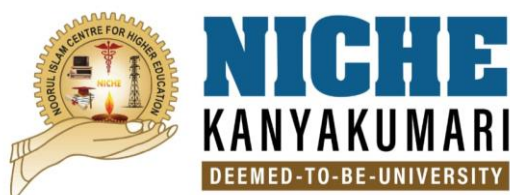


NOORUL ISLAM CENTRE FOR HIGHER EDUCATION

(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 2021



NOORUL ISLAM CENTRE FOR HIGHER EDUCATION

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Regulation: 2021

Curriculum and Syllabi

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, antisocial activities 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.
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.

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 counseling 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 geneticians 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

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	Not	H	A	A	A	A	A	H

H- Highly Associated

A- Associated

Not – Not Associated

**Mapping of Programme Educational Objective (PEOs) and Programme Outcomes
(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 : 79

CURRICULUM & SYLLABUS**(REGULATION - 2021)****SEMESTER I**

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	HG3701	Clinical Biochemistry and Physiology	4	0	0	4
2	HG3702	Techniques in Microbiology	3	0	0	3
3	HG3703	Concepts of Human Genetics	3	0	0	3
4	HG3704	Cell Biology and Genomes	3	0	0	3
5	HG3705	Molecular Biology	3	0	0	3
PRACTICALS						
6	HG3771	Clinical Biochemistry and Physiology Lab	0	0	2	2
7	HG3772	Techniques in Microbiology Lab	0	0	2	2
TOTAL			16	0	4	20

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	HG3706	Human Molecular Genetics	4	0	0	4
2	HG3707	Immunology and Immunogenetics	3	0	0	3
3	HG3708	Developmental and Behavioural Genetics	3	0	0	3
4	HG3709	Genetic Engineering	3	0	0	3
5	HG3710	Epigenetics	3	0	0	3
PRACTICALS						
6	HG3773	Human Molecular Genetics Lab	0	0	2	2
7	HG3774	Immunology and Immunogenetics Lab	0	0	2	2
TOTAL			16	0	4	20

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	HG3711	Bioinformatics and Computational Biology	4	0	0	4
2	HG3712	Cytogenetics	3	0	0	3
3	HG3713	Research Methodology and Biostatistics	3	0	0	3
4	HG3714	Clinical Genetics and Genetic Counselling	3	0	0	3
5	HG3715	Neurogenetics and Onco genes	3	0	0	3
PRACTICALS						
7	HG3775	Bioinformatics and Computational Biology Lab	0	0	2	2
8	HG3776	Cytogenetics Lab	0	0	2	2
TOTAL			16	0	4	20

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	HG3716	Molecular Diagnostic methods	4	0	0	4
2	HG3717	Genomics and Proteomics	3	0	0	3
3	HG3718	Bioethics and IPR	3	0	0	3
4	HG3719	Stem Cell biology and Regenerative Medicine	3	0	0	3
PRACTICALS						
5	HG37P1	Project + Internship and Industrial visit	0	0	5	5
6	HG37P2	Publication and Presentation	0	0	1	1
TOTAL			13	0	6	19

SEMESTER – I

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	HG3701	Clinical Biochemistry and Physiology	4	0	0	4
2	HG3702	Techniques in Microbiology	3	0	0	3
3	HG3703	Concepts of Human Genetics	3	0	0	3
4	HG3704	Cell Biology and Genomes	3	0	0	3
5	HG3705	Molecular Biology	3	0	0	3
PRACTICAL						
6	HG3771	Clinical Biochemistry and Physiology Lab	0	0	2	2
7	HG3772	Techniques in Microbiology Lab	0	0	2	2
TOTAL			16	0	4	20

HG3701	Clinical Biochemistry and Physiology	L	T	P	C
		4	0	0	4

OBJECTIVE

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

Course Outcome At the end of the course the students will able to		Cognitive Skill
CO-01	Students will understand the blood parameters and diagnostic enzymology.	U
CO-02	Students will ensure the knowledge about the disorders of biomolecule and mineral metabolism.	R, An
CO-03	To analyse about the clinical importance of the hormones and reproductive endocrinology.	R
CO-04	Students will acquire knowledge about the circulatory, respiratory, gastrointestinal and reproductive system.	U
CO-05	To study and understand about the hepatobiliary system, excretory system, muscular and nervous system.	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	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, CBC, total differential and platelet counts, blood groups, Rh factor, rare blood groups, Rh typing, ESR and its clinical significance, coagulation, anti-coagulants, thrombolysis and myocardial infarction, anemias, 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, lipodosis, lipoproteins, diagnostic tests for cholesterol, disorders of amino acid metabolism and nucleic acid metabolism, disorders of mineral metabolism.

Unit III: Hormones

12

Protein hormones, steroid hormones, adrenocorticosteroids, reproductive endocrinology, thyroid and its importance and Complications, Techniques in hormones, detoxification mechanism of our body, enzymes involved, mechanism of drug action and channels of excretion.

Unit IV: Organ Systems in Human body

12

Circulatory system, heart and its structure, function, mechanism of blood clotting, blood pressure and its regulation, respiratory system, lungs – structure and function, gas exchange mechanism, digestive system- composition, function and regulation of the gastrointestinal secretion, gastrointestinal hormones, 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, mechanism of contraction of muscles, nervous system- components, structure of brain and spinal cord, importance of CSF. Diagnostic enzymology in liver, urine analysis and kidney function tests.

TOTAL: 60 HOURS**TEXT BOOKS**

1. Lehninger principles of biochemistry, by David Nelson, 1989. Micheal. M. Cox, (7th edition) 2017, W.H. Freeman publishers
2. 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.
3. Biochemistry, by R. L. Miesfeld and M.M.Evag, 2017, (2nd edition) 2020, W.W. Norton and company.

REFERENCES

1. 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.
2. 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 educational publishers.

HG3702	Techniques In Microbiology	L	T	P	C
		3	0	0	3

OBJECTIVES

Students will learn the importance of techniques in Microbiology

Course Outcome		Cognitive Skill
At the end of the course the students will able to		
CO-01	Students get a deep knowledge about History, scope and the principles of Microscope	R
CO-02	Students acquire knowledge in different sterilization techniques	U
CO-03	Students learn to prepare culture media and pure culture techniques	An

CO-04	Students get an idea in the concept of staining techniques	U
CO-05	Students obtain information 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	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

9

History and Scope of Microbiology, Microscopy- Principles and applications, dark field, bright field, resolving power, numerical aperture, chromatic aberration, phase contrast microscopy, fluorescent microscopy, inverted microscopy, stereo microscopy, electron microscopy, TEM and SEM. Sample preparation for microscopy, use of oil immersion objective. Micrometry and cell measurement- Use of ocular and stage micrometer, cell count (haemocytometer).

Unit II: Sterilization

9

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. Antibiotic sensitivity tests by cup plate/paper disc method.

Unit III: Culture media and culture techniques

9

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**9**

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**9**

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: 45 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.

REFERENCES

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

HG3703	Concepts of Human Genetics	L	T	P	C
		3	0	0	3

OBJECTIVE

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

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

9

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 –Deviation from Mendel’s Dihybrid phenotype, Linkage, Sutton’s view on linkage, Morgan’s view on linkage, Bateson & Punnet’s Coupling & Repulsion hypothesis. Crossing over -Chromosome theory of Linkage, kinds of linkage, linkage groups, types of Crossing over, mechanism of Meiotic Crossing over, kinds of Crossing over, theories about the mechanism of Crossing over, cytological detection of Crossing over, significance of Crossing over.

Unit II: Chromosomal aberrations**9**

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**9**

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, Simple Mendelian traits in Man, Unifactorial inheritance, Multi-factorial inheritance. Maternal inheritance, uniparental inheritance, human traits. Complex traits-Approaches to analysis of complex traits- ‘Nature Vs nurture’, role of family and shared environment, monozygotic and dizygotic twins and adoption studies.

Unit IV: Pedigree and its patterns**9**

Pedigrees–gathering family history, 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–nonpenetrance, 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**9**

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

TOTAL: 45 HOUR

TEXT BOOKS

1. Human genetics (wcb cell & molecular biology) by Lewis (12th edition), 5 October 2017. Published by McGraw-Hill Education;
2. Basic human Genetics, by Mange and Mange (2nd Revised Edition), 1999. Published by Sinauer Associates, U.S
3. An introduction to genetic analysis, by Griffiths and Miller (Seventh Edition) 2000. Published by W. H. Freeman.

REFERENCES

1. Molecular and genetic analysis of human traits, by Maroni Gustavo, 2001. Published by Wiley, Malden, Blackwell Science.
2. An introduction to molecular genetics, by Jack J. Pasternack (Second Edition) 2000. Published by Wiley-Liss Blackwell Science.
3. Human Molecular genetics, by Tom Strachan (Third Edition), 2003. Published by Garland Science/Taylor & Francis Group.
4. Genes IX, by Benjamin Lewin (9th Edition) 2007. Published by Jones and Bartlett Publishers.
5. Principles of Genetics, by Snustad and Simmons, 4th Edition (2005) Published by Wiley Malden, Blackwell Science.
6. Molecular Biology of The Cell, by Alberts et al. (4th Edition), Garland 2007. Published by Garland Science, New York.

HG3704	Cell Biology and Genomes	L	T	P	C
		3	0	0	3

OBJECTIVE

To give a detailed and comprehensive knowledge on the various aspects of cell biology and genomes including cell structure and its functions

Course Outcome		Cognitive skill
At the end of the course the students will be able to		
CO-01	Students will understand about basic structure of cell organelles and their functions.	U
CO-02	Students will acquire knowledge about cell-cell communication mechanisms and signal transduction pathways.	R

CO-03	Students will understand about Cell cycle and cancer.	U
CO-04	Students will learn about various mechanisms involved in Cell aging and cell death.	E
CO-05	Students will 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

9

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. Intracellular trafficking.

Unit II: Cell signalling

9

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.

Unit III: Cell cycle, regulation and cancer biology

9

Cell cycle- Mitosis and meiosis, Cytological, genetical and evolutionary 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, dedifferentiation of cancer cells, theories of cancer, carcinogenesis, oncogenes and tumor suppressor genes.

Unit IV: Cell aging and cell death**9**

Cell aging and cell Death: Cell biology of cell aging process and its significance. Molecular mechanism of cell death: Cell necrosis and apoptosis. CASPASE types and molecular mechanisms, proapoptotic regulators, inhibitors of apoptosis. Molecular biology of Survivin and Bcl2 family members. Computer aided tools for studying cell signaling.

Unit V: Genome organization**9**

Genome organization & Concept of gene: Conventional and modern views. Fine structure of gene, split genes, pseudogenes, non-coding genes, overlapping genes and multi-gene families. Genome Organization: Genome organization in eukaryotes- chromatin structure and function, genome packaging, chloroplast and mitochondrial genome. Genome mapping: Physical maps -an overview and approaches. Genome evolution.

TOTAL: 45 HOURS**TEXT BOOKS**

1. Concepts of Genetics by Klug W. S. and Cummings M. R Prentice-Hall
2. Genetics- Analysis of Genes and Genomes by Hartle D. L. and Jones E. W. Jones & Bartlett (6th edition) 2004.
3. Molecular Cell Biology by Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell (4th edition) 2000. New York: W. H. Freeman.
4. The Cell: A Molecular Approach by Cooper, G.M. and R.E. Hansman (4th Edition), 2007. ASM Press.
5. Molecular Biology of the Cell by Alberts, Bruce et al., (4th Edition), 2002. Garland Science (Taylors Francis).

REFERENCES

1. Cell Biology: Organelle Structure and Function by Sadava, D. 2004. Panima Publishing.
2. Cell Biology by Rastogi, S.C. (2nd Edition) 2002. New Age International.
3. The Cell by Gerald Karp (7th edition) 2013. Published by Wiley.

HG3705	Molecular Biology	L	T	P	C
		3	0	0	3

OBJECTIVES

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

Course Outcome At the end of the course students will able to		Cognitive skill
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	S	S	L	L	M	M	N	N	M	S	S	S
CO-02	S	S	S	L	M	N	M	N	L	S	S	M	S
CO-03	S	S	S	M	M	M	M	N	N	M	S	M	S
CO-04	S	S	S	S	M	M	S	N	L	S	M	M	S
CO-05	S	S	S	M	L	L	M	N	N	S	S	M	S

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

Unit I: Genome organization, Structure of DNA and RNA

9

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

9

DNA replication DNA- The genetic material- Experimental evidence of DNA as the genetic material DNA replication in prokaryotes- semi conservative replication, enzymology of DNA replication. Discontinuous replication, replication in circular DNA, replication in eukaryotic chromosome. Types of DNA damage, DNA repair- alteration 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

9

Transcription: RNA Polymerases (eukaryotic and prokaryotic), Steps in transcription- initiation, elongation and termination. Rho dependent and Rho independent termination. inhibitions of transcription. Eukaryotic RNA polymerases-structure and functions. RNA pol I, II and III promoters, transcription factors, transcription complex assembly and mechanism of

transcription, phosphorylation (STAT proteins). Post transcriptional processing of mRNA, rRNA and tRNA. Alternative splicing. Catalytic RNA (ribozymes), RNA editing, Antisense RNA.

.Unit IV: Translation and Gene transfer Techniques 9

Translation: Genetic code- major features. Wobble hypothesis. Components of protein synthesis- mRNA, ribosomes and tRNA. Translation- activation of amino acid, initiation, elongation and termination, inhibitors of translation. Regulation of protein synthesis- constitutive, and narrow domain regulation, Inhibition of protein synthesis. Co and post translation modification. Protein degradation: the Ubiquitin pathway. Protein folding models, molecular chaperones. Lytic and lysogenic cycle. Gene transfer techniques - Transformation, Bacterial conjugation, transduction, Mutations-Types and Mechanism.

Unit V: Regulation of Gene Expression, Transposons and operon concept 9

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-Transcriptional regulation in eukaryotes-hormonal (steroid hormone receptors). 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: 45 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.
5. Genes VII by, Lewin. 2000. Published by Oxford University Press, USA.

REFERENCES

1. Advanced Molecular Biology by Twyman. (2nd ed), 1998. Published by Garland Science; Oxford, New York.
2. Molecular cell biology, by Lodish et al (4th ed) 2000. Published by Freeman & Co., New York.
3. Molecular Cell Biology, by Stansfield et al 1996. Published by Schaum's Outlines. Mc Graw Hill Education.

HG3771	Clinical Biochemistry and Physiology Laboratory	L	T	P	C
		0	0	2	2

OBJECTIVE

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

Course Outcome At the end of the course the students will be able to		Cognitive skill
CO-01	To understand about the normal lipid, urea, creatinine, albumin levels.	U
CO-02	To perform the routine, microscopic examination of urine.	E
CO-03	To analyse and estimate the percentage of haemoglobin, blood grouping, Rh typing, bleeding and clotting time.	An
CO-04	To demonstrate the PCV, ESR, osmotic fragility and prothrombin time.	U
CO-05	To 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

HG3772	Techniques In Microbiology Lab	L	T	P	C
		0	0	2	2

OBJECTIVES

Students will learn the importance of techniques in Microbiology

Course Outcome		Cognitive Skill
At the end of the course the students will able to		
CO-01	Students get a deep knowledge about principles of sterilization methods	R
CO-02	Students acquire knowledge in different staining techniques	U
CO-03	Students learn to prepare culture media and pure culture techniques	An
CO-04	Students get an idea in the concept of antibiotic sensitivity test and preservation of microbes	U
CO-05	Students 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) Anaerobic culture technique.
6. Antibiotic sensitivity test
7. Collection and transport of clinical samples
8. Preservation of bacterial cultures by various techniques
9. Molecular diagnosis of Pathogens –PCR

TOTAL: 30 HOURS

SEMESTER – II

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	HG3706	Human Molecular Genetics	4	0	0	4
2	HG3707	Immunology and Immunogenetics	3	0	0	3
3	HG3708	Developmental and Behavioural Genetics	3	0	0	3
4	HG3709	Genetic Engineering	3	0	0	3
5	HG3710	Epigenetics	3	0	0	3
PRACTICAL						
6	HG3773	Human Molecular Genetics Lab	0	0	2	2
7	HG3774	Immunology and Immunogenetics Lab	0	0	2	2
TOTAL			16	0	4	20

HG3706	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 At the end of the course the students will able to		Cognitive Skill
CO-01	It helps to study about Genetic mapping.	R
CO-02	Enables to study about methods of genome mapping.	A
CO-03	Students will acquire knowledge about molecular pathology of gene.	U
CO-04	Students will acquire knowledge about Identifying Human disease genes.	E
CO-05	It deals 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, Chromosome walking.

Unit III: Mutation and Molecular Pathology **12**

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. Molecular Biology by Glick and Pasternack, 2003.
2. Basic Human Genetics, by Mange and Mange, (2nd Edition), 1999 Sinauer Assoc.
3. The Human Genome, by Howley and Mori, 1999 Academic Press
4. Principles of Genetics, by Gardner, Simmons and Snustad, (8th Edition) 2006.

REFERENCES

1. Human Molecular Genetics, by Tom Strachan and Andrew, 1996. P.Read, Bios Scientific Pub UK.
2. An Introduction to Molecular Human Genetics, by Pastemak, (2nd Edition), 2005 Fritzgarald,.
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.

HG3707	Immunology And Immunogenetics	L	T	P	C
		3	0	0	3

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 At the end of the course the students will able to		Cognitive Skill
CO-01	Interpret the basics of immune system such as immunity, immune cells and organs.	U
CO-02	Create ability to 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

9

Historical perspective of immunology, Introduction to immune system - innate and adaptive immunity, Cells and organs of the immune system, Primary and secondary immune responses, T and B cell activation and differentiation, Structure and functions of B and T cell receptors. Antigens: Adjuvants and Haptens, Factors influencing immunogenicity, Basis of antigen specificity, Antigen processing and presentation to T- lymphocytes, Diversity of TCR, T cell surface alloantigen.

Unit II: Immunoglobulins and Complement System

9

Immunoglobulin structure and functions, Organization of immunoglobulin genes, Genetics of Immunoglobulin diversity, 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

9

Major Histocompatibility antigens: MHC genes and products, Structure of MHC molecules, antigen presentation and processing by MHC class I and class II 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

9

Autoimmune diseases, Cytokines, Interleukins, Transplantation Immunology: Relation between donor and recipient, types of grafts, bone marrow & hematopoietic stem cell transplantation, Tumour Immunology, Immunodeficiency disorders, Immunoinformatics,

Immunostimulation, Immunosuppression and its clinical significance. Hypersensitivity reactions and types.

Unit V: Immunization and Immunotechniques

9

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: 45 HOURS

TEXT BOOK

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 Janeway Travers, 1997 Current Biology Ltd. London, New York. 3rd ed.
4. Encyclopedia of Immunology, by Peter J. Delves, Ivan M. Roitt, 1998 Academic Press. 2nd ed. Publications, London.
5. The experimental foundations of modern immunology, by Clark WR, 1991 John Wiley and Sons Inc. New York.

REFERENCES

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.
3. Immunogenetics and Immunodeficiency, by Benacerraf B, 1975 William Clowes and Sons Ltd. London.
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
7. Essentials of Clinical Immunology, by Chapel H and Halbey M, 1986, ELBS.

8. Clinical Immunology, by Pravash Sen. Gupta, 2003 Oxford University Press.
9. Immunology, by Roit, I.N., Brostoff, J.J. and Male, D.K., 2007 C. Mosby, St. Louis.
10. Immunobiology, by Murphy, K., Travers, P., and M. Walport. 2008 7th- Jane way's Garland Science (Taylor and Francis).

HG3708	Developmental And Behavioral Genetics	L	T	P	C
		3	0	0	3

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 behavioral diseases.

Course Outcome At the end of the course the students will able to		Cognitive Skill
CO-01	Students will gain Knowledge in the basic Concepts of Early Embryonic development.	U
CO-02	Students will be familiar with the Developmental process in vertebrates.	U, An
CO-03	Students will understand about the Developmental and signalling pathways in Drosophila.	U
CO-04	Students will acquire knowledge in Genetics of Human Behaviour.	R
CO-05	Enables the students to 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 9

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. Early development- fertilization, types of cleavage, blastula stage and gastrulation.

Unit II: Development in vertebrates 9

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, Generation of transgenic "knock-out" mice (insertional mutagenesis).

Unit III: Development in Drosophila 9

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 9

Scope and importance of behavioral genetics, Chromosomes and Genes, Gene-Environment Correlations: Nature or Nurture, Twin, Adoption and Family Studies, The Influence of Genes on Behavior, Heritability.

Unit V: Behavioral disease and disorders 9

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: 45 HOURS

TEXT BOOKS

1. Principles of Developmental biology, by Wolpert, 2002
2. Synopsis of psychiatry, by Kaplan and Sadock, 1998.

REFERENCES

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

HG3709	Genetic Engineering	L	T	P	C
		3	0	0	3

OBJECTIVES

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

Course Outcome At the end of the course the students will able to		Cognitive Skill
CO-01	The students will have knowledge about the enzymes used in the genetic engineering.	U
CO-02	Students will acquire an understanding about the types of cloning vectors and their applications.	U, A
CO-03	To study and understand about the methods in genetic engineering and their and the principles.	U
CO-04	Students can apply the knowledge of genetic engineering in the construction of DNA libraries and hybridization techniques.	E
CO-05	Understanding of 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 **9**

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, topoisomerases, transferases, types and properties of restriction enzymes, restriction analysis of genomes, restriction sites.

Unit II: Cloning Vectors **9**

Cloning vectors, plasmids and their properties, pBR, pSc, PUC, pGEM3Z, M13 cosmids, phasmids, phagemids, TA cloning shuttle vectors, yeast vectors- yCP, y AC, artificial chromosomes- BAC, AC, viral and virus derived vectors for animal cells- sv40, adenovirus, baculo virus, lenti virus, pox virus, plant vectors- Gemini virus, Ti plasmid

Unit III: Techniques in Genetic Engineering **9**

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 **9**

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 **9**

Applications of rDNA technology, transgenic plants and animals, vaccine development, PCR based disease diagnosis, gene therapy, Gene knock out, chromosome engineering, animal pharming, CRISPR-CAS, GM foods, negative aspects of genetic engineering

TOTAL: 45 HOURS

TEXT 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.

REFERENCES

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.

HG3710	Epigenetics	L	T	P	C
		3	0	0	3

OBJECTIVES

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

Course Outcome At the end of the course the students will able to		Cognitive Skill
CO-01	Students get a deep knowledge about the history of epigenetics. They will understand the fundamentals of gene expression and regulation.	R
CO-02	Students 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	Students 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	Students learn the concept of epigenetics and various human disorders and how to treat the human disorders by epigenetic therapy.	An
CO-05	Students 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

9

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, Mechanism of histone modifications: Role of Polycomb group proteins and Tri-thorax group proteins.

Unit II: DNA Methylation and Epigenetic control of Gene **9**

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 **9**

Role of regulatory elements such as boundary elements and insulators, mechanism to regulate development, differentiation and complex diseases. Factors influencing epigenetic modifications: Diet, Metabolism, stress, Aging, memory.

Unit IV: Human disorders and Epigenetic therapy **9**

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 **9**

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: 45 HOURS

TEXT BOOKS

1. The Epigenetics Revolution by Nessa Carey, 2012. Publisher: Garland Science: 1st Edition.
2. Epigenetics by Lyle Armstrong, 2014. Garland Science, 1st Edition.

REFERENCES

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

HG3773	Subject Name: Human Molecular Genetics Lab	L	T	P	C
		0	0	2	2

OBJECTIVE

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

Course Outcome At the end of the course the students will able to		Cognitive Skill
CO-01	It helps to understand the chromosomal abnormalities using Karyotyping.	U
CO-02	Enables to study about the isolation of RNA, Plasmid DNA and Genomic DNA.	A
CO-03	Students will be able to understand about the estimation of RNA and DNA.	An
CO-04	Students will acquire knowledge about Restriction Digestion and Ligation.	E
CO-05	Students will able to 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

HG3774	Immunology And Immunogenetics	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 At the end of the course the students will 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.
10. 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	HG3711	Bioinformatics and Computational Biology	4	0	0	4
2	HG3712	Cytogenetics	3	0	0	3
3	HG3713	Research Methodology and Biostatistics	3	0	0	3
4	HG3714	Clinical Genetics and Genetic Counselling	3	0	0	3
5	HG3715	Neurogenetics and Onco genes	3	0	0	3
PRACTICALS						
7	HG3775	Bioinformatics and Computational Biology Lab	0	0	2	2
8	HG3776	Cytogenetics Lab	0	0	2	2
TOTAL			16	0	4	20

HG3711	Bioinformatics And Pharmacogenomics	L	T	P	C
		4	0	0	4

OBJECTIVE

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

Course Outcome At the end of the course, students should able to		Cognitive Skill
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 and its relation with Molecular Biology. General Introduction of Biological Databases- Types of Biological data- Genomic DNA, cDNA, rDNA, ESTs, GSSs, RNA Proteomics, Primary Databases -Nucleotide sequence databases-GenBank, EMBL, DDBJ, Protein Sequence Databases- UniProtKB, UniProt, TrEMBL, Swiss-Prot, Literature Databases- PubMed, BioMed Central. Introduction to Secondary or Derived Databases- PDB, MMDB, SCOP, CATH, FSSP, KEGG ENZYME, BRENDA; Composite Databases-NRDB, Genome Databases,

Unit II: Sequence Alignments and Structure Prediction

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 and application in Nucleic acid and protein

sequences 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: Structure Prediction

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, Molecular Dynamics of Protein, Structure Prediction Tools, Motif and Domain: Motif databases and analysis tools. Domain databases (CDD, SMART, ProDom) and Analysis tools, Programming in Bioinformatics.

Unit IV:Introduction to drug design and discovery

12

Introduction: - Natural product, Drugs - Principles of drug Development, Bioinformatics in drug development, Chemoinformatics and Pharmacoinformatics, Drug Databases, Insilico Drug Designing – Types and Applications, Active Site Identification, Lipinski's Rule of Five, Clinical Trials. Policies in drug designing - Quality assurance: ISO, WHO, certification, Good manufacturing practices, Government regulations, policies, Food and drug administration.

Unit V:Personalized Medicine

12

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, (2021) 1st Edition, Springer edition
2. Introduction to Bioinformatics, Bagchi (2018), Narosa Publishing House.
3. Pharmacogenomics An Introduction and Clinical Perspective. BY Joseph S. Bertino, Angela Kashuba, Joseph D. Ma, UweFuhr, C. Lindsay DeVane. Published by McGraw Hill Publications.

REFERENCES

1. Bioinformatics for beginners, R. Amjesh, S.S. Vinodchandra, (2019), LAP LAMBERT Academic Publishing

2. Genetics, Genomics, Proteomics & Bioinformatics, by Rajeev Tyagi and Yougesh Kumar. Published by Mangalam Publishers and Distributors
3. Pharmacogenetics by Ian P. Hall and MunirPir Mohamed. Taylor and Francis.

HG3712	Cytogenetics	L	T	P	C
		3	0	0	3

OBJECTIVES

At the end of the course the student will learn techniques in cytogenetics and solve problems on Mendelian genetics and its deviation.

Course Outcome		Cognitive Skill
At the end of the course, students should able to		
CO1	Discuss clinical cases with pathological karyotypes.	An
CO2	Develop a piece of deep knowledge in extra Chromosomal Inheritance.	U
CO3	Know about linkage analysis.	U,E
CO4	Understand the crossing over mechanisms.	U.E
CO5	Know the mechanisms underlying the formation of the main chromosomal anomalies.	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

Unit I: Chromosome Structure

9

Physical Basis of Inheritance: Definition, Description of chromatin structure, Chromosome theory of inheritance. Eukaryotic Chromosome: Macro-molecular organization. Primary and Secondary constriction, Sat-bodies, Telomeres, Histones, DNA, Nucleosome. Heterochromatin and Euchromatin and its significance. Ultrastructure of Chromosome -

Nucleosome model, Karyotype, and Idiogram. Special types of Chromosomes: - Structure and Significance of Special type of Chromosomes: Polytene Chromosome - Salivary gland chromosome in *Drosophila*, Lampbrush chromosome in amphibian Oocyte. Supernumerary B Chromosome, Nomenclature in Cytogenetics.

Unit II: Organellar DNA

9

Extra Chromosomal Inheritance / Cytoplasmic Inheritance: - Characteristic features of Cytoplasmic Inheritance. - Inheritance of: Mitochondrial DNA, Chloroplast DNA, Kappa articles in *Paramecium*, Sigma factor in *Drosophila*, Shell coiling in snail. Cytoplasmic Male Sterility (CMS) in maize.

Unit III: Linkage

9

Linkage: Definition of Linkage, Coupling and Repulsion hypothesis, Linkage group- *Drosophila*, maize and man, Types of linkage-complete linkage and incomplete linkage, Factors affecting linkage, Significance of linkage. Sex Linkage: - Definition of sex linkage, Meiotic behavior of chromosome, and non - disjunction. Bridges theory of non-disjunction., Sex linkage in *Drosophila*. Sex-linked genes in poultry, moths, and man -Sex-linked inheritance in man (Colour-blindness, Haemophilia) -Attached X-chromosome.

Unit IV: Crossing Over

9

Crossing over: Crossing over definition and types of crossing over, Germinal and Somatic crossing over. Cytological basis of crossing over: Stern's experiments in *Drosophila*, Creighton and Mc Clintock experiment in maize. Mechanism of crossing over: Chiasma type theory, Breakage first theory, Contact first theory, Strain or torsion theory. Molecular mechanism of crossing over - Holiday model, Crossing over in *Drosophila*. Interference and coincidence, Steps in Construction of genetic map (*Drosophila*).

Unit V: Chromosomal Aberrations and its disorders

9

Chromosomal aberrations and its disorders: Numerical: Euploidy (Monoploidy, Haploidy, and Polyploidy) Polyploidy- Autopolyploidy and Allopolyploidy. Aneuploidy- Monosomy, Nullisomy, and Trisomy. Structural - Deletions (Terminal, Interstitial), Duplication (Tandem, Reverse tandem, and Displaced), Translocation (Simple, Isochrome, Reciprocal, Displaced), and Inversions (Pericentric and Paracentric). Significance of chromosomal aberrations.

TOTAL: 45 HOURS

TEXT BOOKS

1. Principles of Genetics by DP Snustad and MJ Simmons (2012), John Willey & Sons Publication, 6th Edition.
2. Human Genetics ByGangane5th Edition 2017.
3. Principles Of Genetics by Gardner 8th Edition.

REFERENCES

1. Principles of Genetics by Snustad and Simmons, 4th Edition, Wiley'2005.
2. Textbook of Human Genetics: The Yale journal of biology and medicine 45(5) · Sep1972

HG3713	Research Methodology And Biostatistics	L	T	P	C
		3	0	0	3

OBJECTIVES

To provide knowledge about tools and techniques related with scientific communication and research methodology

Course Outcome At the end of the course, students should able to		Cognitive Skill
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 ,A
CO-03	Understand the basics of biostatistics such as tabulation, graphical and diagrammatic representation	R, An
CO-04	Calculate and interpret measures of central tendency, correlation and regression analysis in statistical data	U, A, An
CO-05	Identify appropriate tests to perform hypothesis and compare different population sample using ANOVA and interpret the output adequately	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	S	S	M	L	L	N	M	N	N	S	S	S	S
CO-02	M	S	M	L	M	N	M	N	L	S	M	M	S
CO-03	S	S	M	M	M	N	M	L	N	M	M	M	S
CO-04	M	S	L	S	M	M	S	L	L	S	S	M	S
CO-05	M	S	L	M	L	N	M	L	N	S	S	M	S

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

Unit I: Research methodology **9**

Research – definition, objective, types and importance of research, Research methods in sciences, Research process, Literature survey, scientific databases, research report writing, parts of thesis and dissertation. Empirical science, scientific method, manipulative experiments and controls, deductive and inductive reasoning, descriptive science, reductionist vs holistic biology, Process of communication- concept of effective communication, non-verbal communication, Presentation skills, computing skills for scientific research.

Unit II: Scientific communication **9**

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, elements of a scientific paper - abstract, introduction, materials & methods, results, discussion, references, drafting titles and framing abstracts, 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 **9**

Definition, scope of biostatistics, Population and Sample, collection, 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 **9**

Measures of central tendency – mean, median, mode, dispersion – range, quartile deviation, mean deviation, standard deviation, variance, coefficient of variation. Standard error, correlation – positive correlation, negative correlation and no correlation. correlation coefficient, regression –linear regression and Logistic Regression.

UNIT V: Hypothesis **9**

Hypothesis – definition, basic concepts concerning testing of hypotheses, test of hypotheses and its limitations, types – simple hypothesis and composite hypothesis testing, significance test and fixing level of significance, Chi square test, student's t test. ANOVA – one way and two ways ANOVA, Use of statistical software.

Total: 45 Hours

TEXT BOOKS

1. .Research Methodology: Methods and Techniques, by Kothari CR and Garg G, 2019
New Age International Publishers, ISBN: 978-9386649225, 4th Edition.

2. Research Methodology for Biological Science, by Gurumani N, 2006 MJP Publishers, Chennai.

REFERENCES

1. Communicate Science Papers, Presentations, and Posters Effectively, by Patience GS, Boffito DC, Patience P, 2015 Academic Press, ISBN: 978-0128015001.
2. Successful Scientific Writing: A Step-by-Step Guide for the Biological and Medical Sciences, by Matthews JR and Matthews RW, 2014 Cambridge University Press ISBN: 978-1107691933, 4th Edition.
3. On Being a Scientist: a Guide to Responsible Conduct in Research, by Washington DC, 2009 National Academies Press, 3rd Edition.

HG3714	Clinical Genetics and Genetic Counselling	L	T	P	C
		3	0	0	3

OBJECTIVE

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

Course Outcome		Cognitive Skill
At the end of the course, students should able to		
CO1	Strategies in this program encompass cell biological and genomic approaches	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 Obstetrics,	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	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

Unit1: Genetic basis of syndromes and disorders**9**

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 syndromes.

Unit 2: Inborn errors of Metabolism**9**

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

Unit 3: Disorders of Haematopoietic systems**9**

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

Unit-4: Clinical genetics in Gynaecology and Obstetrics**9**

Clinical genetics in Gynaecology and Obstetrics, Andrology, Sexology. Genetic aspects of pregnancy failure and primary infertility - reproductive problems – male and female infertility, recurrent miscarriages and stillbirths; disorders of sex development (DSD); transsexualism - transgenderism, homosexuality.

Unit-5: Treatment of Genetic Disease**9**

Treatment of Genetic Disease - Conventional Approaches to Treatment of Genetic Disease, Therapeutic Applications of Recombinant DNA Technology, Gene therapy -classification and types, Lentiviral and adenoviral vectors for correction of single gene disorders; safety concerns in clinical applications, Stem Cell Research: Induced pluripotent stem cells in human genetics research; Stem Cell Therapy.

TOTAL: 45 HOURS**TEXT BOOKS**

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

REFERENCES

1. Helen V. Firth and Jane A. Hurst (2017). Clinical Genetics and Genomics (Oxford Desk Reference Series- 2nd Edition). Oxford University Press.
2. Jorde Carey, and Bamshad (2015). Medical Genetics (5th Edition). Elsevier.

HG3715	Neurogenetics And Oncology	L	T	P	C
		3	0	0	3

OBJECTIVES

Students will learn the structure of nervous system, its disorders, cancer genes, Cancer developmental pathway and the therapy of cancer.

Course Outcome – COs		Cognitive Skill
At the end of the course, students should be able to		
CO-01	Get a deep knowledge about the physiology of nervous system and conduction of nerve impulse	U, R
CO-02	Acquire knowledge about the concept of neurological disorders and its therapy	U
CO-03	Gains understanding about cancer genes and its progression process.	R
CO-04	Learns about the cell cycle and cancer developmental pathway	A, R
CO-05	Obtains information about the cancer syndromes and therapy.	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	S	S	M	L	L	N	M	L	N	S	S	S	S
CO-02	S	S	M	L	M	N	M	L	L	S	S	S	S
CO-03	S	S	M	M	M	N	M	L	N	M	S	S	S
CO-04	S	S	L	S	M	M	S	L	L	S	S	S	S
CO-05	S	S	L	S	L	N	M	L	N	S	S	S	S

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

Unit I: Organization of the Nervous System **9**

Organization of the nervous system - Histology of the nervous tissue: supporting cells and neurons (Structure of neuron) and its type, Anatomy and Physiology of ANS and CNS, Conduction of nerve impulse - Resting membrane potential, Membrane potentials and signals, Synapse, postsynaptic potentials, presynaptic potential - action potential, de potential, hyper potential and synaptic integration, Neurotransmitters and receptors, Neuroendocrine system.

Unit II: Neurological Diseases **9**

Autosomal - recessive and dominant and X-linked neurological diseases. Neurodegenerative diseases, Unstable mutation (repeat expansion) causing spinocerebellar ataxias, Huntington's disease, Myotonic dystrophy, Fragile-X syndrome. Metabolic defects causing neurological diseases - Tay-Sach's and Gaucher's diseases, Cerebrovascular accidents, stroke, Parkinson disease and Alzheimer's disease: history, causes, signs, symptoms, pathophysiology, diagnosis, preventions and management. Diagnostic procedures for assessing neurogenetic diseases - MRI Scan, EEG, EMG, PRT, Therapeutics and novel therapeutics

Unit III: Cancer Genetics **9**

Cancer: Introduction, Common types of cancer and their prevalence, Classification based on tissue types - carcinoma; sarcoma; myeloma; leukemia; and lymphoma. Genetics of sporadic, familial, and hereditary cancers. Molecular biology of tumor invasion and metastasis, Tumour progression: angiogenesis and metastasis. Multi- step evolution of cancer. Oncogenes, Tumor suppressor genes, micro satellite instability, tumor mutation burden.

Unit IV: Cell Cycle and Cancer **9**

Control of the cell cycle, Control of the integrity of the genome, Activation of proto - oncogenes, Role of proto- oncogenes in regulating cell growth and survival .Mechanisms of activation of oncogenes: retro viral activation, point mutations, fusion genes, gene amplification, chromosome rearrangements, promoter insertion. RAS signaling molecule in cancer. Tumor Suppressor pathways - The p16 - cyclin D - pRb - E2F pathway, p19ARF - Mdm2 - p53 pathway.

Unit V: Cancer Syndromes and Therapy **9**

Cancer syndrome: Retinoblastoma, Wilm's tumour, Li- Fraumeni syndrome, hereditary breast and ovarian cancer, Familial adenomatous polyposis. Cancer Biomarkers - Principle classification, and applications .Cancer Biomarkers on the basis of biomolecules -DNA,

RNA, MiRNA, Carbohydrate, Pathogenic cancer biomarker, Imaging biomarker. Cancer Biomarkers for selected organs -Colorectal cancer, Breast cancer, Lung cancer, Liver cancer, Prostate cancer. Genetic testing for cancer syndromes. Cancer therapy: cellular, gene and protein level. Chemotherapeutics for cancer, Phytotherapy for cancer. Advance therapies in cancer -current and potential roles of gene therapy for cancer, Immuno therapy, precision Oncology.

TOTAL: 45 HOURS

TEXT BOOKS

1. Neurogenetics, Part II, Volume 148 (ISSN Book 148) 1st Edition, January 29, 2018, by Daniel H. Geschwind, Henry L. Paulson, Christine Klein the latest release in the Handbook of Clinical
2. Oncogenes: An Introduction to the Concept of Cancer Genes (2nd Edition) Dec 6, 2012 by Kathy B. Burck et al., Published by Springer.

REFERENCES

1. Principles of cancer Genetics by Fred Bung, (2nd edition) 2016. Published by Springer
2. Neurogenetics: A Guide for Clinicians (1st Edition, Kindle Edition) ,12 April 2012 by Nicholas Wood. Published by Cambridge University Press.

HG3775	Bioinformatics And Pharmacogenomics	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 At the end of the course, students should able to		Cognitive Skill
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. Exploration of the resources available in NCBI and PUBMED
2. Retrieval & Analysis of a Genbank Entry using an accession number
3. Retrieval and analysis of a protein sequence from protein database
4. Secondary structure prediction, validation & visualization of a protein
5. Pair-wise and multiple sequence alignment
6. Alignment of two Sequences and determination of Scoring Matrix
7. Similarity Search using BLAST and Interpretation of Results - Nucleotide
8. Conversion of Gene Sequence into its Corresponding Amino Acid Sequence
9. Primer Designing
10. Genome annotation

TOTAL: 30 HOURS

HG3776	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 At the end of the course, students should able to		Cognitive Skill
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. Dermatoglyphics as a Model for Polygenic Inheritance
9. Karyotype study of aneuploidies
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	HG3716	Molecular Diagnostic methods	4	0	0	4
2	HG3717	Genomics and Proteomics	3	0	0	3
3	HG3718	Bioethics and IPR	3	0	0	3
4	HG3719	Stem Cell biology and Regenerative Medicine	3	0	0	3
Practicals						
5	HG37P1	Project + Internship and Industrial visit	0	0	5	5
6	HG37P2	Publication and Presentation	0	0	1	1
Total			13	0	6	19

HG3716	Molecular Diagnostics Methods	L	T	P	C
		4	0	0	4

OBJECTIVES

The course is to familiarize students with genetic techniques “hands-on” using a variety of genetic techniques with a clinical perspective to facilitate application to and education of future clientele. These genetics techniques are applied to problems in human genetics, such as diagnosis, determining prognosis, family studies and mutation analysis; and used to determination test results, interpretation and reporting findings.

Course Outcome		Cognitive Skill
At the end of the course, students should able to		
CO1	Students can able to understand the molecular genetic techniques.	U
CO2	Know about the protein analysis techniques such as PAGE, SDS etc.	An, E
CO3	Know the genetic techniques in clinical field including types of ELISA.	A
CO4	Understand and Inculcate knowledge in the techniques of chromosome analysis.	U,E
CO5	Apply the learned patenting procedure in the Prenatal analysis techniques.	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	M	L	L	N	M	N	N	S	M	M	S
CO-02	S	M	M	L	M	N	M	N	L	S	S	M	S
CO-03	S	M	M	M	M	N	M	N	N	M	S	M	S
CO-04	S	S	M	S	M	M	S	N	L	S	M	M	S
CO-05	S	S	M	S	L	N	M	N	L	S	M	M	S

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

Unit I: Molecular Genetic techniques

12

Electrophoretic Techniques – Agarose gel electrophoresis, Pulse field Gel electrophoresis - Polymerase chain reaction(PCR), quantitative Polymerase chain reaction (qPCR), Reverse transcription Polymerase chain reaction (RT-PCR), Gene mapping, DNA and RNAi Microarray, Exome sequencing, Genetic analysis using RNAi - Antisense technology, Blotting Techniques – Southern and Northern Blotting.

Unit II: Protein analysis techniques

12

Polyacrylamide Gel Electrophoresis (PAGE), Native gel electrophoresis, Isoelectric focusing, Two dimensional Gel Electrophoresis (2DGE) - Western blotting, Protein tagging, Protein microarray - Chromatographic method for protein identification,

Unit III: Prenatal analysis techniques

12

Prenatal analysis techniques- Ultrasonography, Amniocentesis, Chorionic villus sampling(CVS), Maternal blood sampling techniques, Fetoscopy, Pre implantation genetic screening technique, Next Generation sequencing, SNP Array Method, Whole genome amplification(WGA), Array- Comparative genomic Hybridization (Array-CGH).

Unit IV: Genetic Variation and Mutation analysis Techniques

12

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

Unit V: Artificial Intelligence in Genetics**12**

Artificial intelligence / Machine learning in Genetics – Computer vision – Time series analysis – Variant calling – Gene annotation and variant classification – Classification of coding and non-coding variant – phenotype to genotype mapping – image to genetic diagnosis – genotype to phenotype prediction. AI in Disease diagnosis – AI in disease therapy.

TOTAL: 60 HOURS**TEXT BOOKS**

1. Human Genetics: The Basics by Ricky Lewis, 2nd Edition (Special Indian Edition-2020)
2. Basics of human genetics 2ND edition published on 2017, by Katira. V(Author)

REFERENCES

1. Wilson And Walkers Principles And Techniques Of Biochemistry And Molecular Biology 8thEdition,(Pb 2018) by HOFMANN A (Author).
2. Human Genetics, 6th edition Paperback – 1 January 2021 by Gangane (Author).

HG3717	Genomics And Proteomics	L	T	P	C
		3	0	0	3

OBJECTIVES

It deals with basics of Genomics, Transcriptomics, Metagenome, Proteomics and Research Areas and Applications of Proteomics and Genomics.

Course Outcome At the end of the course, students should able to		Cognitive Skill
CO-01	Gain knowledge in Genomics and its gene expression	U, A, An
CO-02	Understand about Transcriptome Analysis, Gene expression and DNA microarray	R, U, A
CO-03	Know about functional Genomics	R, An
CO-04	Familiar with Proteomics	U, A, An
CO-05	Understand about research areas in Genomics and Proteomics	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	S	S	M	L	L	N	M	N	N	L	M	S	L
CO-02	S	M	M	L	M	N	M	L	L	S	S	M	L
CO-03	S	M	S	M	M	N	S	L	N	M	S	N	M
CO-04	S	S	M	S	M	M	S	N	L	S	S	M	S
CO-05	S	S	L	S	L	N	M	L	N	S	M	M	S

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

Unit I: Genomics

9

Genomics: Large scale genome sequencing strategies. Basic principles, application of methods to prokaryotic and eukaryotic genomes and interpretation of results. Basic concepts on identification of disease genes, role of bioinformatics-OMIM database, reference genome sequence, integrated genomic maps, gene expression profiling; identification of SNPs, SNP database (DbSNP). Role of SNP in Pharmacogenomics, SNP arrays.

Unit II: Transcriptome Analysis, Gene expression and DNA microarray

9

Transcriptome Analysis - Gene Expression Omnibus (GEO), ArrayExpress, Gene expression-Introduction, Basic steps for gene expression, Microarray:- Concept of microarrays; spotted arrays, oligonucleotide arrays, designing the experiment, Two-color microarray experiments, Clustering gene expression profiles; Agglomerative, Hierarchical, Nearest neighbour (Single-linkage), complete linkage, average-linkage, weighed pair-group average, k-means clustering, self-organizing maps (SOM) clustering, Tools for microarray analysis; soft-finder, xCluster, MADAM, SAGE, Microarray design, microarray experimentation, fabrication computational analysis of Microarray data, Applications of microarray technology.

Unit III: Functional genomics

9

Functional genomics: Application of sequence based and structure-based approaches to assignment of gene functions – e.g. sequence comparison, structure analysis (especially active sites, binding sites) and comparison, pattern identification, etc. Use of various derived databases in function assignment, use of SNPs for identification of genetic traits. Gene/Protein function prediction using Machine learning tools viz. Neural network, SVM.

Unit IV: Proteomics**9**

Evolution from protein chemistry to proteomics: The proteomics workflow - Basic of separation sciences: Protein and peptides; Two-dimensional electrophoresis (2-DE), Advancement in solubilization of hydrophobic proteins, development of immobilized pH gradient strips, gel casting, staining of gels and image analysis. Two-dimensional fluorescence difference in-gel electrophoresis (DIGE), Blue native PAGE (BN-PAGE), gel free proteomics – LCMS, Quantitative Proteomics: Bioinformatics tools for proteomics (SEQUEST, MASCOT etc.), Protein identification tool – RASMOL, Protein Microarray in protein expression, profiling and diagnostics, drug target discovery.

Unit V: Research Areas and Applications of Proteomics and Genomics**9**

Functional genomics, Structural genomics, comparative genomics Epigenomics, Metagenomics, Pharmacogenomics, Study systems - Viruses and bacteriophages genomics, Cyanobacteria genomics, Human genomics. Cancer and regenerative biology, Biomarker discovery, epigenetics, agriculture, pharmaceuticals, genomic medicine, Synthetic biology and bioengineering, metabolomics and microbiomics.

TOTAL: 45 HOURS**TEXT BOOKS**

1. Concept and techniques in genomics and proteomics, N Saraswathy, P Ramalingam (2011), Elsevier Science publications.
2. Bioinformatics: Genomics and Proteomics, Ruchi Singh (2015), Vikas Publishing House.

REFERENCES

1. Bioinformatics, Methods And Applications - Genomics, Proteomics And Drug Discovery, Rastogi, S.C., Rastogi, Parag, Mendiratta, Namita, (2022), fifth edition, PHI Learning Pvt. Ltd.
2. Advances in Bioinformatics, Ajay Kumar, Vijai Singh (2021), Springer Singapore.
3. Introduction to Bioinformatics, Lesk, A.M. (2007), Oxford University Press, Oxford.

HG3718	Bioethics And Intellectual Property Rights	L	T	P	C
		3	0	0	3

OBJECTIVES

This course shall provide an overview of the ethical issues, biosafety associated with scientific research and practice in biotechnology and also deal with the critical aspects of Intellectual property rights and there relevant guide lines and regulations.

Course Outcome At the end of the course, students should able to		Cognitive Skill
CO-01	Get exposed to the principles of bioethics and emerging issues of biotechnology's impact on society.	U, R
CO-02	Illustrate bio-safety levels required in the laboratory and understand Biohazards	R, U
CO-03	Know the ethical, legal and socioeconomic aspects in latest biotechnological advancements and guidelines to be followed during animal experimentation.	R, U
CO-04	Understand and inculcate knowledge on the principles of IPR types, Patentable and non-patentables and infringement	U
CO-05	Apply the learned patenting procedure in India and abroad	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	N	L	M	S	L
CO-02	M	M	M	L	M	N	M	L	L	S	S	M	L
CO-03	M	M	S	M	M	L	S	N	N	M	S	N	M
CO-04	S	S	M	S	M	M	S	N	L	S	S	S	S
CO-05	M	S	L	S	L	M	M	L	L	S	S	S	S

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

Unit I: Introduction to bioethics

9

Introduction to bioethics-The principles of bioethics :autonomy ,human rights, beneficence, privacy, justice, equity etc. concepts, ethical terms, issues on genetic modification and recombinant DNA technologies, ethics in agriculture and Environment benefits, risks, transhumanism, Special procedures for DNA based product production. Overview of National Regulations of Bioethics and International considerations. Regulatory bodies for Bioethics in India.

Unit II: Biosafety**9**

Biosafety-Introduction to biosafety. Concepts, symbols and significance in experimental biological sciences. International laws on Biosafety. Levels of Biosafety(BSL-1to3)for Specific microorganisms. Introduction to Biological Safety Cabinets. Introduction to the concept of Good Laboratory Practices (GLP). Biosafety regulations, r-DNA guidelines- National and international , levels of containment. Role of Institutional biosafety committee, GEAC, RCGM, Cartagena protocol.

Unit III: Ethics and Human Ethics**9**

Animal Ethics- Animal rights, ethics of human cloning, Reproductive cloning, Ethical legal and Socio economic aspects of Gene therapy, Somatic, Embryonic and Adult stem cell research, ELSI of human genome project, Challenges to public policy and regulations, ID 50, IC 50, CCAC Guidelines on Transgenic Animals (1997), CCAC Guidelines on Animal Welfare, Laboratory Animal Management, The Need for Ethical Review, guidelines for human ethics.

Unit IV: Intellectual Property Rights**9**

Intellectual Property Rights(IPR)- Introduction to IPR–types; copyrights, patents, trademarks, tradeseecret design rights, geographical indication, PVPR, patentable and non-patentable – PCT, importance of IPR, Types of Patent applications, PCT (Patent Cooperation Treaty) cost, procedure and requirements for international patenting-patent infringement–scope, litigation, meaning,c ases studies & examples.TKDL,Biopiracy.Patenting of biological material. Precautions to be taken before, patenting. World Trade Organization and its related intellectual property provisions.

Unit V: Patent**9**

Patent- Introduction and Importance, WTO, GATT,WIPO,TRIPS, Patenting in India, Indian patent act, WIPO treaty, budapest treaty, publication of patents-Gazette of India, Patenting by research students, lectures and scientist University/Organizational rules in India and abroad. Global scenario of patents and Indian position. IP as a determining factor in biotechnology.

TOTAL: 45 HOURS**TEXT BOOKS**

1. A Textbook of Bioethics for Healthcare Professionals, Princy Louis Palatty , Ashish Kumar U , Russell Souza.. (2017) Jaypee Brothers Medical Publishers (P) Ltd.
2. Bioethics: the basics, Alastair V. Campbell, Rutledge (2017).

REFERENCES

1. Biotechnology and Safety Assessment (2014), Thomas, J.A., Fuch, R.L. 3rd Edition, Academic Press,
2. Biological safety Principles and practices (2017), Fleming, D.A., Hunt, D.L, 3rd Edition, ASM Press, Washington2017.
3. Intellectual Property Rights: Protection and Management, Nithyananda. K. V. Publisher Cengage Learning India Pvt. Ltd. (2019)

HG3719	Genetic Counselling	L	T	P	C
		3	0	0	3

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 At the end of the course, students should able to		Cognitive Skill
CO1	Strategies in this program encompass Genetic Counseling approaches	U
CO2	Understand the Individual and Group counseling approaches.	An
CO3	Understand the process of genetic counseling to make genetic disease a curable one.	U,E
CO4	Understand the psychological aspects of counseling and the problems to be faced in genetic counseling.	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 Counselling**9**

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

Unit 2: Individual and Group counselling**9**

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

Unit3: Process of Genetic Counselling**9**

Process of Genetic Counselling: 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 counselling and testing in late onset disorders imparting results of predictive testing; Counselling and management in follow up sessions Reproductive risk assessments: Reproductive failures; consanguinity; endogamous marriages and its impact on genetic disorders.

Unit4: Psychological aspects of counselling**9**

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

Unit5: Antenatal, Prenatal, Peri-conceptional Counseling**9**

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-conceptional counseling -Counseling recurrent pregnancy loss, pre – marital counseling. Treatment of Genetic Disease - Conventional Approaches to Treatment of Genetic Disease, Gene therapy, Stem Cell Therapy.

TOTAL: 45 HOURS

TEXT BOOKS

1. Family communication about genetics: theory and practice, Clara L. Gaffand Carma L. Bylund (2010).

REFERENCES

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 McCarthyVeach, Bonnie S. LeRoy and Nancy P. Callanan (2018).
3. Foundations of perinatal genetic counseling: a guide for counselors, AmberMathiesen and Kali Roy (2018).
4. Gardner and Sutherland's chromosome abnormalities and genetic counselling, R.J. McKinlay Gardner and David J. Amor (2018).

HG37P1	Project and internship	L	T	P	C
		0	1	5	6

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. 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	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.

TOTAL -90 HOURS

INTERNSHIP 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 interneers 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.

HG37P2	Publication and Presentation	L	T	P	C
		0	0	1	1

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	Formulate a scientific question	U,A
CO-02	Encourage students to contribute to the academic and scientific community through published work.	An, A
CO-03	Prepare students for future academic or industry roles that require research, presentation, and publication skills.	U,A
CO-04	Gain experience in presenting 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

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.

TOTAL -15 HOURS