workflow, Choice of sequencing methods and tools for identification of splicing variants and differential expression analysis, Non-coding RNAs, Target prediction and functional prediction for small RNAs and long non coding RNAs, Applications of transcriptomics using case studies.	**9 Hours**
Module-4	**Proteomics**: Techniques for protein separation and digestion, 2D PAGE, Mass spectrometry based proteomics, MALDI- TOF, Quantitative proteomics and multiplexing, Protein modifications, Mass Array, Spot array, Tools for proteomics data analysis, Applications of proteomics using case studies.	**9 Hours**
Module-5	**Metabolomics**: Tools and techniques available for metabolomics analysis, Targeted vs non-targeted metabolomics, Workflow, Data analysis tools, Data formats and key challenges, Metabolite identification, Metabolic fingerprinting, Applications of metabolomics and functional mapping, Integrative omics.	**9 Hours**
	Total	**42 Hours**

Text Books:

T1. C. W. Sensen, ***Handbook of Genome Research: Genomics, Proteomics, Metabolomics, Bioinformatics, Ethical and Legal Issues***, Volume 1, Wiley-VCH, 2005.

T2. S. B. Primrose and R. M. Twyman, ***Genomics: Application in Human Biology***, Blackwell Publishing, 2004.

Reference Books:

R1. Y. Liu, ***Omics in Clinical Practice: Genomics, Pharmacogenomics, Proteomics, and Transcriptomics in Clinical Research***, Apple Academic Press, 2014.

Online Resources:

1. https://omicstutorials.com/omics-tutorials-sitemap/
2. https://nptel.ac.in/courses/102101072: by Prof. S. Srivastava, IIT Bombay

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Describe the importance of omics in disease diagnosis.
CO2	Identify various approaches of modern genomics and significance in disease diagnosis.
CO3	Apply multiple tools and online resources to analyze transcriptomics data related to disease.
CO4	Search protein database and correlatethe data with disease condition.
CO5	Distinguish and differentiate various tools and techniques used to study metabolomics.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO2	Develop various methods of molecular biology techniques to detect the changes in the DNA and associate them with various disease conditions.
PO3	Design novel and innovative DNA based platforms for clinical application and early detection of diseases like Cancer, Infertility, and Life style Disorders.
PO4	Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.
PO5	Integrate the tools of Biochemistry, Molecular Biology, Immunology and Genetics to develop panels and sytems to explain the diseases at the molecular level and determine possible treatments or management.
PO9	Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	2	3	2				2	2	2	2	2
CO2	3	3	2	3	2				3	3	2	2	2
CO3	3	3	3	3	2				3	3	3	3	3
CO4	3	3	3	3	3				3	3	3	3	3
CO5	3	3	3	3	3				3	3	3	3	3

Category	Code	Nutritional Genetics	L-T-P	Credits	Marks
PEL	MM6011		3-0-0	3	100

Objectives	The objective of this course is to develop an understanding of genomics and gene regulation with respect to diet and the role and importance of nutrition in prevention of diseases.
Pre-Requisites	Basic knowledge of roles & functions of genes in human physiology is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on case studies and practical examples.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Introduction**: Definition, History, Development and scope of nutritional genetics, Nutritional intake, Metabolism and response.	**8 Hours**
Module-2	**Nutrients and Gene Expression**: Sterol regulatory element binding proteins (SREBPs) and carbohydrate sensitive response element binding protein (ChREBP) – Transcription factors influenced by dietary lipids and glucose, Superfamily of nuclear receptors, Nuclear Receptors – Structure and function, Nuclear receptors as metabolic sensor, Vitamins, Phytoestrogens – Nutrients mimicking estrogens, Polymorphisms.	**10 Hours**
Module-3	**Genetic Variation and Nutritional Requirements**: Genetic Diversity – Ethnic differences and gene variants, Nutrients and disease prevention, Impact of variability in folate genes, MTHFR 677C→T polymorphism.	**8 Hours**
Module-4	**Nutritional Genetics & Disease Risk**: Genetics of Type 2 diabetes, Gene variants and obesity, Gene polymorphisms, Nutrition, and inflammatory response, Gene variants, Nutritional parameters and hypertension, Gene variants, Nutrition and cancer.	**8 Hours**
Module-5	**Technologies in Nutritional Genetics**: Genomics Techniques - Different sequencing approaches, Microarray, Massarray, SNP genotyping, PCR and RT-PCR techniques; Proteomics Techniques - 1-D, 2-D gel electrophoresis, DIGE, Novel peptide identification, Peptide sequencing methods; Metabolomics Techniques - Chromatography and mass spectrometry techniques, Discovery and validation of biomarkers for important diseases and disorders; Computational Approaches - Public domain databases, Data mining strategies, Primer designing.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. A. P. Simopoulos and J. M. Ordovas, ***Nutrigenetics and Nutrigenomics***, 1st Edition, S. Karger AG, 2004.

Reference Books:

R1. W. R. Bidlack and R. L. Rodriguez, ***Nutritional Genomics***, 1st Edition, CRC Press, 2012.

R2. J. Kaput and R. L. Rodriguez, ***Nutritional Genomics: Discovering the Path to Personalized Nutrition***, 1st Edition, Wiley-Interscience, 2006.
R3. R. Brigelius-Flohé and H-G. Joost, ***Nutritional Genomics***, 1st Edition, Wiley-Blackwell, 2006.

Online Resources:

1. https://pubmed.ncbi.nlm.nih.gov/16567153/
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3571637/
3. https://pubmed.ncbi.nlm.nih.gov/19665868/

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Outline the relationship between human genome, human nutrition and health.
CO2	Correlate effects of nutrients and other food components on gene expression and regulation.
CO3	Explain the influence of human epigenetic variation on nutritional requirements.
CO4	Apply nutritional genomics to design nutritional strategies for prevention of chronic diseases.
CO5	Illustrate various applications of technologies in nutritional genetics.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO2	Develop various methods of molecular biology techniques to detect the changes in the DNA and associate them with various disease conditions.
PO3	Design novel and innovative DNA based platforms for clinical application and early detection of diseases like Cancer, Infertility, and Life style Disorders.
PO4	Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.
PO5	Integrate the tools of Biochemistry, Molecular Biology, Immunology and Genetics to develop panels and sytems to explain the diseases at the molecular level and determine possible treatments or management.
PO9	Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	3	3	3				2	2	3	3	3
CO2	3	3	3	3	3				2	2	3	3	3
CO3	3	3	3	3	3				3	3	3	3	3
CO4	3	3	3	3	3				3	3	3	3	3
CO5	3	3	3	3	3				3	3	3	3	3

Category	Code	DNA Sequencing Lab	L-T-P	Credits	Marks
PCR	MM6003		0-0-6	3	100

Objectives	The objective of this laboratory course is to understand the fundamentals of nucleic acid sequencing and practice the methods of next generation sequencing using various advanced instruments and techniques.
Pre-Requisites	Basic concepts of molecular biology and cancer biology is required.
Teaching Scheme	Regular laboratory experiments conducted under supervision of the teacher.

Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test / Project	Viva-voce	Total
10	30	15	30	15	100

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Introduction to process flow of Seq-studio Genetic Analyzer & Ion PGM/Ion S5.
2	Quality assessment of Nucleic Acid by Qubit Fluorometer.
3	Gene amplification by PCR and Cleanup for downstream application.
4	Dideoxy Chain termination PCR for Sanger sequencing.
5	Mutation Annotation and bioinformatics tools for NGS data analysis.
6	Sample preparation, sequencing Plate setup and data analysis.
7	Target amplification for NGS.
8	Digestion, adapter ligation and barcoding of given sample.
9	Purification of PCR product using Magnetic bead-based technique.
10	Sample dilution and oil emulsion PCR set up.
11	Amplicon enrichment by Streptavidin coated magnetic beads.
12	Instrument initialization & NGS chip loading.
13	NGS data analysis and interpretation.

Text Books:

T1. I. Ravi, M. Baunthiyal, and J. Saxena, ***Advances in Biotechnology***, 1st Edition, Springer, 2013.
T2. F. Pezzella, M. Tavassoli, and D. J. Kerr, ***Oxford Text Book of Cancer Biology***, 1st Edition, Oxford University Press, 2019.
T3. W. A. Schulz, ***Molecular Biology of Human Cancers***, Springer, 2007.

Reference Books:

R1. M. Kappelmann-Fenzl, ***Next Generation Sequencing and Data Analysis***, Springer, 2021.
R2. L. Low and M. Tammi, ***Bioinformatics: A Practical Handbook of Next Generation Sequencing and its Applications***, World Scientific, 2016.

Online Resources:

1. https://learn.gencore.bio.nyu.edu/
2. https://www.ebi.ac.uk/training/search-results?query=next-generation-sequencing&domain=ebiweb_training&page=1&facets=

P.T.O

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Assess the quality of isolated nucleic acid using various instruments.
CO2	Prepare genomic and cDNA library.
CO3	Perform experiment related to target amplification and enrichment.
CO4	Perform DNA sequencing experiment.
CO5	Analyze DNA sequencing data using various bioinformatics tools.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO2	Develop various methods of molecular biology techniques to detect the changes in the DNA and associate them with various disease conditions.
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PO4	Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.
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Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	3	3	3				3	3	3	3	3
CO2	3	3	3	3	3				3	3	3	3	3
CO3	3	3	3	3	3				3	3	3	3	3
CO4	3	3	3	3	3				3	3	3	3	3
CO5	3	3	3	3	3				3	3	3	3	3

Category	Code	Case Reporting & Interpretation Lab	L-T-P	Credits	Marks
PCR	MM6004		0-0-2	1	100

Objectives	The objective of this laboratory course is to provide practical exposure on clinical data and assessment, analysis, interpretation, and presentation of those clinical data.
Pre-Requisites	Basic concepts of molecular biology and cancer biology is required.
Teaching Scheme	Regular laboratory experiments conducted under supervision of the teacher.

Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test / Project	Viva-voce	Total
10	30	15	30	15	100

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Categorization of Diseases Pathogenic/Benign and Prognostication.
2	Patient Demographics and reporting patterns.
3	PCR based single mutation studies and reporting.
4	RT-PCR based quantitative correlation with disease load in hematological malignancy.
5	MDS group of Diseases and MDR Tracking.
6	Molecular Cytogenetic confirmation of Leukemia via panel
7	Sanger Sequencing and MLPA based reporting of Thalassemia.
8	Solid Tumor Sequencing and Data interpretation.
9	Multi-platform integrated complex reporting.
10	Relapse and same patient follow up reporting
11	Predictive Scoring and Prognostication in few Cancer cases.
12	Familial Cancers and Gene Dosage.
13	Pre Natal Diagnostics and Genetic Counseling.

Text Books:

T1. R. J. Lee, J. S. Abramson, R. A. Goldsby, and W. W. Norton, ***Case Studies in Cancer***, W. W. Norton & Company, 2018.
T2. A. N. Harnett, B. McGlynn, and R. N. Meddings, ***Case Studies in Urological Cancer***, Greenwich Medical Media, 2002.

Reference Books:

R1. A. Harnett, ***Case Studies in Breast Cancer***, Greenwich Medical Media, 2001.
R2. M. Watson, A. Barrett, R. A. J. Spence, and C. Twelves, ***Oncology***, 2nd Edition, Oxford University Press, 2006.

Online Resources:

1. https://jmedicalcasereports.biomedcentral.com/
2. https://casereports.bmj.com/

P.T.O

Course Outcomes: *At the end of this course, the students will be able to:*

CO1	Categorize stage/ status of the disease.
CO2	Write patient demographic data and reporting.
CO3	Identify different types of mutation from different patient samples using PCR based methods.
CO4	Interpret solid tumor sequencing data as well as hematological malignancy.
CO5	Review etiological factors associated with different types of cancer.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of Life Sciences, Molecular Biology, and Genetics of various diseases or health conditions for detection and management in the real clincial world.
PO2	Develop various methods of molecular biology techniques to detect the changes in the DNA and associate them with various disease conditions.
PO3	Design novel and innovative DNA based platforms for clinical application and early detection of diseases like Cancer, Infertility, and Life style Disorders.
PO4	Apply the skills in molecular medicine in different clinical settings and manage the patient data with advanced and precision tools for personalized treatment.
PO5	Integrate the tools of Biochemistry, Molecular Biology, Immunology and Genetics to develop panels and sytems to explain the diseases at the molecular level and determine possible treatments or management.
PO6	Function effectively as an individual or as a member of a multidisciplinary team with professional and managerial skills.
PO8	Communicate effectively and present technical information in oral and written reports supported by diagrams and models for easy visualization.
PO9	Review research literature in the areas of Molecular Medicine and its associated domains to develop advanced techniques, systems, and tools.
PO10	Recognize the need and engage in continuous lifelong learning to enhance the knowledge & skills of Molecular Medicine related to the real world applications.

Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	2	3	3	3		3	3	3	3	3	3
CO2	3	2	2	3	3	3		3	3	3	3	3	3
CO3	3	2	2	3	3	3		3	3	3	3	3	3
CO4	3	2	2	3	3	3		3	3	3	3	3	3
CO5	3	2	2	3	3	3		3	3	3	3	3	3

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