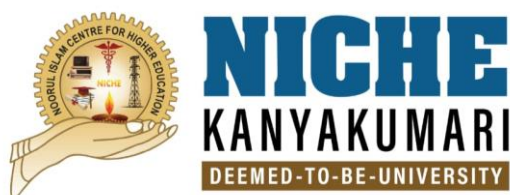


NOORUL ISLAM CENTRE FOR HIGHER EDUCATION

(Deemed to be University Under Section 3 of the UGC Act, 1956)

Kumaracoil, Thuckalay

DEPARTMENT OF ALLIED HEALTH SCIENCE



M.Sc. HUMAN GENETICS AND MOLECULAR BIOLOGY CURRICULUM AND SYLLABI

REGULATION 2023



NOORUL ISLAM CENTRE FOR HIGHER EDUCATION

Kumaracoil - 629 180, Kanyakumari District, Tamil Nadu, India
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Regulation : 2023

Curriculum and Syllabi

M.Sc Programme

DEPARTMENT OF ALLIED HEALTH SCIENCES

M.Sc., HUMAN GENETICS AND MOLECULAR BIOLOGY

Vision of the University

To be recognized by the Government and society at large as an institution able to deliver excellence with relevance in the field of higher education and research focusing on the needs of the nation in tune with the technological revolution to cope with the knowledge explosion and global competence.

Mission of the University

To develop the institution as a Centre of Excellence, keeping pace with the advances in the field, so as to provide quality higher education to the students and instill in them high standards of discipline and ethics so that they become enlightened individuals in the service of humanity and to carry out focused research in the frontier areas of science and technology.

Faculty of Allied Health Sciences

Department of Allied Health Sciences

Vision Statement:

Empower and elevate students to understand the conditions conducive to harmonious healthy society by building up youth towards achieving it when it is practiced effectively.

Mission Statement:

The mission of the department of Allied Health Sciences at NICHE is to build up new chorum of youth towards application and practice of knowledge. Recent techniques provide accessible innovative care service and ways to improve outcomes through science and advanced research.

Description of the programme

Human Genetics and Molecular Biology offers; under graduate and post graduate programmes as of now. The course highlights diverse subjects related to genetic traits passing down from one generation to another. The course also provides in-depth knowledge about how the genetic and genomic technologies can analyze the genomes of humans and disease mechanisms.

Programme Educational Objectives – PEO

PEO-01	The students can be employed as geneticists in hospitals and Health care sector.
PEO-02	The students can go for higher education in reputed National and International Institutions.
PEO-03	The candidates would be able to establish a Genetic testing laboratory
PEO-04	The Students as Clinical Geneticist can transform the knowledge into design the health care tools/methods for disease diagnosis and treatment of genetic diseases.
PEO-05	Delineate and evaluate the clinical data for the diagnosis of diseases of public health concern.

Programme Outcome – POs

PO-A	Students are familiar with basic subjects of Human genetics and Molecular Biology
PO-B	Knowledge on the interdisciplinary subjects make them excel in the programme
PO-C	Provides solutions for their experiments through their theoretical knowledge.
PO-D	Based on the theoretical knowledge obtained, new solutions can be formulated for the genetic disorders
PO-E	Knowledge on genetics and their applications will help them to Diagnose prenatal disorders
PO-F	Provide genetic counselling to the society
PO-G	Giving awareness to the society about existing technologies in human genetics
PO-H	Group assignments and projects will make them to understand and cooperate with co-workers
PO-I	They can communicate with well versed with the team members about the problems and solutions in an effective manner
PO-J	In-plant training enables them to understand their roles and responsibilities as an professional geneticists in the society
PO-K	Designing new experimental methods for society in concern with genetics and social ethics
PO-L	Innovating reliable cost effective technology which can be affordable for all sector of the society
PO-M	Motivating the student to acquire update knowledge and innovations will make them continuous learner

Graduate Attributes-GA	
GA-1	Advanced Scientific Knowledge and Specialization Acquire in-depth knowledge and expertise in specific scientific disciplines, building upon foundational concepts to explore advanced theories, methodologies, and applications in the chosen field of study.
GA-2	Research Methodology and Innovation Demonstrate proficiency in designing, conducting, and interpreting complex research experiments, utilizing advanced research methodologies, tools, and technologies to contribute to scientific innovation and discovery.
GA-3	Data-Driven Decision Making Use sophisticated data analysis techniques, statistical tools, and computational models to solve complex scientific problems, make data-driven decisions, and predict outcomes in research and industry settings.
GA-4	Critical Thinking and Problem-Solving Develop advanced critical thinking and problem-solving skills, enabling the formulation of innovative solutions to theoretical and practical challenges in scientific research and application.
GA-5	Interdisciplinary Collaboration and Leadership Work effectively in interdisciplinary teams, integrating knowledge from various scientific domains to tackle complex, real-world problems, and demonstrate leadership in collaborative research and professional projects.
GA-6	Environmental Stewardship and Sustainable Practices Apply scientific principles to address environmental challenges, promote sustainability, and contribute to the development of environmentally responsible technologies and practices.
GA-7	Ethics and Professional Integrity in Science Uphold the highest standards of ethical conduct and professional integrity in scientific research, ensuring responsible data handling, experimentation, and reporting in accordance with global scientific standards.
GA-8	Advanced Laboratory and Technological Skills Master cutting-edge laboratory techniques, instrumentation, and scientific tools, utilizing them to conduct sophisticated experiments and research that contribute to scientific progress and innovation.
GA-9	Effective Communication of Scientific Ideas Develop strong communication skills, capable of presenting complex scientific concepts, research findings, and technical information clearly and persuasively to both scientific and non-scientific audiences, including through publications and presentations.
GA-10	Lifelong Learning and Professional Development Embrace a commitment to lifelong learning, staying updated with the latest scientific advances, technologies, and best practices, and continuously developing skills to remain at the forefront of the scientific community.

Mapping of Graduate Attributes and Programme Educational Objectives (PEO)

GAs PEOs	GA-01	GA-02	GA-03	GA-04	GA-05	GA-06	GA-07	GA-08	GA-09	GA-10
PEO-A	H	A	A	A	H	H	A	A	A	A
PEO-B	H	A	A	A	H	H	A	A	A	A
PEO-C	H	A	A	A	H	H	A	A	A	A
PEO-D	H	A	A	A	H	H	A	A	A	A
PEO-E	H	A	N	H	A	A	A	A	A	H

H- Highly Associated
A- Associated
Not – Not Associate

Mapping of Programme Educational Objective (PEOs) and Programme Outcome (POs)

PEO PO	PEO-01	PEO-02	PEO-03	PEO-04	PEO-05
PO-A	H	H	H	H	H
PO-B	H	H	H	H	A
PO-C	A	A	H	H	A
PO-D	H	H	H	H	H
PO-E	H	H	H	H	H
PO-F	A	A	A	A	A
PO-G	H	H	H	H	H
PO-H	H	H	H	H	A
PO-I	H	H	H	H	A
PO-J	H	H	H	H	A
PO-K	H	H	H	H	A
PO-L	H	H	H	H	H
PO-M	A	A	A	H	A

H- Highly Associated
A- Associated
Not – Not Associated

Duration of the programme: 2 Years/ 4 Semesters

Total credit: 80

CURRICULUM & SYLLABI
SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	HG4701	Clinical Biochemistry and Physiology	4	0	0	4
2	HG4702	Techniques in Microbiology	3	1	0	4
3	HG4703	Concepts of Human Genetics	4	0	0	4
4	HG4704	Cell Biology and Genomes	4	0	0	4
5	HG4705	Molecular Biology	3	1	0	4
PRACTICAL						
7	HG4771	Clinical Biochemistry and Physiology Lab	0	0	2	2
8	HG4772	Techniques in Microbiology Lab	0	0	2	2
TOTAL			18	2	4	24

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	HG4706	Human Molecular Genetics	4	0	0	4
2	HG4707	Immunology and Immunogenetics	3	1	0	4
3	HG4708	Developmental and Behavioural Genetics	4	0	0	4
4	HG4709	Genetic Engineering	3	1	0	4
5	HG4710	Epigenetics	4	0	0	4
PRACTICAL						
7	HG4773	Human Molecular Genetics Lab	0	0	2	2
8	HG4774	Immunology and Immunogenetics Lab	0	0	2	2
TOTAL			18	2	4	24

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	HG4711	Bioinformatics and Pharmacogenomics	4	0	0	4
2	HG4712	Cytogenetics	3	1	0	4
3	HG47XX	Elective	4	0	0	4
4	HG4714	Clinical Genetics	3	1	0	4
5	HG4715	Genetic Counselling	3	1	0	4
PRACTICAL						
7	HG4775	Bioinformatics and Pharmacogenomics Lab	0	0	2	2
8	HG4776	Cytogenetics Lab	0	0	2	2
Total			17	3	4	24

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	HG47XX	Elective	3	1	0	4
PRACTICAL						
2	HG47P1	Project	0	0	10	10
3	HG47P2	Hospital and Industrial Visits/Summer Internship	0	0	2	2
4	HG47G1	Publication / Presentation/ Five days Workshop	0	0	2	2
Total			3	1	14	18

LIST OF ELECTIVES

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
Theory						
1	HG47A1	Bioethics and Biosafety	3	1	0	4
2	HG47A2	Forensic Biology	3	1	0	4
3	HG47A3	Research Methodology, Biostatistics and IPR	3	1	0	4
4	HG47A4	Radiation Genetics	3	1	0	4
5	HG47A5	Medical Biochemistry	3	1	0	4
6	HG47A6	Human Anatomy and Physiology	3	1	0	4

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	HG4701	Clinical Biochemistry and Physiology	4	0	0	4
2	HG4702	Techniques in Microbiology	3	1	0	4
3	HG4703	Concepts of Human Genetics	4	0	0	4
4	HG4704	Cell Biology and Genomes	4	0	0	4
5	HG4705	Molecular Biology	3	1	0	4
PRACTICAL						
7	HG4771	Clinical Biochemistry and Physiology Lab	0	0	2	2
8	HG4772	Techniques in Microbiology Lab	0	0	2	2
TOTAL			18	2	4	24

HG4701	Clinical Biochemistry and Physiology	L	T	P	C
		4	0	0	4

OBJECTIVES

It deals with the concepts of clinical investigations in biochemistry and various organ systems.

Course Outcome At the end of the course, students will able to		Cognitive Skill
CO-01	Understand the blood parameters and diagnostic enzymology.	U
CO-02	Ensure the knowledge about the disorders of biomolecule and mineral metabolism.	R, An
CO-03	Analyse about the clinical importance of the hormones and reproductive endocrinology.	R
CO-04	Acquire knowledge about the circulatory, respiratory, gastrointestinal and reproductive system.	U
CO-05	Study and understand about the hepatobiliary system, excretory system, muscular and nervous system.	U

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L	PO-M
CO-01	S	S	S	M	L	M	M	M	S	M	L	S	S
CO-02	S	S	M	M	M	S	S	S	M	S	M	M	S
CO-03	S	S	M	S	M	M	L	M	M	M	M	M	S
CO-04	S	S	S	S	M	S	S	S	S	M	S	M	S
CO-05	S	S	S	M	S	S	M	S	M	S	M	L	M

S-Strong, M-Medium, L-Low, N-Not relevant

Unit I: Blood Components and Electrolytes

12

Blood composition, Blood groups, Rh factor, rare blood groups, Rh typing, CBC, total differential and platelet counts, ESR and its clinical significance, Mechanism of blood clotting, anti-coagulants, Anemias –Iron deficiency Anemia, Hemolytic Anemia, Disorders of Blood clotting pathway, Hemophilias. Electrolytes, Acid base balance and its disorders,

Unit II: Metabolic disorders

12

Disorders of carbohydrates metabolism- Diabetes mellitus, hypoglycemia, glucose tolerance tests, Disorders of lipid metabolism - Hyper and hypocholesterolemia. Lipoproteins- Atherosclerosis and fatty liver, Disorders of aminoacid metabolism - cystinuria, phenylketonuria, maple syrup urine disease, albinism. Disorders of protein metabolism- proteinuria.

Unit III: Hormones

12

Classification of hormones, Mechanism of hormone action, class I and Class II hormone receptors. Protein hormones, steroid hormones, Adrenocorticosteroids, Reproductive endocrinology-androgens and estrogens, Thyroid hormone and its importance, Mechanism of drug action and channels of excretion.

Unit IV: Organ Systems in Human body

12

Circulatory system: heart and its structure, function, blood pressure and its regulation. Respiratory system: lungs – structure and function, gas exchange mechanism, Digestive system- composition, function and regulation of the gastrointestinal secretion, absorption of the biomolecules, Reproductive system- structure of male and female reproductive organs.

Unit V: Excretory and Nervous system

12

Hepato-biliary system, importance of bile salts, Excretory system: structure of nephron, mechanism of urine formation, kidney hormones, regulation of pH and water balance. Muscular proteins, Types of muscles , mechanism of contraction of muscles. Nervous

system- components, structure of brain and spinal cord, importance of CSF. Diagnostic enzymology in liver, and kidney function tests.

TOTAL: 60 HOURS

TEXT BOOKS

1. Fundamentals of biochemistry, by D. Voet and J.G.Voet, 2004, John Wiley and sons, USA biochemistry, by R.H. Garrett and L.M.Grisham (5th edition) 2016, Saunders college publishers.
2. Biochemistry, by R. L. Miesfeld and M.M.Evag, 2017, (2nd edition) 2020, W.W. Norton and company.
3. Harper's Illustrated Biochemistry, by Robert. K. Murray, Darryl. K. Granner, Peter. A. Mayes and Victor. W. Rodwell. 1988. (31st edition) 2018. Mc Graw hill education publishers

REFERENCE BOOKS

1. Lehninger principles of biochemistry, by David Nelson, 1989. Micheal. M. Cox, (7th edition) 2017, W.H. Freeman publishers
2. Lippincott's illustrated reviews: Biochemistry by Pamela. C. Champe, Richard. A. Harvey and Denise. R. Ferrier. 1987. (6th edition) 2013, CCH, a Wolters Kluwer Business.

HG4702	Techniques in Microbiology	L	T	P	C
		3	1	0	4

OBJECTIVES

Students will learn the importance of techniques in Microbiology

Course Outcome At the end of the course, students will able to		Cognitive Skill
CO-01	Get a deep knowledge about History, scope and the principles of Microscope	R
CO-02	Acquire knowledge in different sterilization techniques	U
CO-03	Learn to prepare culture media and pure culture techniques	An
CO-04	Get an idea in the concept of staining techniques	U
CO-05	Obtain information about chromatography, electrophoresis and spectrophotometry	E

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L	PO-M
CO-01	N	S	N	M	S	M	M	S	L	S	S	M	N
CO-02	S	M	S	N	S	L	M	N	S	M	L	M	S
CO-03	N	L	S	M	M	S	L	M	S	L	N	M	N
CO-04	S	L	N	M	N	L	S	N	S	M	N	S	S
CO-05	M	L	M	N	L	S	M	L	N	N	M	S	L

S-Strong, M-Medium, L-Low, N-Not relevant

Unit I: Microscopy

12

History and Scope of Microbiology, Microscopy- Principles and applications, dark field, bright field, phase contrast microscopy, fluorescent microscopy, inverted microscopy, stereo microscopy, electron microscopy, atomic force microscopy, TEM and SEM. Micrometry and cell measurement- Use of ocular and stage micrometer, cell count (haemocytometer).

Unit II: Sterilization

12

Methods of sterilization: principles and their limitations- Physical and Chemical methods of sterilization (dry heat, moist heat, radiation, filtration, chemical sterilization, fumigation); Determination of phenol coefficient of disinfectant. Rideal Walker test. Plasma sterilization, Principles, functioning and types of Biosafety cabinets. Antibiotic sensitivity tests by cup plate/paper disc method.

Unit III: Culture media and culture techniques

12

Growth media - General methods of isolation of microorganisms, Cultivation of bacteria- Types of growth media (natural, synthetic, complex, enriched, selective- definition with example), pure culture methods (streak plate, spread plate, pour plate, stab culture, slant culture). Anaerobic (thioglycolate, anaerobic chamber, Robertson's media, microaerophilic), liquid shake culture of aerobic bacteria. Preservation of bacterial cultures by various techniques.

Unit IV: Staining techniques

12

A general knowledge of techniques used in identification of various types of microorganisms, Staining techniques: principles, and their applications - simple staining, negative staining, differential staining, Gram and acid fast staining, flagella staining, capsule and endospore staining. Staining of yeast (methylene blue), lactophenol cotton blue, staining of mould (Penicillium, Aspergillus), Agaricus.

Unit V: Molecular diagnosis of Pathogens

12

Collection and transportation of clinical samples, Processing of samples, Molecular techniques – principles and applications of direct sequencing, polymerase chain reaction-based assays (PCR), and hybridization, DNA microarray, Phage typing in disease diagnosis.

TOTAL: 60 HOURS

TEXT BOOKS

1. General Microbiology by Robert F Boyd (1984). Times mirror/Mosby college publishers.
2. Text Book of Microbiology by Ananthanarayan R and Jayaram Paniker CK 2005. Seventh edition, Orient Longman Limited, Hyderabad.
3. A text of Microbiology by Dubey RC and Maheswari DK 2012. (Revised edition). S.Chand and Company Ltd., New Delhi.

REFERENCE BOOKS

1. Microbiology by Prescott L M, J P Harley and D A Klein 2005. Sixth edition, International edition, Mc Graw Hill.
2. Microbiology by Pelczar TR M J Chan ECS and Kreig N R, 2006. Fifth edition, Tata Mc Graw-Hill INC. New York.

HG4703	Concepts Of Human Genetics	L	T	P	C
		4	0	0	4

OBJECTIVES

It deals with basic concepts of genetics, inheritance patterns, chromosomal aberrations and inborn errors of metabolism.

Course Outcome At the end of the course, students will able to		Cognitive Skill
CO-01	Understand the basic knowledge of genetics.	U
CO-02	Develop basic knowledge in chromosomes and chromosomal aberrations.	An
CO-03	Know and understand the inheritance patterns and twin studies.	U
CO-04	Analyse and understand the details of complications of pedigree patterns.	An
CO-05	Analyse the concept of inborn errors of metabolism and its treatment process.	An

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	P O - A	PO- B	PO- C	PO- D	PO- E	PO- F	PO- G	PO- H	PO- I	PO- J	PO- K	PO- L	PO- M
CO-01	S	N	M	M	S	N	M	M	M	S	L	L	M
CO-02	M	M	M	L	S	N	M	M	M	S	M	N	M
CO-03	S	M	S	M	M	N	M	M	N	S	N	M	N
CO-04	M	N	M	L	S	N	M	M	M	S	N	L	M
CO-05	N	M	M	M	M	N	M	N	S	M	L	M	M

S-Strong, M-Medium, L-Low, N-Not relevant

Unit I: Concepts of Genetics**12**

History of Human Genetics- History and Development of Human Genetics–Genes, Structure of chromosome, Mendelism–Mendel’s principles, applications of Mendel’s principles, Extension of Mendelism. Linkage, Sutton’s view on linkage, Morgan’s view on linkage, Bateson & Punnett’s Coupling & Repulsion hypothesis. Chromosome theory of Linkage, kinds of linkage, linkage groups, Crossing over - types of Crossing over, mechanism of Meiotic Crossing over, cytological detection of Crossing over, significance of Crossing over.

Unit II: Chromosomal aberrations**12**

International system of Human Chromosome-Nomenclature, Nomenclature of aberrant karyotypes, Chromosomal variation in Number & Structure, Common syndromes due to numerical chromosomal changes, Common syndromes due to Structural chromosomal alterations, Centromeric & Non-centromeric breaks in chromosomes, Non –disjunction, Chromosomal aberrations & evolution. Chromosomal basis and non - Chromosomal basis of sex determination.

Unit III: Inheritance**12**

Inheritance patterns in Human -Monogenic traits, Autosomal inheritance–dominant, recessive, Sex–linked inheritance, Sex–limited and sex–influenced traits, Mitochondrial inheritance, MIM number, Consanguinity and its effects. Multiple gene inheritance, Unifactorial inheritance, Multi-factorial inheritance. Maternal inheritance, uniparental inheritance, human traits. Complex traits - Approaches to analysis of complex traits. Monozygotic and dizygotic twins and adoption studies.

Unit IV: Pedigree and its patterns**12**

Pedigrees– pedigree symbols, construction of pedigrees, presentation of molecular genetic data in pedigrees, Pedigree analysis –Symbols of Pedigree, Pedigrees of Sex-linked & Autosomal (dominant & recessive), Mitochondrial. Complications to the basic pedigree patterns–non penetrance, variable expressivity, pleiotropy, late onset, dominance problems, anticipation, genetic heterogeneity, genomic imprinting and uniparental disomy, mosaicism and chimerism, male lethality, X–inactivation.

Unit V: Transmission Genetics**12**

Transmission genetics -Allelic Variation & Gene function –Multiple allele, Genetic interaction, Non-allelic genetic interactions, Atavism/Reversion, Penetrance complete & incomplete, Expressivity, Pleiotropism, Modifier/Modifying genes. Evidences for Cytoplasmic factors, Cytoplasmic inheritance, Extra-nuclear inheritance, Non -chromosomal inheritance.

TOTAL: 60 HOURS

TEXT BOOKS

1. Basic human Genetics, by Mange and Mange (2nd Revised Edition), 1999. Published by Sinauer Associates, U.S.
3. Molecular and genetic analysis of human traits, by Maroni Gustavo, 2001. Published by Wiley, Malden, Blackwell Science.
4. An introduction to molecular genetics, by Jack J. Pasternack (Second Edition) 2000. Published by Wiley-Liss Blackwell Science.
5. Human Molecular genetics, by Tom Strachan (Third Edition), 2003. Published by Garland Science/Taylor & Francis Group.
6. An introduction to genetic analysis, by Griffiths and Miller (Seventh Edition) 2000. Published by W. H. Freeman.

REFERENCE BOOKS

1. Human genetics (wcb cell & molecular biology) by Lewis (12th edition), 5 October 2017. Published by McGraw-Hill Education;
2. Genes IX, by Benjamin Lewin (9th Edition) 2007. Published by Jones and Bartlett Publishers.
3. Principles of Genetics, by Snustad and Simmons, 4th Edition (2005) Published by Wiley Malden, Blackwell Science.
4. Molecular Biology of The Cell, by Alberts et al. (4th Edition), Garland 2007. Published by Garland Science, New York.

HG4704	Cell Biology And Genomes	L	T	P	C
		4	0	0	4

OBJECTIVES

The course gives the life activities at cellular and molecular level and basic functions of the various cellular compartments and organelles.

Course Outcome-COs At the end of the course, students will be able to		Cognitive skill
CO-01	Understand about basic structure of cell organelles and their functions.	U
CO-02	Acquire knowledge about cell-cell communication mechanisms and signal transduction pathways.	R
CO-03	Understand about Cell cycle and cancer.	U
CO-04	Learn about various mechanisms involved in Cell aging and cell death.	E
CO-05	Understand about Genome organization in eukaryotes and concept of genes.	An

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	S	M	S	M	M	M	S	M	L	S	S
CO-02	S	S	S	M	M	S	S	S	M	S	M	M	S
CO-03	S	S	S	S	M	M	L	M	M	M	M	M	S
CO-04	S	S	S	S	M	S	S	S	S	M	S	M	S
CO-05	S	S	S	M	M	S	M	S	M	S	M	L	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Structure of Cell and membrane transport system

12

Outline of cell architecture. Ultrastructure of plasma membrane. Structure and functions of mitochondria, chloroplast, nucleus, endoplasmic reticulum, golgi, lysosomes, ribosomes, cytoskeletal elements. Membrane transport - Membrane channels and pumps, exocytosis and endocytosis.

Unit II: Cell signaling

12

Cell -cell communication: Principles of cell communication, Cell adhesion and role of adhesion molecules, Gap junction, Extracellular matrix. cellular response to the environment, and mechanism of signal transduction. Cell surface receptors, Signalling through G-protein-coupled receptors, Signal transduction pathways, Second-messenger systems, Regulation of signalling pathways. Computer aided tools for studying cell signaling.

Unit III: Cell cycle and cancer biology

12

Cell cycle- Mitosis and meiosis, Cytological significance of Mitosis and Meiosis. Molecular events and regulation of cell cycle in eukaryotes. Check points, Cyclins and protein kinases, MPF (maturation promoting factor). Biology of cancer: characteristics of cancer cells, theories of cancer, types of cancer - carcinogenesis, oncogenes and tumor suppressor genes.

Unit IV: Cell aging and cell death

12

Cell biology of cell aging process and its significance. Properties of telomeres in cell aging. Cell necrosis and apoptosis – Molecular Mechanism. CASPASE types and molecular mechanisms, regulators and inhibitors of apoptosis. Molecular biology of Survivin and Bcl2 family members.

Unit V: Genome organization

12

Concept of gene: Conventional and modern views. Fine structure of gene, split genes, pseudogenes, coding/non-coding genes, overlapping genes and multi-gene families. Genome Organization: Genome organization in eukaryotes- chromatin structure and function, genome packaging. Structure and function of organellar genome.

TOTAL: 60 HOURS

TEXT BOOKS

1. Molecular Biology of the Cell by Alberts, Bruce et al., (4th Edition), 2002. Garland Science (Taylors Francis).
2. Cell Biology: Organelle Structure and Function by Sadava, D. 2004. Panima Publishing.
3. Cell Biology by Rastogi, S.C. (2nd Edition) 2002. New Age International.
4. Concepts of Genetics by Klug W. S. and Cummings M. R Prentice-Hall
5. Genetics- Analysis of Genes and Genomes by Hartle D. L. and Jones E. W. Jones & Bartlett (6th edition)2004.

REFERENCE BOOKS

1. Molecular Cell Biology by Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell(4thedition)2000.New York: W. H. Freeman.
2. The Cell: A Molecular Approach by Cooper, G.M. and R.E. Hansman (4th Edition), 2007. ASM Press.
3. The Cell by Gerald Karp (7th edition) 2013. Published by Wiley.

HG4705	Molecular Biology	L	T	P	C
		3	1	0	4

OBJECTIVES

It deals with basic concepts of Chromosome, genetic mechanisms and gene regulations.

Course Outcome-COs		Cognitive skill
At the end of the course, students will able to		
CO-01	Understand the genome organization.	U
CO-02	Evaluate and understand about replication.	E
CO-03	Analyse about the transcriptional process.	An
CO-04	Understand about translation.	U
CO-05	Study and Understand about gene regulation.	U

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	M	L	M	S	S	S	S	S	L	M	L	S
CO-02	S	S	S	M	M	L	S	M	L	S	S	S	S
CO-03	S	S	S	M	L	S	M	L	S	S	S	M	L
CO-04	S	S	S	M	L	S	S	S	S	S	L	M	M
CO-05	M	L	S	S	L	S	S	M	L	S	S	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Genome organization, Structure of DNA and RNA **12**

Eukaryotic and Prokaryotic genome organization: Prokaryotic Genomes - Physical organization of bacterial genomes (Structure of the bacterial nucleoid). Eukaryotic Genomes: (Structure of Chromatin, coding and non - coding sequences, satellite DNA). Chemical structure of DNA and RNA, RNA types and functions.

Unit II: Replication of DNA and DNA damage **12**

DNA- Experimental evidence of DNA as the genetic material. DNA replication and its type. Enzymology of DNA replication. DNA replication in prokaryotes and Eukaryotes. Rolling circle model of DNA replication. Types of DNA damage, DNA repair- alternation in the DNA molecule and its repair, methylation and mismatch repair, excision, recombination and SOS repair.

Unit III: Transcription in prokaryotes and eukaryotes and regulation **12**

Transcription: Prokaryotes- RNA Polymerases, Steps -initiation, elongation and termination. Rho dependent and Rho independent termination, inhibitors of transcription. Eukaryotes- RNA polymerases, structure and functions. RNA pol I, II and III, promoters, transcription factors, transcription complex assembly and mechanism of transcription, inhibitors of eukaryotic transcription.

Unit IV: Translation and Gene transfer Techniques **12**

Translation: Prokaryotic and eukaryotic translation. Post transcriptional processing of mRNA, rRNA and tRNA. Alternative splicing. Catalytic RNA (ribozymes), RNA editing, Antisense RNA. Regulation of protein synthesis-constitutive, and narrow domain regulation, Inhibition of protein synthesis. Co and post translation modification. Protein degradation: the Ubiquitine pathway. Protein folding models, molecular chaperones.

Unit V: Regulation of Gene Expression, Transposons and operon concept **12**

Regulation of gene expression: Transposons and Transposon mechanism, Molecular Mechanism of gene regulation in prokaryotes -Transcriptional regulation in prokaryotes (inducible and repressible system, positive regulation and negative regulation. Operon concept- lac, trp, arabinose operons. DNA methylation in prokaryotes-modification systems, Dam methylation. Dcm methylation. DNA methylation in eukaryotes-cytosine methylation, CpG islands. Epigenetic gene regulation by DNA methylation in mammals-role of imprinting and X-chromosome inactivation.

TOTAL: 60 HOURS

TEXT BOOKS

1. Molecular Biology of the cell. by Alberts, D., Lewis, J.Roberts, K. and Watson, J.D. 2010. Published by Garland publishers, Oxford, New York.
2. Cell biology by Celis J.E. (A laboratory handbook, Vol 1, 2, 3), 2006. Published by Academic Press, UK.
3. Cytology, Genetics and Evolution by Gupta, P.K. (2008). Published by Rastogi publications, Meerut, India.

4. Cell and Molecular Biology: Concepts and Experiments, by Karp, G. 2010. Published by John Wiley & Sons. Inc. New Delhi, India

REFERENCE BOOKS

1. Genes VII by ,Lewin. 2000. Published by Oxford University Press, USA.
2. Advanced Molecular Biology by Twyman. (2nd ed), 1998. Published by Garland Science; Oxford, New York.
3. Molecular cell biology, by Lodish et al, (4th ed) 2000. Published by *Freeman & Co.*, New York.
- 4 Molecular Cell Biology, by Stansfield et al. 1996. Published by Schaum's Outlines. McGraw Hill Education.

HG4771	Clinical Biochemistry And Physiology Laboratory	L	T	P	C
		0	0	2	2

OBJECTIVES

It deals with the important investigations of blood and other important clinical parameters.

Course Outcome-COs At the end of the course, students will able to		Cognitive skill
CO-01	Understand about the normal lipid, urea, creatinine, albumin levels.	U
CO-02	Perform the routine, microscopic examination of urine.	E
CO-03	Analyse and estimate the percentage of haemoglobin, blood grouping, Rh typing, bleeding and clotting time.	An
CO-04	Demonstrate the PCV, ESR, osmotic fragility and prothrombin time.	U
CO-05	Understand and perform the differential counting of RBC, WBC and platelets in the given blood samples.	U

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	M	L	M	S	S	S	S	S	L	M	L	S
CO-02	S	S	S	M	M	L	S	M	L	S	S	S	S
CO-03	S	S	S	M	L	S	M	L	S	S	S	M	L
CO-04	S	S	S	M	L	S	S	S	S	S	L	M	M
CO-05	M	L	S	S	L	S	S	M	L	S	S	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Practicals:

1. Estimation of triglycerides, total cholesterol, HDL and LDL
2. Estimation of serum albumin
3. Estimation of serum urea and creatinine
4. Urine analysis- routine and microscopic examination
5. Estimation of haemoglobin
6. Bleeding time and clotting time
7. Demonstration of PCV, ESR, osmotic fragility and prothrombin time
8. Total platelet count
9. Differential counting of the blood cells (WBC and RBC)
10. Testing of Liver Function Test
 - a. Bilirubin
 - b. AST
 - c. ALT
11. Renal Function Test (Urea, Uric acid, Creatinine)

TOTAL: 30 HOURS

HG4772	Techniques In Microbiology Laboratory	L	T	P	C
		0	0	2	2

OBJECTIVES

Students will learn the importance of techniques in Microbiology

Course Outcome – COs		Cognitive Skill
At the end of the course, students will able to		
CO-01	get a deep knowledge about principles of sterilization methods	R
CO-02	acquire knowledge in different staining techniques	U
CO-03	learn to prepare culture media and pure culture techniques	An
CO-04	get an idea in the concept of antibiotic sensitivity test and preservation of microbes	U
CO-05	learn about chromatography, electrophoresis and spectrophotometry	E

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	M	L	L	M	M	S	N	S	L	S	S	N
CO-02	S	M	M	L	S	L	M	N	L	S	S	N	M
CO-03	M	S	L	S	N	M	S	L	N	M	M	N	S
CO-04	S	S	M	L	S	M	L	S	S	M	N	M	S
CO-05	S	S	L	S	N	M	S	L	N	M	M	N	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Practicals:

1. Microbiology Good Laboratory Practices and Biosafety
2. Sterilization: principles & operations – Autoclave, Hot Air Oven, laminar air flow
3. Staining Techniques (Simple, Gram's staining, acid fast staining, capsule staining, Endospore staining, motility test, negative staining and lactophenol cotton blue staining).
4. Preparation of culture media (Nutrient broth, nutrient agar, enriched and selective media)
5. Pure culture techniques (Serial dilution, pour plate, spread plate and streak plate, stab culture and slant culture)
6. Anaerobic culture technique.
7. Antibiotic sensitivity test
8. Collection and transport of clinical samples
9. Preservation of bacterial cultures by various techniques
10. Molecular diagnosis of Pathogens –PCR

TOTAL: 30 HOURS**SEMESTER – II**

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	HG4706	Human Molecular Genetics	4	0	0	4
2	HG4707	Immunology and Immunogenetics	3	1	0	4
3	HG4708	Developmental and Behavioural Genetics	4	0	0	4
4	HG4709	Genetic Engineering	3	1	0	4
5	HG4710	Epigenetics	4	0	0	4
6		Assignment & Seminar	0	0	0	0
PRACTICAL						
7	HG4773	Human Molecular Genetics Lab	0	0	2	2
8	HG4774	Immunology and Immunogenetics Lab	0	0	2	2
TOTAL			18	2	4	24

HG4706	Human Molecular Genetics	L	T	P	C
		4	0	0	4

OBJECTIVES

The course objective is to develop the required skill of the students in the area of Molecular human genetics. Especially in understanding the concept of Gene Mapping, disease gene identification and Human Karyotypes.

Course Outcome – COs At the end of the course, students will able to		Cognitive Skill
CO-01	Study about Genetic mapping.	R
CO-02	Study about methods of genome mapping.	A
CO-03	Acquire knowledge about molecular pathology of gene.	U
CO-04	Acquire knowledge about Identifying Human disease genes.	E
CO-05	Deal with genetic testing and human karyotype.	An

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	S	S	S	M	M	L	N	N	S	N	S
CO-02	S	S	S	S	S	M	M	L	N	S	N	N	S
CO-03	S	S	S	S	S	M	L	M	N	S	L	L	S
CO-04	S	S	S	S	S	M	L	L	M	N	M	M	S
CO-05	S	S	S	S	S	M	M	N	N	S	N	L	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Genetic mapping

12

History of Human Genetics: Pedigrees- gathering family history; Pedigree symbols; Construction of pedigrees. Identifying recombinants and non- recombinants in pedigrees, Genetic and Physical map distances, Mapping with molecular markers, Genetic markers-PCR based genetic markers, Hybridization based genetic markers and their applications.

Unit II: Human genome mapping methods

12

Physical mapping: Restriction mapping-Fingerprint mapping and Optical mapping, Fluorescent in situ hybridisation (FISH) mapping, Sequence tagged mapping. Hybridization mapping. Mapping of genetic traits: Two-point mapping, Multipoint mapping, Homozygosity mapping, Methods of positional cloning-Chromosome walking.

Unit III: Mutation and Molecular Pathology

12

Types of mutation, Rules for nomenclature of mutations, databases of mutations, Loss of function mutations, Gain of function mutations, Mutation and instability of human genome. Molecular pathology from gene to disease, Molecular pathology of chromosomal disorders, Pathogenicity associated with repeated sequences. Slipped strand mispairing, Gene silencing approach and RNAi in treating human diseases.

Unit IV: Identifying Human disease genes**12**

Principles and various ways of identifying disease genes, Identifying the susceptibility alleles, Genetic susceptibility in complex traits- Alcoholism, cardiovascular disease, diabetes mellitus, obesity & epilepsy. Genome-wide association studies- Allele sharing methods, affected sib pair analysis. Genomic imprinting and uniparental disomy, Spontaneous mutations- Mosaicism and chimerism, Male lethality- X-inactivation, Consanguinity and its effects in the pedigree pattern.

Unit V: DNA testing and Human Karyotypes**12**

Methods of Genetic testing, Direct DNA studies and in direct DNA studies. DNA tests for identity and relationships including forensic applications. International system of Human Chromosome Nomenclature, Nomenclature of aberrant karyotypes, common syndromes due to numerical chromosomal changes, Structural alterations (translocations, duplications, deletions, microdeletions, fragile sites), Chromosomal basis and non-chromosomal basis of sex-determination.

TOTAL: 60 HOURS**TEXT BOOKS**

1. An Introduction to Molecular Human Genetics, by Pastemak, (2nd Edition), 2005 Fritzgarald,.
2. Basic Human Genetics, by Mange and Mange, (2nd Edition), 1999 Sinauer Assoc.
3. Human Genetics, by Vogel and Motulsky, (3rd Edition), 1997 Springer Verlag.
4. Human Molecular Genetics, by Strachen and Read, (3rd Edition), 2004 Garland Sci. Publishing,
5. Molecular and Genetic Analysis of Human Traits, by Maroni, (1st Edition), 2001 Wiley- Blackwell.

REFERENCE BOOKS

1. Principles of Genetics, by Gardner, Simmons and Snustad, (8th Edition) 2006.
2. Human Molecular Genetics, by Tom Strachan and Andrew, 1996. P.Read, Bios“ Scientific Pub UK.
3. Molecular Biology by Glick and Pasternack, 2003.
4. The Human Genome, by Howley and Mori, 1999 Academic Press.

HG4707	Immunology And Immunogenetics	L	T	P	C
		3	1	0	4

OBJECTIVES

The candidate will gain knowledge about the immune system and Create ability to distinguish different types of Immunoglobulin and role of HLA in transplantation and teach the background information of vaccines.

Course Outcome – COs At the end of the course, students will able to		Cognitive Skill
CO-01	Interpret the basics of immune system such as immunity, immune cells and organs.	U
CO-02	distinguish different types of immunoglobulin and illustrate various complement pathways.	R
CO-03	Assess the detailed information about the MHC and know the genetics of human blood groups.	U
CO-04	Improve the knowledge about various hypersensitive reactions and transplantation immunology.	E
CO-05	Analyze the antigen and antibody interactions and know the background information of vaccines and vaccination.	An

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	S	S	S	M	M	L	N	N	S	N	S
CO-02	S	S	S	S	S	M	M	L	N	S	N	N	S
CO-03	S	S	S	S	S	M	L	M	N	S	L	L	S
CO-04	S	S	S	S	S	M	L	L	M	N	M	M	S
CO-05	S	S	S	S	S	M	M	N	N	S	N	L	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I Immunity and Immune response

12

Historical perspective of immunology, lymphoid organs, lymphocytes. Cells of immune system, T and B cell activation and maturation, Haematopoiesis, Haematopoietic stem cells, apoptosis and necrosis. Antigens, Antibodies The molecular basis of antigen and antibody interactions. Types of immunity and immune response.

Unit II Immunoglobulins and Complement System

12

Immunoglobulin structure and functions, Organization of immunoglobulin genes, isotypes, class switching, allotypes, and idiotypes. Molecular biology of immunoglobulin biosynthesis, Immunoglobulin purification techniques, Production and applications of monoclonal antibodies, genetically engineered monoclonal antibodies. Complement system: Classical, alternate and lectin pathways.

Unit III Major Histocompatibility and Immunohematology

12

Major Histocompatibility antigens: MHC genes and products, Structure of MHC molecules, Genetics of HLA Systems, HLA typing. Genetics of Immunohematology: Genetic basis and significance of ABO and other minor blood groups in humans, Bombay blood groups, Secretors and Non-secretors, Rh System and genetic basis of D- antigens.

Unit IV Autoimmune diseases and Hypersensitivity**12**

Autoimmune diseases and application of Artificial Intelligence in autoimmune disease. Cytokines, Interleukins, Transplantation Immunology, Tumour Immunology, Immunodeficiency disorders, Immunoinformatics, Immunostimulation, Immunosuppression. Hypersensitivity reactions and types.

Unit V Immunization and Immunotechniques**12**

Immunization: Principles of vaccination, active and passive immunization. Vaccines: whole organism vaccine, synthetic peptide vaccine, multivalent subunit vaccine, anti idiotypic vaccine, designer vaccine, edible vaccine, DNA vaccine, recombinant vector vaccine. Immunotechniques -Immunoprecipitation, Immuno electrophoresis, Radioimmuno Assay, ELISA, Immunofluorescence technique.

TOTAL: 60 HOURS**TEXT BOOKS**

1. Practical Immunology, by Leslie Hudson and Frank C. Hay. 1989 Blackwell Scientific Publication. 3rd ed.
2. Manual of Clinical Laboratory Immunology, by Noel R. Rose, Herman Friedman, John L. Fahey. 1986 ASM. 3rd ed.
4. Immunogenetics, by Zaleski MB, Dubiski S, Niles EG and Cunningham RK, 1983 Pitman, Toronto.
5. Basic Immunogenetics, by Hugh Fudenberg H, Pink JRL, Wang A and Ferrera GB, 1984 Oxford University Press, NY.
6. Essential Immunogenetics, by Williamson AR and Turner MN, 1987 Blackwell Scientific Publications, London.
7. The experimental foundations of modern immunology, by Clark WR, 1991 John Wiley and Sons Inc. New York.
8. Essentials of Clinical Immunology, by Chapel H and Halbey M, 1986 ELBS.
9. Clinical Immunology, by Pravash Sen. Gupta, 2003 Oxford University Press.
10. Immunobiology, by Murphy, K., Travers, P., and M. Walport. 2008 7th- Jane way's Garland Science (Taylor and Francis).

REFERENCE BOOKS

1. Immunology, by Ivan M. Roitt, J. Brostoff and D. K. Male, 1993 Gower Medical Publishing, London.
2. Immunology, by Janis Kuby, 2008 W. H. Freeman and Company, New York.
3. Immunobiology- the immune system in health and disease, by Jane way Travers, 1997 Current Biology Ltd. London, New York. 3rd ed.
4. Encyclopedia of Immunology, by Peter J. Delves, Ivan M. Roitt, 1998 Academic Press.

HG4708	Developmental And Behavioral Genetics	L	T	P	C
		4	0	0	4

OBJECTIVES

The course objective is to develop the required skill of the students in the area of Developmental and Behavioural Genetics. Especially in understanding the concept of developmental process in Vertebrates, Drosophila and also about the genes determining the behavioural diseases.

Course Outcome – COs At the end of the course, students will able to		Cognitive Skill
CO-01	Gain Knowledge in the basic Concepts of Early Embryonic development.	U
CO-02	Familiar with the Developmental process in vertebrates.	U, An
CO-03	Understand about the Developmental and signalling pathways in Drosophila.	U
CO-04	Acquire knowledge in Genetics of Human Behaviour.	R
CO-05	Understand the genetics of Behavioural disease and disorders.	U, An

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	M	M	L	S	N	S	S	M	N	S	L	M
CO-02	S	S	M	S	S	M	N	S	L	N	S	L	S
CO-03	M	S	L	S	N	M	N	S	L	N	M	N	S
CO-04	S	M	L	L	M	M	S	N	S	L	S	S	N
CO-05	S	S	L	M	N	S	L	S	M	N	L	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Concepts of Early Embryonic development

12

Definitions and historical concepts of developmental biology, fate and commitment, cytoplasmic determinants, induction, developmental patterns – developmental dynamics of cell specification (autonomous, syncytial & conditional), potency, morphogen and morphogenetic fields, genomic equivalence, genomic imprinting, cell lineage, competence, determination and differentiation.

Unit II: Development in vertebrates

12

Fertilization, Types of cleavage, Blastulation and Gastrulation: Cell movement and formation of germ layers in Model organisms: vertebrates -Frog, Chick and Mouse. Organogenesis - Development of vertebrate nervous system, Formation of neural tube, Formation of brain regions, Axes formation and HOX genes, limb development and regeneration in vertebrates, Phenocopies and malformation, the development of structure and birth defects in humans; sex differentiation and its errors.

Unit III: Development in Drosophila

12

Pattern formation in Drosophila–Maternal effect genes, Segmentation genes and Homeotic genes function in formation of body axes, Imaginal disc development, Signaling pathways in development- Hedgehog pathway, ‘Canonical’ WNT pathway, and “non-Canonical” WNT pathway, Genetic determination of sex in Drosophila.

Unit IV: Genetics of Human Behavior**12**

Scope and importance of behavioral genetics, Classical Genetics and Molecular Foundations Chromosomes and Genes, Gene-Environment Correlations: Nature or Nurture, Twin, Adoption and Family Studies, The Influence of Genes on Behavior, Heritability. Genetics of human behavior, behavioral genetic experiments in the mouse, Behavioural genetics and affective disorders.

Unit V: Behavioral disease and disorders**12**

Cognitive study designs: Genetic and environmental manipulations, Circadian rhythms, Learning and memory. Psychopathology, Schizophrenia, Mood disorders, Anxiety disorders, Disorders of childhood Personality and personality disorders—antisocial personality disorder, criminal behavior. Cognitive disabilities, Mental retardation, Learning disorders, Communication disorders, Dementia.

TOTAL: 60 HOURS**TEXT BOOKS**

1. Molecular Biology of the cell, by Bruce Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts and P. Walter, (5th Edition), 2008, John Wiley and sons Inc.
2. Principles of Developmental biology, by Wolpert, 2002
3. Synopsis of psychiatry, by Kaplan and Sadock, 1998.

REFERENCE BOOKS

1. Developmental Biology, by Scott F. Gilbert, (8th Edition), 2006 Sinauer Associates Inc., Publishers, Sunderland, Massachusetts USA.
2. Genes, by Benjamin Lewin, (10th Edition), 2010, Jones and Bartlett Publishers, England

HG4709	Genetic Engineering	L	T	P	C
		3	1	0	4

OBJECTIVES

The objective of the course is to familiarize the students with the basic concepts of genetic engineering.

Course Outcome – COs At the end of the course, students will able to		Cognitive Skill
CO-01	Get knowledge about the enzymes used in the genetic engineering.	U
CO-02	acquire an understanding about the types of cloning vectors and their applications.	U, A
CO-03	study and understand about the methods in genetic engineering and their and the principles.	U
CO-04	apply the knowledge of genetic engineering in the construction of DNA libraries and hybridization techniques.	E
CO-05	Understand the applications of rDNA technology and genetic engineering for the therapeutic, industrial purposes	A

Mapping of Course Outcome with Programme Outcome

PO CO	PO- A	PO- B	PO- C	PO- D	PO- E	PO- F	PO- G	PO- H	PO - I	PO- J	PO- k	PO -L	PO- M
CO-01	S	S	M	L	M	S	S	M	L	M	M	S	S
CO-02	S	S	S	M	M	S	S	M	S	M	L	M	L
CO-03	M	S	S	M	S	S	S	M	L	M	L	M	M
CO-04	M	S	S	S	S	S	M	M	S	S	M	S	M
CO-05	S	S	S	M	M	S	S	M	S	M	L	M	L

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Genetic Engineering and Enzymes

12

Milestones in the development of genetic engineering, isolation of genetic materials, enzymes involved in the modification of nucleic acids, kinases, phosphatases, exo and endonucleases, restriction enzymes, types and properties of restriction enzymes, restriction analysis of genomes, restriction sites. topoisomerases, transferases.

Unit II: Cloning Vectors

12

Cloning vectors, plasmids and their properties, PBR, PUC, M13 cosmids, phasmids, shuttle vectors, yeast vectors - artificial chromosomes- BAC, YAC, viral and virus derived vectors for animal cells- SV40, Retro viral vector, adenovirus, Insect vectors - baculovirus, plant vectors- Gemini virus, Ti plasmid.

Unit III: Techniques in Genetic Engineering

12

Method in genetic engineering- western, northern and southern blotting, DNA foot printing, DNA sequencing and sequence assembly, site directed mutagenesis, shot gun sequencing, PCR- principle and applications, various types of PCR.

Unit IV: DNA library and DNA Analysis

12

DNA libraries, cDNA library, genomic library, preparation of the libraries and their application, gene cloning and expression, DNA analysis - labelling DNA and RNA probes, *insitu* hybridisation, DNA fingerprinting, chromosome walking, NGS

Unit V: Application of Genetic Engineering

12

Applications of rDNA technology, transgenic animals, vaccine development, erythropoietin synthesis, PCR based disease diagnosis, gene therapy, Gene knock out, animal pharming, CRISPR-CAS, Reverse engineering - Synthetic Biology, negative aspects of genetic engineering

TOTAL: 60 HOURS

TEXT BOOKS

1. Human Molecular Genetics 4 E (pb) by Strachan, Routledge Taylor and Francis (4th edition) 2012. Routledge Taylor and Francis group publishers.
2. Genomes by Terence. A. Brown (4th edition). 2017. Garland science publishers

3. Concept of Genetics, Global edition by William Klug, Micheal cummings, Charolette Spencer, Micheal Palladino and Darrell Killian. (12th edition). 2019. Pearson publishers.

REFERENCE BOOKS

1. Karp's cell and molecular biology by Gerald Karp, Janet Iwasa, Wallace Marshall. (9th edition) 2020, Wiley publications.
2. Lewin's Genes XII by Joycelyn. E. Krebs, Elliott. S. Goldstein and Stephen. T. Kilpatrick (12th edition) 2018, Jones and Barlett publishers.

HG4710	Epigenetics	L	T	P	C
		4	0	0	4

OBJECTIVES

Students will know the importance of epigenetics and the role of epigenetics in human gene expression and regulation.

Course Outcome – COs At the end of the course, students will able to		Cognitive Skill
CO-01	Get a deep knowledge about the history of epigenetics. They will understand the fundamentals of gene expression and regulation.	R
CO-02	Acquire knowledge about the DNA methylation and the analysis of DNA methylation. Also they will get knowledge in gene variegation, X chromosome inactivation.	U
CO-03	Study about the role of regulatory elements and the mechanism which regulates the development, differentiation etc. Also they will study about the factors influencing the epigenetic modifications.	E
CO-04	Learn the concept of epigenetics and various human disorders and how to treat the human disorders by epigenetic therapy.	An
CO-05	Obtain information about the neuronal development, evolutionary significance of epigenetics and epigenetics in drug discovery.	R

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	M	L	M	S	S	M	L	M	M	S	S
CO-02	S	S	S	M	M	S	S	M	S	M	L	M	L
CO-03	M	S	S	M	S	S	S	M	L	M	L	M	M
CO-04	M	S	S	S	S	S	M	M	S	S	M	S	M
CO-05	S	S	S	M	M	S	S	M	S	M	L	M	L

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Organization of Chromatin and Histone **12**

Introduction and brief history of epigenetics, Fundamentals of regulation of gene expression, histone code and chromatin organization – nucleosome solenoid model, Histone modifications and Histone variants and their role in gene regulation, Role of Polycomb group proteins and Trithorax group proteins.

Unit II: DNA Methylation and Epigenetic control of Gene **12**

DNA methylation and its effect on gene regulation, Mechanisms of DNA methylation, analysis of gene-specific DNA methylation, methods of assessing genome-wide DNA methylation, chromosomal position effect and gene variegation, epigenetic control of gene activity, X-chromosome inactivation.

Unit III: Regulatory elements and mechanism of regulation **12**

Role of regulatory elements - boundary elements and insulators, mechanism to regulate development, differentiation and complex diseases. Impact factors of epigenetic modifications: Diet, Metabolism, stress, Aging, memory.

Unit IV: Human disorders and Epigenetic therapy **12**

Epigenetics and human diseases: Cancer epigenetics, Cancer metabolic regulation of epigenetics metabolic diseases, brain disorders, imprinting disorders. Role of epigenetic in immune diseases and disorders. Epigenetic therapy. Non-coding RNA (ncRNA)-associated gene silencing role of epigenetics in a variety of human disorders and fatal diseases.

Unit V: Neuronal, evolutionary epigenetics and Epigenetics in drug discovery **12**

Neuronal development and function. Evolutionary significance of epigenetic modifications, transgenerational inheritance. Epigenetic programming in cell renewal and pluripotency, Epigenetics in drug discovery, Model animal systems for studying epigenetic regulation.

TOTAL: 60 HOURS

TEXT BOOKS

1. Introduction to Epigenetics by Renato Paro, Ueli Grossniklaus, Raffaella Santoro and Anton Wutz, 2021. Springer International Publishing, Nature Switzerland AG ISBN: 9783030686697.
2. Handbook of Epigenetics: The New Molecular and Medical Genetics by Trygve O. Tollenesbol, 2017, Edition 2. Academic Press, USA.

REFERENCE BOOKS

1. Epigenetics by C. David Allis, Marie-Laure Caparros, Thomas Jenuwein, Danny Reinberg, Associate editor, Monica Lachner, 2015. Edition 2 Cold Spring Harbor Laboratory Press, New York
2. The Epigenetics Revolution by Nessa Carey, 2012. Publisher: Garland Science: 1st Edition.
3. Epigenetics by Lyle Armstrong, 2014. Garland Science, 1st Edition.

HG4773	Human Molecular Genetics Laboratory	L	T	P	C
		0	0	2	2

OBJECTIVES

The course objective is to develop the required skill of the students in the area of Molecular human genetics.

Course Outcome – COs At the end of the course, students will able to		Cognitive Skill
CO-01	Understand the chromosomal abnormalities using Karyotyping.	U
CO-02	Study about the isolation of RNA, Plasmid DNA and Genomic DNA.	A
CO-03	Understand about the estimation of RNA and DNA.	An
CO-04	Acquire knowledge about Restriction Digestion and Ligation.	E
CO-05	Understand the molecular techniques such as Southern blotting and Polymerase Chain Reaction.	An

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	M	S	M	L	S	M	M	S	L	M	M	S
CO-02	S	M	M	S	L	S	M	M	M	L	M	M	S
CO-03	S	S	M	M	M	S	M	S	S	L	M	M	S
CO-04	S	S	M	S	S	S	S	S	M	M	M	L	S
CO-05	S	S	S	S	S	S	S	M	S	S	S	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Practicals

1. Karyotyping
2. Isolation of Plasmid DNA
3. Isolation of Blood genomic DNA
4. Isolation of RNA
5. Estimation of DNA
6. Estimation of RNA
7. Restriction Digestion and Ligation
8. Southern Blotting
9. Polymerase Chain Reaction

TOTAL: 30 HOURS

HG4774	Immunology And Immunogenetics Laboratory	L	T	P	C
		0	0	2	2

OBJECTIVES

The candidate will gain hands-on knowledge and acquire adequate skill required to perform immune techniques for understanding the antigen antibody interaction and its use in disease diagnosis.

Course Outcome – COs At the end of the course, students should able to		Cognitive Skill
CO-01	Identify various blood cells and types of blood groups.	An
CO-02	Develop their ability to perform qualitative and quantitative assay of Widal test.	E
CO-03	Improve their ability to perform latex agglutination ASO test.	A
CO-04	Analyse the antigen-antibody interactions demonstrated in gels and to visualize the bands.	An
CO-05	Comprehend the antigen and antibody interactions using ELISA	A

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	M	M	M	L	L	L	S	S	N	N	N	M
CO-02	S	M	N	M	L	L	L	S	S	L	L	L	S
CO-03	S	S	S	S	S	S	S	S	S	S	S	S	S
CO-04	S	S	M	M	M	L	L	M	M	M	L	L	M
CO-05	S	S	N	N	N	N	N	M	M	L	L	L	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Practicals

1. Agglutination reaction with reference to blood grouping and Rh typing.
 2. Blood smear identification of leucocytes by Giemsa stain.
 3. Widal test qualitative and quantitative assay.
 4. Latex agglutination test Anti-Streptolysin O (ASO).
 5. Examination of blood cells – Total count.
 6. Examination of blood cells – Differential count.
 7. Single radial immunodiffusion.
 8. Ouchterlony double immuno diffusion.
 9. Rocket immuno-electrophoresis.
- Detection of antigen and antibody interactions using ELISA.

TOTAL: 30 HOURS

SEMESTER III

Sl. No.	Course Code	Course Title	L	T	P	C
Theory						
1	HG4711	Bioinformatics and Pharmacogenomics	3	1	0	4
2	HG4712	Cytogenetics	3	1	0	4
3	HG47XX	Elective	3	1	0	4
4	HG4713	Clinical Genetics	3	1	0	4
5	HG4714	Genetic Counselling	3	1	0	4
Practicals						
7	HG4775	Bioinformatics and Pharmacogenomics Lab	0	0	2	2
8	HG4776	Cytogenetics Lab	0	0	2	2
Total			15	5	4	24

HG4711	Bioinformatics and Pharmacogenomics	L	T	P	C
		3	1	0	4

OBJECTIVES

It deals with basics of Biological Databases, Structure Prediction, Various Sequence analysis tools and Insilico Drug Designing.

Course Outcome – COs		Cognitive Skill
At the end of the course, students should able to		
CO-01	Gain knowledge in Biological Databases	U, A, An
CO-02	Understand about Sequence Alignment and Visualization Tools	R, U ,A
CO-03	Know about Sequence Analysis Tools	R, An
CO-04	Familiar with Protein Structure Prediction	U, A, An
CO-05	Understand about Drug Designing	U, R

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO- A	PO -B	PO- C	PO -D	PO- E	PO- F	PO -G	PO -H	PO - I	PO - J	PO- k	PO -L	PO- M
CO-01	M	S	M	L	L	N	M	N	N	L	M	S	L
CO-02	M	M	M	L	M	N	M	L	L	S	S	M	L
CO-03	M	M	M	M	M	N	M	L	N	M	S	N	N
CO-04	M	S	L	S	M	M	S	N	L	S	S	M	M
CO-05	M	S	L	S	L	N	M	L	N	S	M	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Introduction to Biological Data Bases

12

Bioinformatics - Introduction, History, Scope, Applications, Biological Databases- Primary Databases - Nucleotide sequence databases- NCBI - GenBank, EMBL, DDBJ, Protein Sequence Databases- UniProtKB, UniProt, TrEMBL, Swiss-Prot, Literature Databases- PubMed. Introduction to Secondary or Derived Databases- PDB, MMDB, SCOP, CATH, FSSP, Pathway Database - KEGG ENZYME, BRENDA; Composite Databases-NRDB, Genome Databases, ENTREZ, PUBMED.

Unit II: Sequence Alignments

12

Sequence Analysis – Basic concepts of sequence similarity, Pairwise sequence alignment – Basic concepts of sequence alignment, gap penalties, Needleman and Wunsch, Smith and Waterman algorithms for pairwise alignments, Multiple sequence Alignment, Phylogenetic Tree – Construction Methods. Methods for presenting large quantities of biological data, sequence viewers (Artemis, SeqVISTA), 3D structure viewers (Rasmol, SPDBv, Chime, Cn3D, PyMol).

Unit III: Computational Genomics

12

Computational Genomics: NGS Data formats & Pre-processing: Data formats overview – FASTQ, Subreads, Nanopore Data, Single cell data. Single-end, Paired-end, Mate-pair. NGS Data sources – NCBI SRA, EBI-ENA, DDBJ-SRA, GEO; Retrieving data from data sources - SRA toolkit; Aspera connect. Sequence quality measures – Phred quality score. Quality check – tool – FASTQC, Pre-processing: Trimmomatic, Fastx-toolkit. Assembly (overview) – principles, output file formats – contigs, scaffolds, assembly quality assessment – N50, total

length, no. of contigs/scaffolds; Mapping (overview) – Principles, tools – BWA, Bowtie, SAM tools, output file formats – BAM, SAM, mapping alignment assessment – no. of reads mapped, concordant reads; Visualisation tools – IGV.

Unit IV: Structure Prediction and Drug Design

12

Secondary structure prediction methods: GOR, Chou-Fasman, PHD, PSI- PRED, J-Pred, Protein Tertiary structure prediction methods - Homology Modeling, Fold Recognition, Abintio Method. Ramachandran plot, Structure Prediction Tools, Motif and Domain: Motif databases and analysis tools. Domain databases (CDD, SMART, ProDom) and Analysis tools. Drug Designing – Types and Applications, Active Site Identification, Lipinski's Rule of Five, Clinical Trials, Lead Identification, Optimization, High throughput Sequencing, ADMET, Drug Databases.

Unit V: Personalized Medicine

12

Pharmacodynamics and Pharmacodynamics, Pharmacogenomics – Roots of Pharmacogenomics, Genetic Drug response profiles, the effect of drugs on gene expression, Concept of Personalized Medicine, Viability and adverse drug reaction in drug response, Multiple inherited genetic factors influence the outcome of drug treatments, Benefits of Pharmacogenomics in Research and Development.

TOTAL: 60 HOURS

TEXT BOOKS

1. Advances in Bioinformatics: Vijai Singh, Ajay Kumar, 1st Edition, Springer edition, 2011.
2. Introduction to Bioinformatics: Bagchi, Narosa Publishing House, 2018
3. Pharmacogenomics An Introduction and Clinical Perspective. BY Joseph S. Bertino, Angela Kashuba, Joseph D. Ma, Uwe Fuhr, C. Lindsay DeVane. Published by McGraw Hill Publications.

REFERENCE BOOKS

1. Genetics, Genomics, Proteomics & Bioinformatics: Rajeev Tyagi and Yougesh Kumar. Published by Mangalam Publishers and Distributors Pharmacogenetics by Ian P. Hall and Munir Pir Mohamed. Taylor and Francis
2. Bioinformatics and Sequencing in Genomics by David W Mount, 2018.
3. Principles of Pharmacogenomics and Pharmacogenetics, by Russ B. Altman, David Flockhart, David B. Goldstein, 2014.

HG4712	Cytogenetics	L	T	P	C
		3	1	0	4

OBJECTIVES:

At the end of the course the student will understand Chromosome Structure and Function, Explore the chromosomal basis of genetic disorders and Study chromosomal changes associated with cancers.

Course Outcome – COs At the end of the course, students should able to		Cognitive Skill
CO-01	Gain knowledge in human cytogenetics and human diseases	U, A, An
CO-02	Understand about Diagnose and interpret pathology of human chromosomes	R, U ,A
CO-03	Demonstrate a professional knowledge of the cytogenetic disorders and clinical diagnosis.	R, An
CO-04	To understand the human karyotype in normal and diseased patients.	U, A, An
CO-05	Understand about the mechanism of cancer progression and its genetic influence	U, R

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	M	S	M	L	L	N	M	N	N	L	M	S	L
CO-02	M	M	M	L	M	N	M	L	L	S	S	M	L
CO-03	M	M	M	M	M	N	M	L	N	M	S	N	N
CO-04	M	S	L	S	M	M	S	N	L	S	S	M	M
CO-05	M	S	L	S	L	N	M	L	N	S	M	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit 1: History of Human Cytogenetics

12

History of Human Cytogenetics, Denver conference (1940), Denver Conference (1960), Chicago conference (1966), Paris conference (1971). Marker chromosome, Derivative chromosome, Ring chromosome, isochromosome, Pseudodicentric chromosome.

Unit II: Chromosomal Analysis **12**

Peripheral blood cultures; banding techniques: G, Q, C and R band identification of 23 pairs of human chromosomes by band position. Molecular Cytogenetics: Fluorescent In-situ Hybridization –Types of FISH probes. Spectral Karyotyping, Multicolor FISH, Applications of FISH: Structural Abnormalities, Microdeletion Syndromes, Interphase FISH for Prenatal Diagnosis of Common Aneuploidies. Preimplantation FISH Diagnosis of Aneuploidies. Molecular Approaches for Delineating Marker Chromosomes

Unit III: Prenatal Diagnosis **12**

Prenatal diagnosis: Chorionic villi sampling, foetoscopy, ultrascopy, amniocentesis. Postnatal diagnosis: Peripheral blood leucocyte culture, Sister chromatid exchange, fragile site, Mitotic index, Genetic Counseling. Mosaicism, PGD, Neonatal diagnostics

Unit IV: Cytogenetic Reporting and Disorders **12**

Standard cytogenetic reports: Components of standard cytogenetic report, Prenatal normal results, Neonatal normal results. ISCN rule and reporting of chromosome. Autosomal trisomies: 21, 13, 18; Trisomy Mosaic: 21, 8, 9, 20, 22. Translocations: Robertsonian translocation.

Unit V: Cancer Cytogenetics **12**

Oncogenes and cancer. Cytogenetic abnormalities in myeloid and lymphoid disorder. Cytogenetic abnormalities in solid tumors. Chromosomal microarray for tumors. Molecular Tests and gene panel sequencing.

TOTAL: 60 HOURS

TEXT BOOKS

1. DP Snustad and MJ Simmons, Principles of Genetics, John Willey & Sons Publication, 6th Edition, 2012.
2. Human Genetics 5th Edition, By Gangane, 2017
3. Principles Of Genetics 8th Edition by Gardner

REFERENCE BOOKS

1. Albertset *al.*, Molecular Biology of the Cell 2nd Edition, Garland, 2007.
2. Snustad and Simmons, Principles of Genetics, 4th Edition, Wiley, 2005.
3. Lewin, Genes IX, 9th Edition Jons and Bartlett, 2007.
4. Textbook of Human Genetics: The Yale journal of biology and medicine 45(5), Sep, 1972.

HG4713	Clinical Genetics	L	T	P	C
		3	1	0	4

OBJECTIVE

At the end of the course the student will developed knowledge in genetic disorders

Course Outcome – COs At the end of the course, students should able to		Cognitive Skill
CO1	Strategies in this program encompass genetic basis of diseases.	U
CO2	Understand the muscle, metabolic disorders and their genetic basis	An, U
CO3	Facilitate the understanding of multiple genetic disorders.	U
CO4	Develop knowledge about Clinical genetics in Gynaecology and cancer,	U
CO5	Understand how genetic techniques can be, used to treat human illness: strategies, advantages, and hurdles to overcome to realize its potential.	U, E

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	P O-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	M	M	M	L	N	M	N	N	S	M	M	S
CO-02	M	S	M	L	M	N	M	N	L	S	S	M	S
CO-03	M	S	M	M	S	N	M	N	L	M	S	M	S
CO-04	S	M	M	S	S	S	S	L	L	S	S	M	S
CO-05	S	S	M	S	L	L	M	N	N	M	S	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit 1: Genetic basis of disease and syndromes **12**

An overview of the genetic basis of syndromes and disorders. Monogenic diseases with well-known molecular pathology - Cystic fibrosis, Tay-Sachs syndrome, Marfan syndrome. Multifactorial diseases- Hyperlipidemia, Atherosclerosis-. Diabetes mellitus. Mitochondrial dysfunction and syndrome- MELAS, LOHN.

Unit II: Inborn errors of Metabolism and muscle disorder **12**

Inborn errors of Metabolism and their genetic basis –Phenylketonuria, Maple Syrup urine syndrome, Mucopolysaccharidosis, Galactosemia. Disorders of muscle-Dystrophies (Duchenne Muscular dystrophy and Becker Muscular Dystrophy), Myotonias, Myopathies .

Unit III: Disorders of Haematopoietic systems eye and skin disorders **12**

Disorders of Haematopoietic systems - -Sickle cell anemia, Thalassemias, Hemophilias. Disorders of eye-. Retinitis pigmentosa,. Cataract, Glaucoma, Diabetic retinopathy, Colour blindness. Bone disorders –Osteogenesis imperfecta, Rheumatoid arthritis. Skin disorder - Albinism. Neurogenetic disorders -Alzheimer's disease. Parkinson's Disease.

Unit IV: Clinical genetics in Gynaecology and cancer **12**

Genetic aspects of pregnancy failure and male and infertility recurrent miscarriages and stillbirths; disorders of sex development (DSD); transgenderism, Cancer: types, somatic and germline mutation, oncogenes, tumor suppressor genes, leukemia, Familial cancer.

Unit V: Diagnostic and Treatment of Genetic Disease **12**

Molecular diagnostics in disease diagnostics-Biomarkers-types, PCR, Real time PCR, fragment analysis, MLPA, Sanger sequencing, NGS, Microarray. Conventional Approaches to Treatment of Genetic Disease, Therapeutic Applications of Recombinant DNA Technology, Gene therapy -classification and types, safety concerns in clinical applications.

TOTAL: 60 HOURS

TEXT BOOKS

1. Handbook of Clinical Adult Genetics and Genomics: A Practice-Based Approach, Shweta U. Dhar, Sandesh C.S. Nagamani, Tanya N. Eble, 1st edition, Elsevier, 2020.
2. New Clinical Genetics, Andrew P. Read, Dian Donna, 4th edition, Scion Publisher, 2020.

3. Genetics and Genomics in Medicine, Tom Strachan, Andrew Read, Rebecca F. Wilson, Garland Science, 2014.
4. Inborn Errors of Metabolism: From Neonatal Screening to Metabolic Pathways, Brendan Lee, Sandesh Nagamani, Oxford University Press, 2014.
5. Hematology: Basic Principles and Practice, Ronald Hoffman, Edward J. Benz Jr., Leslie E. Silberstein, Helen Heslop, 7th edition, Elsevier, 2017.
6. Ophthalmic Genetics, Elias I. Traboulsi, Oxford University Press, 2012.
7. Clinical Gynecologic Oncology, Philip J. DiSaia, William T. Creasman, 9th edition, Elsevier, 2017.
8. Principles of Cancer Genetics, Fred Bunz, Springer, 2016.
9. Molecular Diagnostics: Techniques and Applications for the Clinical Laboratory, William B. Coleman, Gregory J. Tsongalis, 3rd edition, Elsevier, 2016.

REFERENCE BOOKS

1. Clinical Genetics and Genomics (Oxford Desk Reference Series), Helen V. Firth, Jane A. Hurst, 2nd edition, Oxford University Press, 2017.
2. Medical Genetics, Jorde, Carey, Bamshad, 5th edition, Elsevier, 2015.
3. Human Genetics and Genomics, Bruce R. Korf, Mira B. Irons, 4th edition, Wiley-Blackwell, 2013.
4. Principles and Practice of Medical Genetics and Genomics, Reed E. Pyeritz, Bruce R. Korf, Wayne W. Grody, 7th edition, Elsevier, 2018.

HG4714	Genetic Counselling	L	T	P	C
		3	1	0	4

OBJECTIVES

At the end of the course the student will develop deep knowledge in genetic disorders and mastered pedigree construction, analysis and risk calculation Intensive practical knowledge of Genetic Counseling.

Course Outcome – COs At the end of the course, students should able to		Cognitive Skill
CO1	Strategies in this program encompass Genetic Counselling approaches	U
CO2	Understand the Individual and Group counseling approaches.	An

CO3	Understand the process of genetic counselling to make genetic disease a curable one.	U,E
CO4	Understand the psychological aspects of counselling and the problems to be faced in genetic counselling.	U
CO5	Understand how genetic techniques can be, used to treat human illness: strategies, advantages, and hurdles to overcome to realize its potential.	U, E

Mapping of Course Outcome with Programme Outcome

PO CO	PO- A	PO- B	PO- C	PO- D	PO- E	PO- F	PO- G	PO- H	PO - I	PO- J	PO- k	PO -L	PO- M
CO-01	S	M	S	M	L	S	M	M	S	L	M	M	S
CO-02	S	M	M	S	L	S	M	M	M	L	M	M	S
CO-03	S	S	M	M	M	S	M	S	S	L	M	M	S
CO-04	S	S	M	S	S	S	S	S	M	M	M	L	S
CO-05	S	S	S	S	S	S	S	M	S	S	S	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit 1: Genetic Counseling

12

Genetic Counseling: Introduction; Historical over view, types and scope. Counselor: Definition, Role, Qualities and responsibilities; Consultant- Definition, needs, Rights. Registries for Genetic Counseling: Registries and support groups for rare medical disorders. Ethical concerns in genetic counseling: Ethical issues in testing of minors; Prenatal diagnosis in late onset disorders; Ethical, legal and social issues (ELSI). Patient consent, privacy and genetic data protection.

Unit II: Individual and Group counseling

12

Individual counseling: Definition, objectives, important issues in genetic counseling, Counselor's background, cultural knowledge, health benefits, family issues, building rapport, empathy in family. Group counseling: Definition, objectives, types of groups, theoretically oriented group counseling; Behavioral counseling; Transactional counseling; Group crisis intervention. Family counseling – Definition, objectives, family counseling theories and psychoanalytical therapies.

Unit III: Process of Genetic Counseling **12**

Process of Genetic Counseling: Information gathering, Pedigree construction, medical evaluation, Physical examination and investigations. Medico legal case - Diagnosis based on medical history (Past medical, social and family history); Principles of predictive counseling and testing in late onset disorders imparting results of predictive testing; Counseling and management in follow up sessions Reproductive risk assessments: Reproductive failures; consanguinity; endogamous marriages and its impact on genetic disorders.

Unit IV: Psychological aspects of counseling **12**

Psychological aspects of counseling: assessments – Communication, discussion of options. Psychological aspects of counseling: Role of social workers; Nutritional; occupational; Physical; Speech therapist; Psychologists and school professional in genetic counseling. Educating the consultant; Presenting the Risks, Options and Guiding; Diagnostics problems in Genetic counseling; Indications for genetic counseling and genetic counseling case management

Unit V: Antenatal, Prenatal, Peri-conceptual Counseling **12**

Counseling for common congenital anomalies, fetal ultrasonography Prenatal Counseling- Biochemical screening – timing, methods, result interpretation. Counseling regarding various prenatal diagnosis techniques, risks associated with invasive procedures, interpretation of laboratory results and their limitations. Peri-conceptual Counseling -Counseling recurrent pregnancy loss, pre – marital counseling.

TOTAL: 60 HOURS

TEXT BOOKS

1. Family communication about genetics: theory and practice, Clara L. Gaffand Carma L. Bylund, 2010.
2. Harper, Practical Genetic Counseling, Arnold, 2001.

REFERENCE BOOK

1. Doing a literature review in health and social care: a practical guide, Helen Aveyard, 2014.
2. Facilitating the genetic counseling process: practice-based skills. Patricia Mc Carthy Veach, Bonnie S. LeRoy and Nancy P. Callanan, 2018
3. Foundations of perinatal genetic counseling: a guide for counselors, Amber Mathiesen and Kali Roy, 2018.
4. Gardner and Sutherland's chromosome abnormalities and genetic counselling, R.J. McKinlay Gardner and David J. Amor, 2018.

HG4775	Bioinformatics and Pharmacogenomics Laboratory	L	T	P	C
		0	0	2	2

OBJECTIVE:

It deals with basics of Biological Databases, Structure Prediction and Various Sequence analysis tools

Course Outcome – COs		Cognitive Skill
At the end of the course, students should able to		
CO-01	Gain knowledge in Biological Databases	U, A, An
CO-02	Understand about Sequence Analysis and visualization Tools	R, U ,A
CO-03	Know about Primer Designing and Genome Annotation	R, An
CO-04	Familiar with Protein Structure Prediction tools.	U, A, An
CO-05	Understand about Gene Prediction tools.	A, R

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	M	S	M	L	L	N	M	N	N	L	M	S	L
CO-02	M	M	M	L	M	N	M	L	L	S	S	M	L
CO-03	M	M	M	M	M	N	M	L	N	M	S	N	N
CO-04	M	S	L	S	M	M	S	N	L	S	S	M	M
CO-05	M	S	L	S	L	N	M	L	N	S	M	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Practicals:

1. Biological Databases and how they are organized and accessed.
2. Sequence similarity searching

3. Multiple Sequence Alignment and Phylogenetic Analysis
4. Estimating protein secondary structure and physical attributes.
5. Molecular modelling and visualization.
6. Retrieving Gene information from TAIR Database
7. Finding ORF of a given Sequence
8. Finding active sites of a given protein molecule.
9. Retrieving details of a Drug Molecule
10. Finding Drug Receptor Interactions
11. Predict Toxicity of a given Molecule.
12. Primer designing
13. Genome Annotation

TOTAL: 30 HOURS

HG4776	Cytogenetics Laboratory	L	T	P	C
		0	0	2	2

OBJECTIVES

At the end of the course, the student will learn techniques in cytogenetics and solve problems on mendelian genetics and its deviation. Students will prepare and analyze the karyotype of normal and syndromic individual.

Course Outcome – COs		Cognitive Skill
At the end of the course, students should able to		
CO1	Conduct the experimental methods of cell culture.	An, E
CO2	Develop deep knowledge in Chromosomal structure and the number of chromosomes using microscopic analysis.	A
CO3	Discuss clinical cases with pathological karyotypes.	An
CO4	Know about linkage analysis.	U,E
CO5	Understand the crossing over mechanisms.	U.E

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO- A	PO -B	PO- C	PO -D	PO- E	PO- F	PO -G	PO -H	PO -I	PO -J	PO- k	PO -L	PO -M
CO-01	S	M	M	M	L	N	M	N	N	S	M	M	S
CO-02	M	S	M	L	M	N	M	N	L	S	S	M	S
CO-03	M	S	M	M	S	N	M	N	L	M	S	M	S
CO-04	S	M	M	S	S	S	S	L	L	S	S	M	S
CO-05	S	S	M	S	L	L	M	N	N	M	S	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Practicals:

1. Cell Culture – Media preparation
2. Cell Counting using hemocytometer
3. Cell viability by Dye exclusion method
4. Peripheral blood lymphocyte culture – G Banding
5. Culturing of *Drosophila melanogaster* & Observation of Polytene Chromosome
6. Study of stages of meiotic and mitosis chromosomes
7. Mitotic index
8. Barr Body identification
9. Karyotype analysis
10. Sister Chromatid exchange analysis from peripheral blood

TOTAL: 30 HOURS

SEMESTER IV

Sl. No.	Course Code	Course Title	L	T	P	C
THEORY						
1	HG47XX	Elective	3	1	0	4
PRACTICALS						
2	HG47P1	Project	0	0	10	10
3	HG47P2	Hospital and Industrial Visits/Summer Internship	0	0	2	2
4	HG47G1	Publication / Presentation/ Five days Workshop	0	0	2	2
Total			3	1	14	18

HG47P1	Project	L	T	P	C
		0	0	10	10

OBJECTIVES:

To adhere the appropriate project work to the discipline at all times and to adopt safe working practices relevant to the field of research.

Course Outcome At the end of the course, students will able to		Cognitive Skill
CO-01	Formulate a scientific question	U,A
CO-02	Present scientific approach to solve the problem	An, A
CO-03	Interpret, discuss and communicate scientific results in written form.	U,A
CO-04	Gain experience in writing a scientific proposal	An
CO-05	Learn how to present and explain their research findings to the audience effectively.	An.A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO -A	PO -B	PO- C	PO -D	PO- E	PO -F	PO- G	PO -H	PO-I	PO- J	PO- K	PO -L	PO-M
CO-01	S	S	S	M	L	M	M	M	S	M	L	S	S
CO-02	S	S	M	M	M	S	S	S	M	S	M	M	S
CO-03	S	S	M	S	M	M	L	M	M	M	M	M	S
CO-04	S	S	S	S	M	S	S	S	S	M	S	M	S
CO-05	S	S	S	M	S	S	M	S	M	S	M	L	M

S-Strong, M-Medium, L-Low ,N-Not relevant

PROJECT GUIDELINES FOR REVIEW AND EVALUATION

To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same. To train the students in preparing project reports, to face reviews and viva voce examination. The students in a group of 3 to 4 work on a topic approved by the head of the department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. Project work should be presented at a national or international conference. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

HG47P2	Hospital and Industrial Visits/Summer Internship	L	T	P	C
		0	0	2	2

OBJECTIVES:

To allow young academic talent to be associated with the scientific works of Human Genetics Laboratory

Course Outcome At the end of the course, students will able to		Cognitive Skill
CO-01	Gain hands-on experience in clinical and industrial settings related to Human Genetics.	U, A
CO-02	Understand the application of genetic principles in diagnostics and therapeutic interventions.	U, A
CO-03	Develop the ability to document and present professional activities.	U, A
CO-04	Enhance understanding of professional roles and ethical issues in healthcare and biotechnology industries.	An
CO-05	Develop teamwork and communication skills in professional environments.	U, A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L	PO-M
CO-01	S	M	S	S	S	S	S	M	S	S	S	M	S
CO-02	S	S	S	S	S	M	S	M	S	M	M	S	M
CO-03	S	S	M	S	M	M	M	S	S	M	M	M	S
CO-04	S	S	M	S	S	S	S	M	M	S	S	S	S
CO-05	S	M	M	S	M	S	M	S	S	M	M	M	S

S-Strong, M-Medium , L-Low, N-Not relevant

GUIDELINES

- ❖ Internships are mandatory
- ❖ Duration: 15 days (During 4th semester)
- ❖ Maintenance of records by students: Every student shall maintain records of the attendance and the report of the work they do in different areas in forensic science. This should be certified by the head of the institutions or his/her nominee where the students is undergoing internship.
- ❖ Leave: Candidates should have an attendance of at least 90% during the internship period.
- ❖ Grading and evaluation of students: All internees will be assessed based on their attendance and the viva conducted by the examiner during the submission of internship report.
- ❖ Certification: The institutes will award a certificate after successful completion of the internship.
- ❖ The university shall award the degree only after the successful completion of internship.

HG37G1	Publication / Presentation/ Five days Workshop	L	T	P	C
		0	0	2	2

OBJECTIVES:

Encourage students to engage in independent and collaborative research. Develop the ability to critically analyze and synthesize scientific literature. Train students to present their research findings clearly and effectively.

Course Outcome		Cognitive Skill
At the end of the course, students will able to		
CO-01	Develop skills to critically analyze scientific literature.	U,A
CO-02	Write and publish scientific research papers following standard academic protocols	An, A
CO-03	Present research findings effectively in conferences and workshops.	U,A
CO-04	Gain exposure to current research trends and technologies in Human Genetics through workshops.	An
CO-05	Engage in academic discourse and enhance communication skills	An.A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L	PO-M
CO-01	S	M	S	S	L	M	M	S	S	S	M	M	S
CO-02	S	S	S	S	S	M	S	M	S	S	M	S	M
CO-03	S	S	M	S	M	M	M	S	S	M	M	M	S
CO-04	S	S	M	S	M	S	S	M	M	S	S	S	S
CO-05	S	S	S	S	M	M	S	S	S	S	M	S	S

S-Strong, M-Medium , L-Low, N-Not relevant

GUIDELINES FOR PAPER PUBLICATION:

Must be relevant to the student's field of study. Should address a current issue, problem, or gap in the existing literature. Use established scientific methods. Properly document research procedures and outcomes. Follow the standard academic format (Abstract, Introduction, Methods, Results, Discussion, Conclusion, References). Use appropriate citation and referencing styles (APA, IEEE, etc. Ensure the manuscript is plagiarism-free and properly edited. Publish in peer-reviewed national or international journals.

GUIDELINES FOR PAPER PRESENTATION:

The presentation should be based on original research or review work. Ensure the topic is aligned with the field of study and contributes to ongoing academic discourse. Prepare the presentation in a structured format: Title, Introduction, Methodology, Results, Discussion, Conclusion, Reference. Use visual aids such as PowerPoint, posters, or infographics to support the presentation. Present at national or international conferences, seminars, or symposiums. Attend and participate in Q&A sessions and discussions.

GUIDELINES FOR WORKSHOP:

Attend a five-day workshop on advanced topics in Human Genetics and actively participate in discussions. Networking with faculty, researchers, and your peers is highly encouraged, as it can facilitate valuable professional connections.

ELECTIVE PAPERS

HG47A1	Bioethics and Biosafety	L	T	P	C
		3	1	0	4

OBJECTIVES:

To adhere the ethical practices appropriate to the discipline at all times and to adopt safe working practices relevant to the bio industries and field of research.

Course Outcome At the end of the course, Students can able to		Cognitive Skill
CO-01	Understand the Bioethics, Biosafety and Intellectual Property Rights.	U
CO-02	Interpret the Intellectual Property Rights to take measure for the protecting their ideas.	U
CO-03	Analyze the devise business strategies by taking account of Intellectual Property Rights.	An
CO-04	Evaluate to assists in technology upgradation and enhancing competitiveness.	E
CO-05	Create the more advanced insights into regulatory affairs.	S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Program Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	M	S	S	M	M	M	S	M	M	M	S	M
CO-02	S	M	M	S	M	M	M	M	S	M	S	M	S
CO-03	S	S	S	S	S	M	M	S	M	S	S	M	M
CO-04	S	S	S	S	S	S	S	S	M	M	S	S	M
CO-05	S	M	M	S	S	S	S	S	S	M	M	M	L

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit: I Introduction to Bioethics

12

Introduction to bioethics. Definition of biosafety. Biosafety for human health and environment. Social and ethical issue. Special procedure for rDNA based products, transgenic plants and animals.

Unit: II Human and Animal Ethics

12

Human ethics – underlying ethical principles, General regulatory oversight, ethical and regulatory debate, ethics in human research, the Nuremberg code, common rules. Animal

ethics - CPCSEA guidelines for laboratory animal facility - Goal, Animal procurement, Quarantine, Sterilization, Surveillance, Animal care and technical personnel, Multiple surgical procedures on single animal, Duration of experiments, Dose fixation, facilities, Environment, Animal husbandry, Activity, Food, Bedding, Water, Sanitation and cleanliness, Assessing the effectiveness of sanitation, Waste disposal, Pest control, Emergency measures.

Unit: III Regulatory affairs

12

Regulatory affairs: regulation, national and international guidelines of biosafety, rDNA guidelines, regulatory requirements for drugs and biological Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP). Types of biosafety containment.

Unit: IV Biosafety

12

Introduction to biosafety. Concepts, symbols and significance in experimental biological sciences. Levels of Biosafety (BSL-1to3) for Specific microorganisms. Biological Safety Cabinets. Introduction to the concept of Good Laboratory Practices (GLP).

Unit: V Intellectual Property Rights

12

Intellectual Property Rights: Intellectual property rights and protection, patents and methods of application of patents, Trade secrets, copyrights, Trademarks, legal implication, farmer's rights, International and National conventions on biotechnology and microbiology areas, WTO guidelines.

TOTAL: 60 HOURS

TEXT BOOKS

1. Mike, Martin and Roland Schinzinger, Ethics in Engineering, McGraw-Hill, New York, 1996.
2. Govindarajan M, Natarajan S, Senthil Kumar. V.S, Engineering Ethics, Prentice Hall of India, New Delhi, 2004.
3. Byers K.B. and Wooley D.P, Biological safety: Principles and practices. 5th Edition, ASM books, 2017.
4. Sateesh M.K, Bioethics and Biosafety. I K International Publishing, 2013.
5. Goel and Parashar, IPR Biosafety and Bioethics. 1st edition. Pearson Education India, 2013.

REFERENCE BOOKS

1. Sasson A, Biotechnologies and Developing countries present and future, UNESCO Publishers, 1993.
2. Sasson A, Biotechnologies and Development countries, UNESCO Publication, 1998.
3. Edmund G Seebauer and Robert L Barry, Fundamentals of Ethics for Scientists and Engineers, Oxford University Press, Oxford, Singh K, Intellectual Property Rights on Biotechnology, BCIL, New Delhi, 2001.

HG47A2	Forensic Biology	L	T	P	C
		3	0	0	3

OBJECTIVES

At the end of the course the student will develop deep knowledge in the application of biology to prove a suspect at crime scene, identify illegal products from crime scene, solve crimes by matching crime scene evidence to suspects.

Course Outcome – COs		Cognitive Skill
At the end of the course, students should be able to		
CO1	Know about the Forensic botany	U
CO2	Know about various techniques for Forensic serology	An
CO3	Learn about the Forensic anthropology	U,E
CO4	Study about the Forensic Dermatoglyphics	U
CO5	Understand about Wild life Forensics and Forensic entomology.	U, E

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	M	S	M	S	S	S	M	S	S	M	S	S
CO-02	S	S	M	S	L	S	M	M	M	L	M	M	S
CO-03	S	N	S	M	M	N	M	S	S	S	S	M	S
CO-04	S	S	M	S	S	S	S	S	M	M	M	L	S
CO-05	S	S	S	S	S	S	S	M	S	S	S	L	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit 1: Forensic Botany **12**

Forensic Botany: Introduction, historical development, botanical evidence encounter in forensic investigation: Wood and leaves, Forensic Palynology: Forensic analysis of pollen grains, algae. Investigation of ornamental, imported, stolen, endangered plants. Forensic Limnology: collection, examination, comparison and identification of diatoms. Plant based drugs- plants as evidence, Common poisonous plant.

Unit II: Forensic serology **12**

Collection, packaging and preservation of blood stains. Examination of blood stains: Presumptive tests Benzidine test, Phenolphthalein test, Leucomalachite test, Tetra-Methylbenzidine test and O-Tolidine, Luminol test. Confirmatory tests- Haemochromogen test, Haematin test and Haemin test. Blood stain pattern identification and analysis. Types of blood spatter.

Unit III: Forensic anthropology **12**

Scope of forensic anthropology. Study of human skeleton. Nature, formation, and identification of human bones. Determination of age, sex, stature from skeletal material Somatoscopy Somatometry. Identification of the recently dead and decomposed bodies. Laboratory analysis of skeletal and decomposing remains; maceration, skeletal analysis. Role of Forensic Anthropology in Mass disasters.

Unit IV: Forensic Dermatoglyphics **12**

Principle of Fingerprint Identification, Friction Ridge Skin. Types of fingerprints found at the scene of crime, Classification of Fingerprints for Comparison purposes: Pattern area, Core, Delta, Type lines, ridge characteristics, Fingerprint Pattern types. Fingerprint Analysis and record of Fingerprints. Automated Fingerprint Identification System. Friction ridge identification process: Analysis, Comparison, Evaluation and verification

Unit V: Wild life forensics and Forensic Entomology **12**

Wildlife Forensics - Importance of wildlife and Environment; Types of wildlife crimes, Recovering evidence at poaching scenes, locating the burial: Wild animals as pharmacopeias, Wildlife artifacts (Bones, skin, fur, hair, nails, blood, feather, etc.), Trade in wild animals. Forensic Entomology – collecting insects at the scene of crime, classification of insects, rearing insects' calculation of PMI, other Forensic use and case study

TOTAL: 60 HOURS

TEXT BOOKS

1. "Forensic Botany: Principles and Applications to Criminal Cas ework", Heather Miller Coyle CRC Press, Boca Raton, 2004.
2. "Forensic Entomology: The Utility of Arthropods in Legal Investigations", Jason H. Byrd, James L. Castner CRC Press, Boca Raton, 2nd Edition, 2009.
3. Quantitative-Qualitative Friction Ridge Analysis, D.A. Ashbaugh, CRC Press, BocaRaton,.
4. Fingerprints and other Ridge SkinImpressions, C. Champod, C. Lennard, P. Margot an M. Stoilovic, CRC Press, Boca Raton, 2004.
5. Advances in Fingerprint Technology, Leeand Gaensleen's, 3rdEdition, R.S.Ramotosk CRC Press, BocaRaton, 2013.

REFERENCE BOOKS

1. "Forensic Biology", Richard Li CRC Press, Boca Raton, 2nd Edition 2015.
2. Serology and DNA typing in, Introduction to Forensic Sciences G.T. Duncan and M.I. Tracey, 2nd Edition, W.G. Eckert (Ed.), CRC Press, Boca Raton ,1997.
3. Forensic Science in Wildlife Investigations - Adrian Linacre Taylor and Francis, 2009
4. Introduction to Forensic Anthropology, Steven N. Byers, Pearson/Allyn and Bacon, 2011.
5. Forensic Anthropology: Current Methods and Practice, Angi M. Christensen, Nicholas V. Passalacqua and Eric J. Bartelink, Academic Press, USA, 2014.

HG47A3	Research Methodology, Biostatistics and IPR	L	T	P	C
		3	1	0	4

OBJECTIVES:

To provide knowledge about tools and techniques related with scientific communication and research methodology. To give students a brief knowledge about the various methods of organization of statistical data and its presentation. To provide knowledge on the principles of Intellectual property rights.

Course Outcome – COs		Cognitive Skill
At the end of the course, students should able to		
CO-01	Understand the methodologies of scientific research and acquiring the skills of scientific reading, writing and presentations.	U, A, An
CO-02	Analyze the tools and techniques related with scientific communication and research methodology.	R, U ,An

CO-03	Understand the basics of biostatistics such as tabulation, graphical and diagrammatic representation.	U,R, An
CO-04	Calculate and interpret measures of central tendency, correlation, regression, hypothesis and ANOVA.	U, A, An
CO-05	Understand and apply the knowledge on the principles of IPR and their types.	U, R,A

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO- A	PO -B	PO- C	PO -D	PO- E	PO- F	PO -G	PO -H	PO - I	PO - J	PO- k	PO -L	PO- M
CO-01	S	S	M	L	L	L	M	N	L	S	S	S	S
CO-02	M	S	M	M	M	L	S	N	M	S	S	M	S
CO-03	S	S	M	M	M	L	M	L	L	M	M	S	S
CO-04	S	S	M	S	M	M	S	L	M	S	S	M	S
CO-05	S	S	L	M	L	M	M	L	L	S	S	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Research methodology

12

Research – definition, objective, types and importance of research, research methods in sciences, research process, literature survey, scientific databases and search engines. Research report writing. Empirical science, scientific method, manipulative experiments and controls, deductive and inductive reasoning, descriptive science, reductionist vs holistic biology, computing skills for scientific research.

Unit II: Scientific communication

12

Technical writing skills - types of reports, layout of a formal report, scientific writing skills - importance of communicating science, problems while writing a scientific document, plagiarism- software for plagiarism, scientific publication writing, publishing scientific papers - peer review process and problems, recent developments such as open access and non

blind review, characteristics of effective technical communication, scientific presentations, ethical clearance, scientific misconduct.

Unit III: Biostatistics

12

Definition, scope of biostatistics, population and sample, classification and tabulation of data, graphical and diagrammatic representation - scale diagram, histograms, pie diagrams, line diagram, bar diagram, pictogram, cartogram, frequency polygon, frequency curves, sampling – probability, non – probability and random probability.

Unit IV: Statistical Analysis

12

Measures of central tendency – mean, median, mode, standard deviation, standard error, correlation – types and calculation, regression – basics. Hypothesis - test of hypotheses and its limitations, types. Chi square test, small and large sample testing. ANOVA – one way and two ways, Use of statistical software- SPSS, SAS and Stata.

Unit V: Intellectual Property Rights and Issues

12

Intellectual property rights types - patents, trademarks, copyright & related rights, industrial design, importance of IPR, legal protection of bioscience discoveries (patentable and non patentable). Procedure for filing Indian, International and US patent. Application of artificial intelligence in intellectual property rights.

TOTAL : 60 HOURS

TEXT BOOKS:

1. Introductory Biostatistics, by Lee T, Wiley – Interscience Publishers, 2007.
2. Statistical methods, by Stephen W Looney, Humana publications, 2002.
3. Fundamentals of Biostatistics, by Khan and Khanum, Ukaaz Publications, 2004.
4. Research Methodology: Methods and Techniques, by Kothari CR and Garg G, New Age International Publishers, ISBN: 978-9386649225, 4th Edition, 2019.
5. Research Methodology for Biological Science, by Gurumani N, MJP Publishers, Chennai, 2006.
6. Intellectual Property Rights: Protection and Management, by Nithyananda. K. V. Publisher Cengage Learning India Pvt. Ltd. 2019.

REFERENCE BOOKS:

1. Biostatistics - A Methodology for the Health Sciences, by Gerald Van belle, Wiley – Interscience publication, 2nd Edition, 1903.
2. Biostatistics- A foundation for health Sciences, by Daniel WW, John Wiley Publications, 1983.
3. Biostatistical analysis, by Jerrold H Jar, Pearson Publications, 5th Edition, 2009.
4. Communicate Science Papers, Presentations, and Posters Effectively, by Patience GS, Boffito DC, Patience P, Academic Press, ISBN: 978-0128015001, 2015

HG47A4	Radiation Genetics	L	T	P	C
		3	0	0	3

OBJECTIVE:

To provide knowledge of the effects of ionising radiation on the living organism, its evaluation methods and molecular mechanisms.

Course Outcome – COs		Cognitive Skill
At the end of the course, students should able to		
CO-01	Gain knowledge in Radiation.	U, A, An
CO-02	Understand about Environmental Radioactivity.	R, U ,A
CO-03	Know about Radiochemistry.	R, An
CO-04	Familiar with Genetic effects of Ionizing Radiation.	U, A, An
CO-05	Understand about methods to assess Internal and External Exposure.	U, R

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO- A	PO -B	PO- C	PO -D	PO- E	PO- F	PO -G	PO -H	PO - I	PO - J	PO- k	PO -L	PO- M
CO-01	M	S	M	L	L	N	M	N	N	L	M	S	L
CO-02	M	M	M	L	M	N	M	L	L	S	S	M	L
CO-03	M	M	M	M	M	N	M	L	N	M	S	N	N
CO-04	M	S	L	S	M	M	S	N	L	S	S	M	M
CO-05	M	S	L	S	L	N	M	L	N	S	M	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Introduction to Radiation**12**

Radiation and its types. Non-ionising radiation. Ionising radiation. The concept of ionising radiation and dose of exposure. Units of measurement of ionising radiation (dosimetric units).

Unit II: Environmental Radioactivity**12**

Sources of exposure. Natural background of ionising radiation. Environmental radioactivity and natural radiation. Radionuclides in the atmosphere, soil, water systems. Accumulation of radionuclides into plants and animals. Human exposure to ionizing radiation of cosmic and Earth origin. Technogenic exposure. Occupational exposure. Medical exposure. Prenatal exposure effects. Radiation and nuclear accidents.

Unit III: Radiochemistry**12**

Radiochemistry. Radiolysis of water molecules. The formation of free radicals, their significance. Effects of oxygen. Action of ionizing radiation on DNA. DNA damage. Chromosome damage. DNA reparation mechanisms. Effects of ionising radiation on the cell. Sensitivity of cells to ionising radiation. Changes in the life cycle of cells. Cell survival rate. Apoptosis. Necrosis. Tissue and organ damage.

Unit IV: Genetic Effects of Ionising Radiation**12**

Genetic effects of ionising radiation. Methods for assessing the risk of genetic effects. Biodosimetric methods. Stochastic effects of ionising radiation. Cancerogenicity. Deterministic effects of ionising radiation. Acute radiation syndrome. Mechanisms for the development of predetermined phenomena. General peculiarities of human exposure to ionising radiation.

Unit V: Methods to Assess Internal and External Exposure**12**

General methods for the assessment of external and internal exposure. Basic biokinetic models, assessment of doses of internal exposure. Assessment of the risk of exposure to ionising radiation. Absolute and relative risk models. Risk assessment of cancer. Basic principles of radiation protection. Dose limits for population and workers.

TOTAL: 60 HOURS

TEXT BOOKS

4. Hall E.J, Graccia A.J. Radiobiology for Radiologist. 7th edition. Lippincott Williams & Wilkins, USA, 2011
5. ICRP publ.103. Recommendations of the International Commission on Radiological Protection. Annals of the ICRP. Oxford: Pergamon. 2007;37(2-4), 2011.
6. V. Atkočius, P. Valuckas. Įvadas į radiobiologiją. Vilnius, 2008, 332 psl.
7. Radiation biology: A handbook for teachers and students. International Atomic Energy Agency, Vienna, 2010

REFERENCE BOOKS

1. R E Pyeritz, B R Korf, W W Grody (Ed.). Emery & Rimoin's Principles & practice of medical genetics & Genomics. Academic Press.
2. R F Mueller & I D Young. Elements of Medical Genetics. Published by Churchill Livingstone
3. J M Connor & M A Ferguson-Smith. Essential Medical Genetics. Blackwell publishers
4. W. R. Uhlmann, J. L. Schuette, B. M. Yashar. (Ed.) A Guide to Genetic counseling. Wiley Blackwell publication.
5. P S Harper. Practical genetic counseling. Published by Butterworth Heinemann

HG47A5	Medical Biochemistry	L	T	P	C
		3	1	0	4

OBJECTIVES: To provide the strength to acquire an advanced knowledge and understanding of the core principles of Medical Biochemistry.

Course Outcome – COs		Cognitive Skill
At the end of the course, students should be able to		
CO-01	Understand the biochemical investigations on body fluids to assess health and disease.	U, A, An ,R
CO-02	Analyze the energy content of food and nutritional profile of principal foods.	R, U ,An

CO-03	Understand the basics of Hemoglobin metabolism and assessment of glucose metabolism in blood.	U,R, An
CO-04	Analyze and understand the clear knowledge about inborn error and hereditary defects.	U, R, An
CO-05	Apply and understand the organ function test for diagnosis and therapeutic complications.	U, R,A,An

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO- A	PO -B	PO- C	PO -D	PO- E	PO- F	PO -G	PO -H	PO -I	PO -J	PO- k	PO -L	PO -M
CO-01	S	S	S	M	L	L	M	N	L	S	S	S	S
CO-02	S	S	M	M	M	M	S	N	M	S	S	M	S
CO-03	S	M	M	M	M	L	M	L	L	S	M	S	S
CO-04	S	S	S	S	L	M	S	L	M	S	S	S	S
CO-05	S	S	L	M	L	M	M	L	L	S	S	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Body fluids

12

Role of Biochemistry in Medicine – Biochemical functions of cell organelle. Urine normal and abnormal constituents, CSF composition, Gastric juice, milk, colostrums, Aqueous humor, Pleural fluid, peritoneal fluid, amniotic fluid, synovial fluid composition. Extra cellular and intracellular fluid composition and their normal and abnormal variations under physiological and pathological conditions.

Unit II: Food and Nutrition

12

Caloric value of foods – Respiratory Quotient, SDA, BMR, energy requirements and expenditure – Nutritional significance of dietary constituents. Balanced diet – Nutritional disorders. Digestion and absorption of nutrients from GI tract. Metabolism of xenobiotics - Detoxification, mechanisms in the body. Biological implications. Tissue proteins in health and disease.

Unit III: Hemoglobin metabolism**12**

Biosynthesis of heme and the disorders associated with it – Porphyrrias. Degradation of heme, metabolism of Bilirubin, Jaundice – Types causes and laboratory diagnosis. Assessment of glucose metabolism in blood. Water and electrolyte balance – Acid base balance – disturbances and compensation.

Unit IV: Inborn errors of metabolism**12**

Biochemical changes and symptoms and diagnosis of glycogen and Lipid storage disorders, Phenyl ketonuria, Alkaptonuria, Albinism, Gout, Lesch Nyhan syndrome, Detection and diagnosis of Inborn errors of metabolism.

Unit V Organ function tests**12**

Basic concept of liver function tests, renal function tests, gastric function tests, pancreatic function tests, thyroid function tests. Diagnostic significance of serum enzymes. Routine urine analysis and stone analysis.

TOTAL: 60 HOURS**TEXT BOOKS:**

1. Text book of Biochemistry -A clinically oriented approach-Dinesh Puri, B.I. Churchill Livingstone Inc., India, 2002.
2. Textbook of Biochemistry with clinical correlations-T.M.Devlin. fifth edition, 2002.
3. Biochemistry by Geoffrey L Zubay, Fourth Edition, 1998.
4. Fundamentals of Biochemistry by Donald Voet, Judith Voet and Pratt, second edition, 1995.
5. Harper's Biochemistry by Murray et al. Appleton and Lange Publishers, 27th edition, 2006.

REFERENCE BOOKS:

1. Tietz Fundamentals of Clinical chemistry – Burtis and Ashwood, Fifth Edition, WB Saunders Company, Oxford Science Publications USA, 2001.
2. Principles of Biochemistry with human focus by Garrett and Grisham, Harcourt College Publishers, Orlando, Florida, USA. 2005.
3. Principles of Biochemistry by Lehninger, Nelson and Cox, fourth edition, W H Freeman and Company, New York, USA, 2005.
4. Textbook of Biochemistry with Clinical Correlations, Devlin, T.M. John Wiley & Sons, Inc. (New York), 2011.

HG47A6	Human Anatomy and Physiology	L	T	P	C
		3	1	0	4

OBJECTIVES:

It deals with the structure and functions of human system and organs.

Course Outcome-COs At the end of the course, students should able to		Cognitive skill
CO-01	Understand the basic concepts of human anatomy and physiology.	U
CO-02	Understand the structure and function of Skeletal and muscular system	U, R
CO-03	Understand the structure and function of nervous system and endocrine system	U, A
CO-04	Understand the structure and function of Cardiovascular and lymphatic system	U, An
CO-05	Understand the structure and function of Respiratory, digestive, urinary and reproductive systems	R, U

R- Remember, U – Understand, A – Apply, An – Analyze, E – Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	M	S	S	S	M	M	M	L	M	S	L
CO-02	M	M	M	L	M	N	M	L	L	S	S	M	L
CO-03	M	M	M	M	M	N	M	L	N	M	S	L	L
CO-04	M	S	S	S	M	M	S	N	L	S	S	M	M
CO-05	M	S	S	S	L	L	M	L	N	S	M	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit 1: Introduction, Cells, and Tissues

12

Introduction to Anatomy and Physiology - Definition and scope - Levels of structural organization – Homeostasis - Anatomical terminology - The Chemical Level of Organization - Basic chemistry concepts. The Cellular Level of Organization - Cell structure and function - Cellular metabolism - Cell cycle and cell division - Cellular communication - Tissue Level of Organization - Epithelial tissue - Connective tissue - Muscle tissue - Nervous tissue.

Unit II: Support, Movement, and Integration **12**

The Integumentary System - Structure and function of skin - Accessory structures: hair, nails, glands - Skin repair and aging - The Skeletal System - Bone structure and function - Types of bones and bone formation - Axial and appendicular skeleton - Joints and movements - The Muscular System - Muscle tissue types - Muscle anatomy - Mechanism of muscle contraction - Major muscles of the body.

Unit III: Control Systems **12**

The Nervous System - Organization of the nervous system - Neurons and neuroglia - Central and peripheral nervous systems - Neural pathways and reflex arcs - The Endocrine System - Hormone types and actions - Major endocrine glands and hormones - Regulation of hormone secretion - Feedback mechanisms.

Unit IV: Transport and Defense **12**

The Cardiovascular System - Blood: composition and functions - Heart structure and function - Blood vessels and circulation - Blood pressure and cardiovascular regulation - The Lymphatic System and Immunity - Lymphatic vessels and organs - Immune response mechanisms - Types of immunity: innate and adaptive - Disorders of the immune system.

Unit V: Energy, Maintenance, and Reproduction **12**

The Respiratory System - Anatomy of the respiratory tract - Mechanism of breathing - Gas exchange and transport - Regulation of respiration - The Digestive System - Structure and function of the digestive organs - Digestive processes: ingestion, digestion, absorption, excretion - Nutrient metabolism - Disorders of the digestive system - The Urinary System - Structure and function of the kidneys - Urine formation and elimination - Fluid, electrolyte, and acid-base balance - Disorders of the urinary system - The Reproductive System - Male and female reproductive anatomy - Gametogenesis and reproductive cycles - Hormonal regulation of reproduction - Pregnancy and developmental stages.

TOTAL : 60 HOURS

TEXT BOOKS:

1. Human Anatomy & Physiology" by Elaine N. Marieb and Katja Hoehn (11th Edition, 2018).
2. Principles of Anatomy and Physiology" by Gerard J. Tortora and Bryan H. Derrickson (15th Edition, 2017).

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