BHARATHIAR UNIVERSITY: COIMBATORE– 641 046

M.Sc., HUMAN GENETICS AND MOLECULAR BIOLOGY (CBCS PATTERN)

(For the students admitted during the academic year 2018–2019 batch and onwards)

Duration of the course: 2 Years Eligibility Condition

B.Sc., Genetics	B.Sc., Biochemistry
B.Sc., Animal Sciences	B.Sc., Biotechnology
B.Sc., Microbiology/Environmental Sciences	B.Pharm.,
B.Sc., Forensic Sciences	B.Sc., Bioinformatics
B.Sc., Zoology	B.E./B.Tech., Biotechnology
BAMS/BHMS Ayurveda and Homeopathy	B.Tech., Genetic Engineering
All Branches in Life Sciences	B.Tech., Industrial Biotechnology
MBBS/B.Sc., Nursing	B.Sc., Animal Science and Zoology
B.Sc., Advanced Zoology and Biotech	B.Sc., Agricultural Biotechnology

M.Sc., Human Genetics and Molecular Biology – Semester Wise Syllabus and Scheme

Semester	Core	Subject Code	Title of the Paper	Hours/ Week	Internal	External	Total Marks	Total Credits
I	CORE – I	13A	Medical Biochemistry	4	25	75	100	4
	CORE – II	13B	Cell Biology and Cell Signaling	4	25	75	100	4
	CORE – III	13C	Principles of Human Genetics	4	25	75	100	4
	CORE – IV	13D	Molecular Genetics	4	25	75	100	4
	CORE PRACTICAL– I	13P	Practical– I (Medical Biochemistry, Cell Biology and Cell Signaling, Principles of Human Genetics, Molecular Genetics)	6	25	75	100	4
	ELECTIVE – I	1EB	Genomics and Proteomics (or)	4	25	75	100	4
		1EA	r–DNA Technology					
	SUPPORTIVE – I	GS09	Genetics and Society	2	12	38	50	2
II	CORE – V	23A	Human Cytogenetics	4	25	75	100	4
	CORE – VI	23B	Medical Genetics	4	25	75	100	4
	CORE – VII	23C	Developmental and Behavioral Genetics	4	25	75	100	4
	CORE – VIII	23D	Biostatistics and Bioinformatics	4	25	75	100	4
	CORE PRACTICAL– II	23P	Practical– II (Human Cytogenetics, Medical Genetics, Developmental and Behavioral Genetics, Biostatistics and Bioinformatics)	6	25	75	100	4
	ELECTIVE – II	2EB	Bio Instrumentation (or)	4	25	75	100	4
		2EC	Nanobiology					
	SUPPORTIVE – II	2GS89	Principles of Genetics	2	12	38	50	2
III	CORE – IX	33A	Immunogenetics	4	25	75	100	4
	CORE – X	33B	Cancer Genetics	4	25	75	100	4
	CORE – XI	33C	Neurogenetics and Epigenetics	4	25	75	100	4
	CORE – XII	33D	Bioethics and Biosafety	4	25	75	100	4
	CORE PRACTICAL– III	33P	Practical– III (Immunogenetics, Cancer Genetics, Epigenetics, Bioethics and Biosafety)	6	25	75	100	4
	ELECTIVE – III	3EC	Stress and Biomarkers (or)	4	25	75	100	4
		–	Stem Cell Biology					
	SUPPORTIVE – III	GS106	Genetic toxicology	2	12	38	50	2
IV	CORE – XIII	43A	Genetic Counseling (Self Study)	–	25	75	100	4
	PROJECT AND VIVA	–	Project and Viva Voce	–	–	–	150	6
			Hospital Visits/ Summer Internship*	–	–	–	20	2
			Research /Review Papers in Genetics****	–	–	–	20	
			Industrial Visit*	–	–	–	10	
SWAYAM –MOOCs– NPTEL Online 4weeks Course**				4 weeks	-	-	**50**	**2**
Total							**2300**	**92**

Additional credits / * Report to be submitted along with Project Work

SWAYAM –MOOCs – Online 4weeks course is mantadary and it should be completed within third semester**

PRACTICAL COMPONENTS:

The M.Sc., HGMB Core Practical Examination having the following Marks:

INTERNAL MARKS: 25

Major Practical		10 Marks
Minor Practical		5 Marks
Spotters (A, B, C , D and E)	5x2 =	10Marks
	Total =	25 Marks

EXTERNAL MARKS: 75

Major Practical		20 Marks
Minor Practical		10 Marks
Minor Practical		10 Marks
Spotters (A, B, C,D and E)	5x4 =	20Marks
Record and Viva		10+5 Marks
	Total =	75Marks

THEORY COMPONENTS:

The M.Sc., HGMB Core and Elective theory Examination having the following Marks.

CORE AND ELECTIVE PAPERS:MAXIMUM MARKS– 100

INTERNALMARKS: 25

Test – 15 Marks
Assignment– 5 Marks
Seminar – 5 Marks

EXTERNAL MARKS: 75

SECTION– A:10x1=10 Marks (Question No. 1 to 10)
Choose the best Answer type. Answer all questions. All questions carry equal marks.

SECTION– B: 5x5=25 Marks (Either or type– Question No. 11 to 15)
Answer all questions. All question carry equal marks. Each answer should not exceed 2 pages.

SECTION– C: 5x8=40 Marks (Either or type– Question No. 16 to 20)
Answer all questions. All Question carry equal marks. Each answer should not exceed 4 pages

SUPPORTIVE PAPERS:**MAXIMUM MARKS– 50**

INTERNAL MARKS: 12

Test – 6 Marks
Assignment – 3 Marks
Seminar – 3Marks

EXTERNAL MARKS: 38

SECTION– A: 5x1=5 Marks (Question No. 1 to 5)
Choose the best Answer type. Answer all questions. All questions carry equal marks.

SECTION– B: 3x3=9 Marks (Either or type– Question No. 6 to 8)
Answer all questions. All Question carry equal marks. Each answer should not exceed 1 page.

SECTION– C: 4x6=24 Marks (Either or type– Question No. 9 to 12)
Answer all questions. All Question carry equal marks. Each answer should not exceed 2 pages.

PROGRAMME OBJECTIVE FOR THE ENTIRE PROGRAMME

- **PO1:** This course provides the basic genetic terminology at a general level and describes the organisation and development of the genetic makeup on cellular and chromosomal level and be able to explain the basic molecular genetic mechanisms in relation to the structure and function of the cells.
- **PO2:** This course teaches the students to get an advanced level of knowledge on the activity of genes and genomes and the mechanisms of genome regulation.
- **PO3:** This course explains various types of molecular biological methods that are used to study the regulation and function of biomolecules and describe at a general level the use of different model systems in studies of specific biological questions and the function of genes.
- **PO4:** This course also explains the different hereditary patterns for genetic diseases and be able to describe different ways at a general level to identify disease genes.
- **PO5:** Students will acquire the ability to use their theoretical knowledge in solving applicative problems, with special regard to biomedical issues.

Title of the Subject: CORE–I: MEDICAL BIOCHEMISTRY
No. of Credits: 4
Code No.: 13A
No. of Teaching hours: 4

Course Objectives:

- Medical Biochemistry is a subject that mainly helps the learners to understand the basis of biochemical and physiological changes that are underlined in various genetic defects.
- The learners get familiarized with topics such as synthesis,classification, structure and properties of carbohydrates, lipids, proteins and enzymes.
- The learners will also learn about the genes that are responsible in various biochemical pathways with the chemical nature and properties of biomolecules.

UNIT – I
Molecular Basis of life. Amino acids: common structural features and their classification, properties of amino acids.Proteins: structure and classification, conformation of proteins. Role of proteins in various biological functions.

UNIT – II
Carbohydrates: structure and classification of monosaccharides, disaccharides and polysaccharides, their key roles in the cell. Carbohydrates and their clinical significance. Lipids: structure and classification, storage lipids and structural lipids in membranes, lipids with specific biological activities.

UNIT – III
Enzymes: Introduction,classification of enzymes based on IUB, formation of enzyme substrate complex, lock and key model, enzyme kinetics, allosteric regulation of enzymes. Nucleic acids: Nucleotide bases and pentoses, phosphodiester bond links, properties of nucleotide bases. DNA structure, types and properties, RNA structure,types and properties.

UNIT – IV
Bioenergetics and Metabolism:Biological importance of carbohydrates metabolism. glycolysis, TCA cycle, glycogen breakdown and synthesis, gluconeogenesis, oxidative phosphorylation. Biosynthesis of triglycerides and cholesterol. Oxidation of fatty acids. Biosynthesis of essential and non essential amino acids,urea cycle.Biosynthesis of purines and pyrimidines.

UNIT – V
Hormonal and Genetic Regulations of Metabolism: Hormones: functions and classification, hormonal regulation of fuel metabolism. Genes and chromosomes in metabolism.Molecular mechanism of signal transduction. DNA–as a new weapon in forensic sciences.

REFERENCES

1. Principles of Biochemistry (4^{th} edition) by Albert L. Lehninger, 2004. CBS Publishers and Distributors, New Delhi.

2. Biochemistry (4th edition) by D. Voet and J.G. Voet, 2010. John Wiley and Sons, USA Biochemistry, by R.H. Garrett and C.M. Grisham, Saunders College Publishers.
3. Biochemistry (8th edition) by Lubert Stryer, 2015.Co-written by Jeremy Berg, John L. Tymoczko and Gregory J. Gatto Jr and published by Palgrave Macmillan.
4. Fundamentals of Biochemistry (6th edition) by J.L. Jain *et al.*,2005. Published by S. Chand and Company.
5. Biochemistry (3rd edition) by S. C. Rastogi, 2012. Tata McGraw Hill Publishing Company, Ltd., N. Delhi.
6. Biochemistry: The Molecular Basis of Life (6thEdition) by Trudy McKee and James R. McKee, 2016. Published by New York Oxford University Press.

Course Outcome:

- Having well furnished knowledge about the biochemical basis of the biological substances.
- Knowing the detailed information regarding the role of biochemistry in metabolic reactions.
- Ability to gain knowledge regarding the intermolecular relationships of biomolecules.

Course Prepared by: Dr. A. VIJAYA ANAND

Course Verified by: Dr. A. VIJAYA ANAND

Title of the Subject: CORE–II: CELL BIOLOGY AND CELL SIGNALING
No. of Credits: 4
Code No.: 13B
No. of Teaching hours: 4

Course Objectives:

- Cell Biology gives a detailed understanding of the fundamental processes of cellular function is critical to all specialties within biology.
- This course detail properties of cell-cell and cell-substrate interactions and elaborates on the fundamentals of intracellular signal transduction during these interactions.
- Topics will include the function and regulation of signaling modules and membrane component in the context of cellular interactions with other cells and with the extracellular matrix.

UNIT – I
Cellular organization:Structure of cell organelles,an overview, cell wall and membrane structure. Membrane constituents: phospholipids, glycolipids, cholesterol, membrane proteins, receptors and phospholipases, phospholipid bilayer, fluid mosaic model.

UNIT – II
Membrane transport of small molecules and the ionic basis of membrane excitability.Principles of membrane transport, carrier proteins, passive movements of solutes and active membrane transport, ion channels and electrical properties of membranes. Cell junctions and cell adhesion molecules, basement membrane, extracellular matrix.

UNIT – III
Structure of nuclear envelope, the nuclear pore complex. Selective transport of proteins to and fro from nucleus. Regulation of nuclear protein import, transport of RNA's. Internal organization of nucleus. Chromosomes.

UNIT – IV
Cell Communication: General principles of cell signaling, types and mechanisms.Cell surface receptors,GPCR Molecular structure and functions, enzyme linked receptors, Activated tyrosine kinase and MAP kinase pathways. Cell Division: Overview of cell cycle, Mitosis and Meiosis. Cell Cycle control in mammalian cells.Checkpoint in cell cycle regulation

UNIT – V
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.

REFERENCES

1. Molecular Cell Biology (6th edition) by Lodish, 2007. Published byW. H. Freeman.
2. The Cell (7th edition) by Gerald Karp, 2016. Published by Wiley**.**
3. Cell,A molecular Approach (6th edition) by Cooper, 2013. Published by Sinauer Associates.
4. Molecular Cell Biology (6th edition) by Alberts, 2014. Published by Garland Science.
5. Cell and Molecular Biology (8th edition) by De Robertis, 2010. Published byLippincott Williams & Wilkins.
6. Principles of Biochemistry by Albert L. Lehninger (4th edition) 2004. CBS Publishers and Distributors, New Delhi.

Course Outcome:

- The students will be having a clear idea of the structural arrangements of the components of the cell, a functional unit of living system.
- The cell communication is a crucial part of living systems and their functioning. Being a life science student, this must be learnt from them clearly. This course deals with the same.
- The molecular mechanisms of the cell and cell signaling pathways are basics of the cellular research, this has also been dealt in this course.

Course Prepared by: Dr. A. VIJAYA ANAND

Course Verified by: Dr. A. VIJAYA ANAND

Title of the Subject: CORE–III: PRINCIPLES OF HUMAN GENETICS
No. of Credits: 4
Code No.: 13C
No. of Teaching hours: 4

Course Objectives:

- To study the development of human genetics.
- To study the genetic techniques as to gain the knowledge in the field of basic medical genetics.
- To get updated with the knowledge on genetic diseases and the research approaches.

UNIT – I History and development of human genetics; MendelianLaws (law of segregation, law of independent assortment, law of segregation and independent assortment)

UNIT – II

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.

UNIT – III Monogenic traits, autosomal inheritance, Sex–linked inheritance, Sex–limited and sex–influenced traits, mitochondrial inheritance, MIM number, consanguinity and its effects, Complex traits,approaches to analysis of complex traits, monozygotic and dizygotic twins and adoption studies, linkage, crossing over.

UNIT – IV Pedigree analysis: family history, pedigree symbols, construction of pedigrees, presentation of molecular genetic data in pedigrees, Complications to the basic pedigree patterns, spontaneous mutations, mosaicism and chimerism, male lethality, X–inactivation.

UNIT – V

Phenylketonuria, neurogenetic disorders: Alzheimer's disease, Duchenne Muscular Dystrophy, Sickle cell anemia, Diabetes mellitus*;* Management of genetic disorders.

REFERENCES

1. Human Genetics, Lewis, 1999.
2. Basic human Genetics, Mange and Mange, 1999.
3. Molecular and genetic analysis of human traits, Maroni, 2001.
4. An introduction to molecular genetics,Pasternack, 2000.
5. Human Molecular genetics,Strachan and Read, 2003.

6. An introduction to genetic analysis, Griffith's and Miller.
7. Lewin, Genes IX, 9th Edition Jonsand Bartlett 2007.
8. Snustadand Simmons, Principles of Genetics, 4th Edition, Wiley' 2005.
9. Albert*set al.*, Molecular Biology of the Cell 2nd Edition, Garland 2007.

Course Outcome:

- The principles of human genetics will help the students in obtaining the knowledge on fundamentals of genetics and the study pattern.
- Students will have an idea on identifying the genetic disease and the pattern of analyzation.
- The course would be helpful for the students by getting placed in government hospitals (cytogenetics and medical genetics lab) and private medical laboratories.

Course Prepared by: Dr. V. BALACHANDAR

Course Verified by: Dr. A. VIJAYA ANAND

Title of the subject: CORE–IV: MOLECULAR GENETICS
No.of Credits: 4
Code No: 13D
No.of Teaching hours: 4

Course Objectives:

- To understand thefundamentals of genetic material in living systems.
- To enable them with a better understanding about the defects in genetic material and to modify them for the proper functioning.
- To have an overview of all kinds of diagnostic techniques for such molecular mechanisms.

UNIT – I

Fundamentals of genes and chromosomes, general concept of a gene, gene families, non–coding genes, repetitive DNA, replication, transcription, splicing, translation and post translational changes in Prokaryotes and Eukaryotes. Regulation of Gene Expression at different levels.

UNIT – II Fundamentals of DNA Cloning and Molecular hybridization: Cell based DNA cloning, DNA hybridization assays, PCR based DNA cloning and DNA analyses. Types of mutations and nomenclature, mutagenesis. DNA damage and DNA repair: Types of DNA damage, Endogenous and Exogenous origins of DNA damage. DNA repair pathways: Error–prone, Mismatch, photo activation, excision and SOS.

UNIT – III

Homologous recombination: Models and molecular mechanisms, Site Specific recombination : Molecular mechanism. Transposons and transposition mechanisms.

UNIT – IV

Features of the human Genome: Organization and expression of the human genome, human multigene families. The human genome project: Mapping of the human genome: Physical mapping and Genetic mapping. Footprints of evolution, mutation and instability of human DNA. Chromosome walking.

UNIT – V

Dissecting and manipulating genes: Studying human gene structure and function and creating animal models of disease, gene theory and other molecular genetic based therapeutic approaches.

REFERENCE

1. Tom Strachan and Andrew. P. Read, Human Molecular Genetics, Bios‟ Scientific Pub UK. (1996).
2 Watson, J.D., Hopkins, N.H., Roberts, J.W., Steitz, J. and Weinter, A.M., Molecular Biology of Genes (4th edition) 1987. The Benjamin/Cummings publishing Company Inc., Joky.
3. Lewin, B. Genes VI (1997). Oxford University Press, Oxford, New York, Tokyo.
4. Darvell, J.et.al., Molecular Cell Biology (7th edition) 2002. Garland Publishing Iwc., New York.
5. Lewin, Genes IX, 9th Edition Jones and Bartlett 2007
6. Principles of Genetics Gardner, Simmons, Snustad 8th Edition 2006.
7. Molecular Biology by Glick and Pasternack, 2003.

Course Outcome:

- Being a genetics student, it is necessary to understand the fundamentals of hereditary materials and their role in functioning of human system.
- In Molecular Genetics, it is necessary to identify the damage in hereditary material and malfunctioning of genes to help in eradicating the disease.
- With the wide technical knowledge, the students will be able to modify the genes and restore the functions of the hereditary material.

Course prepared by: Dr. R. SIVASAMY

Course verified by: Dr. A. VIJAYAANAND

PRACTICAL– I (13P): MEDICAL BIOCHEMISTRY, CELL BIOLOGY AND CELL SIGNALING, PRINCIPLES OF HUMAN GENETICS, MOLECULAR GENETICS

MEDICAL BIOCHEMISTRY

1. Determination of blood glucose
2. Estimation of total cholesterol
3. Estimation of total protein and albumin
4. Estimation of AST, ALT and ALP
5. Estimation of Urea
6. Estimation of Creatinine

CELL BIOLOGY AND CELL SIGNALING

1. Uses of Microscope and Micrometry
2. Preparation of blood smear
3. Counting of RBC and WBC using Heamocytometer
4. Slides for Mitosis and Meiosis
5. Preparation of medium and cultivation of Human cell lines
6. DNA Fragmentation Assay

PRINCIPLES OF HUMAN GENETICS

1. Pedigree analysis
2. Karyotyping
3. Buccal micronucleus
4. DSM pattern
5. MIM
6. Mitochondrial DNA isolation
7. Mitochondrial syndromes

MOLECULAR GENETICS

1. Isolation of Blood genomic DNA
2. Isolation of RNA
3. Isolation of plasmid DNA
4. Estimation of DNA and RNA
5. Restriction Digestion and Ligation
6. Southern blotting
7. Polymerase chain reaction
8. Retrieval of sequences from nucleic acid databases

Title of the subject: ELECTIVE–I: GENOMICS AND PROTEOMICS
No.of Credits: 4
Code No: 1EB
No.of Teaching hours: 4

Course Objectives:

- To understand the genome organization of various organisms.
- To understand the corresponding protein and their functional role in various systems.
- To know the principles and working mechanism of all the genomic and proteomic techniques.

UNIT – I
Genomics,genes and chromosomes. Genome: Structure and organization of prokaryotic and eukaryotic genome,genetic and physical mapping. Assembly of a contiguous, DNAsequence,clonecontigapproach,whole genome shot gun sequencing. Human Genome Project:Importance and impact.

UNIT – II
Genomics of *E. coli*, *Arabidopsis thaliana* and *Musmusculus*. Pharmacogenomics: High throughput screening for discovery and identification of drugs. Drug targets and developmentSNP analysis**.**

UNIT – III
Function prediction of Gene, computational and experimental analysis. Transcriptomics,transcriptome,yeasttranscriptome and the human transcriptome,link between the transcriptome and proteome. Transcripts analysis,SAGE, non–array based whole transcriptome analysis, differential display,Yeast two hybrid systems.

UNIT – IV
Proteomics*:* Tools for proteome analysis,2D,PAGE, Mass spectrometry, MALDI,TOF, TANDOM,MS, LC,MS, protein microarray, SAGE. Protein: Protein interactions and uses of their databases. Peptide finger printing: Techniques for protein purification, sequencing of proteins.

UNIT – V
Biological Databases: Overview, applications, gene and protein sequence databases,GenBank, EMBL, DDBJ, and PDB. Sequence alignment and sequence analysis**:** Concept of local and global sequence alignment, Pair–wise sequence alignment, BLAST,Multiple sequence alignment, homology, analogy.

REFERENCE

1. Brown, T.A., 2006, Genomes, John Wiley and Sons, Pvt. Ltd., Singapore.
2. Campbell A,Heyer. 2004, Discovering Genomics, Proteomics and Bioinformatics , Pearson Education, New Jersey.

3. Liebler, Daniel,C.,2002, Introduction to proteomics tool for the new biology, Humana Press, New Jersey.
4. Lesk, A.M. 2007. Introduction to Bioinformatics, Oxford University Press, Oxford.
5. Old, R.W. and Primrose, S.B. 2006. Principles of Gene Manipulation, Blackwell Science Publication, Berlin.
6. Pennington, S.R , Dunn,M,J., 2002, Proteomics from Protein sequence to function, Viva Books Pvt., Ltd, New Delhi.
7. Introduction to Bioinformatics, TramontanoA,Chapman and Hall.
8. Understanding Bioinformatics, Zvelebil M and Baum JO,Taylor and Francis.

Course Outcome:

- They will have a clear understanding behind the role of genes and proteins in various organisms.
- The mechanism of protein product in every genes behind molecular pathways can help students in understanding the functioning of various systems.
- Techniques used in genomics and proteomics study will be helpful in future research by exploring many aspects of defective genes and their products.

Course prepared by: Dr. R. SIVASAMY

Course verified by: Dr. A. VIJAYAANAND

Title of the Subject: ELECTIVE–I: r–DNA TECHNOLOGY
No. of Credits: 4
Code No.: 1EA
No. of Teaching hours: 4

Course Objectives:

- To understand the concepts of gene cloning and vectors used.
- To study the techniques available to reveal the structural architecture of the genetic materials.
- To study the methods used for extracting and eluting the genetic material from biological samples.

UNIT – I
Genes within the cells, genetic elements that control gene expression, restriction and modification enzymes (Restriction enzymes, DNA ligases, Klenow fragment, T_4DNA polymerase, Polynucleotide kinase, Alkaline phosphatase)

UNIT – II
Construction of genomic DNA, Design of linkers and adaptors. Characteristics of plasmid and phage vectors, prokaryotic and eukaryotic expression vectors, Insect, Yeast and Mammalian vectors.

UNIT – III
DNA sequencing (Maxam and Gilbert, Sangers, Pyro, sequencing, Shotgun sequencing method), Protein sequencing,RNA sequencing, Southern and Northern and Western blotting, *In situ* hybridization, Site–directed mutagenesis, DNA labelling, DNA fingerprinting (RAPD, RFLP, AFLP).

UNIT – IV
Isolation of DNA, mRNA and total RNA, polymerase chain reactions (PCR) and modified PCR, gene isolation, gene cloning, screening and expression of cloned gene, transposons and gene targeting.

UNIT – V
Production of insulin, human growth factor, gene therapy (antisense and ribozyme technology), human genome project and its application. Large scale gene expression analysis (Microarray for DNA and protein), strategies for genome sequencing, Safety guidelines of recombinant DNA research.

REFERENCES

1. H.K. Das, Text Book of Biotechnology, 1st ed, 2004, Wiley Publishers.

2. J. M. S. Bartlett and D. Stirling. (Edited). *PCR Protocols, Second Edition. Methods in Molecular Biology*. Vol.2 226. Humana Press Inc., Totowa, NJ
3. Old and Primrose, Principles of Gene Manipulation, 3rd Ed, Blackwell Scientific Publishers.
4. Genetic Engineering by S. Rastogi and N. Pathak, Oxford Univ. Pub.
5. Recombinant DNA Technology: Setubal: Introduction to computational Molecular Biology. Cengage Learning India (P) Limited.
6. D.M. Glover, Genetic Engineering, Cloning DNA, Chapman and Hall, New York, 1980.
7. Brown TA, Genomes, 3rd ed. Garland Science 2006.

Course Outcome:

- rDNA technology is a very important subject dealing with many of the useful techniques and its application.
- It is having information on techniques of basic and advanced which will helps the PG students to understand the techniques to be used in their project work.
- It is very important in respect to CSIR NET for the PG students since one of such unit is there in the competitive examination.

Course Prepared by: Dr. P. VNAYAGA MOORTHI

Course Verified by: Dr. A. VIJAYA ANAND

Title of the subject: SUPPORTIVE–I: GENETICS AND SOCIETY
No.of Credits: 2
Code No: GS09
No.of Teaching hours: 2

Course Objectives:

- To know the impact of genetic diseases on the society.
- To make students aware about the ethical and legal issues behind genetic research.
- To have a better understanding about the social impact on various kinds of research associated with genetics.

UNIT – I
The history and impact of Genetics in Medicine and Society, Medical Genetics, Early beginnings, Centre for Genetics and Societyaround the world, an overview. Genes and Pedigrees in a Population. Creation of Awareness about Genetic diseases and disorders.

UNIT – II
Human Genome Project, Beginning and Organization of the HGP, Sequencing of the Human Genome, Promises and Achievements, Ethical, Legal and Social issues of the HGP, Other Genome Projects initiated as a direct consequence of HGP completion, Human Genome Diversity Project.

UNIT – III
Advances in Modern Genetics: Some of the areas of concern in Modern Genetics, GM crops, personal DNA data, Gene Therapy, Pharming, Ethical and Legal issues in Medical Genetics.

REFERENCE
1. Genetics,A Conceptual Approach, 4th ed., B.A. Pierce, Palgrave Macmillan, 2012.
2. Emery's Elements of Medical Genetics, 14th ed., P.D. Turnpenny and S. Ellard, Churchill Livingstone, 2012.
3. Introduction to Genetics,A Molecular Approach, T. Brown, Garland Science, 2012
4. Genome Duplication, Concepts, Mechanism, Evolution and Disease, M.L. De Pamphilis and S.D. Bell, Garland Science, 2011.
5. Human Molecular Genetics, 4th ed., T. Strachan and A. Read, Garland Science, Taylor and Francis Group, 2011.
6. A Guide to Genetic Counseling,2nd ed., W.R. Uhlmann, J.L. Schuette and B.M. Yashar, Wiley, Blackwell, 2009.

Course Outcome:

- The students will have a great understanding about the impact of genetics in medicine and society

- Learning about the human genome project will make them more understanding about the genetic makeup of all living systems
- The ethical and legal issues involved in genetics will give a better understanding about what not to do in research and will guide them towards good goal oriented path

Course prepared by: Dr. R. SIVASAMY

Course verified by: Dr. A. VIJAYAANAND

Title of the Subject: CORE–V: HUMANCYTOGENETICS
No. of Credits: 4
Code No.: 23A
No. of Teaching hours: 4

Course Objectives:

- To know the cytogenetic methods and the use in genetic diseases.
- To gain knowledge on cytogenetics as diagnostic approach.
- To study about the principles and applications in medical practice.

UNIT – I

History of human chromosome research, Denver conference (1940),Chicago conference (1966),Paris conference (1971), nomenclature of human chromosome, identification of human diploid chromosome, peripheral blood cultures; banding techniques: G,Q,C and R band identification of 23 pairs of human chromosomes by band position.

UNIT – II

Autosomal and sex chromosomal syndromes, structural chromosomal syndromes, molecular pathology of monogenetic diseases. Inborn errors of metabolism: Phenylketonuria and Galactosemia.

UNIT – III

Genetics in medical practice, genetic principles and their application in medical practice*;* case studies (Interacting with patients, learning family history and drawing pedigree chart).

UNIT – IV Prenatal diagnosis: Chorionic villi sampling, foetoscopy, ultrascopy, amniocentesis. Postnatal diagnosis: Peripheral blood leucocyte culture, sister chromatid exchange, fragile site, Mitotic index, Genetic Counseling.

UNIT – V Hereditary forms of cancer, oncogenes and cancer, chromosomes and cancer. Cancer and the environment. Genetic predisposition to sporadic and non–sporadic cancer.

REFERENCES

1. Human Heredity Principles and issues, by Michael R. Cumming's. 3rd Edition.
2. Genetics Medicine, by Karl. H. Muench Elsevier Pb.London.
3. Human Genetics by Elof Axel Carlson, TATA McGraw, Hill Pb. NewDelhi.
4. Attwood, T.K. and Parry Smith, D.J. 1999, Introduction to Bioinformatics, Longman Publications, Pearson Education Ltd., NewDelhi.
5. Baxevanis, A.D. and Francis Ouelletle, B.P., 1998, Bioinformatics, a Practical Guide

to the Analysis of Genes and Proteins, Wiley, Interscience Publication, New York.
6. Bishop, M.J. and Rawlings, C.J., 1987, Nucleic Acid and Protein Sequence Analysis, A Practical Approach, IRL Press, Oxford.
7. Brown, T.A., Genomes, 1999, John Wiley and Sons Inc., NewYork.
8. Zhang, W.E.I. and Shmulevich, I.Y.A. 2002, Computational and Statistical Approaches to Genomics, Kluwer Academic Publishers, London.

Course Outcome:

- The course would help in acquainting with case studies and the practice of genetic counseling individually.
- Cytogenetic studies are basic approach in genetic testing hence, the students will get trained in identifying hereditary diseases and know the importance of chromosomal analysis in medical practice.
- By studying this course, students will be placed in hospitals and R&D laboratories during their career.

Course Prepared by: Dr. V. BALACHANDAR

Course Verified by: Dr. A. VIJAYA ANAND

Title of the subject: CORE–VI: MEDICAL GENETICS
No.of Credits: 4
Code No: 23B
No.of Teaching hours: 4

Course Objectives:

- To have a thorough understanding about human genetic diseases, disorders and syndromes.
- To know the risks associated with genetic diseases, disorders and syndromes.
- To initiate the genetic counselingfor the family members about the chances of inheriting the genetic disease to the following generations.To prevent common people from genetically inherited diseases.

UNIT – I An overview of the genetic basis of syndromes and disorders. Monogenic diseases with well–known molecular pathology : Cystic fibrosis, TaySach's syndrome, Marfan syndrome.

UNIT – II Inborn errors of metabolism–Genetic bases and Classification, Phenylketonuria, Maple syrup urine syndrome, Mucopolysaccharidosis, Galactosemia. Genome imprinting Syndromes: PraderWilli and Angelman syndromes, Beckwith–Wiedemann Syndrome.

UNIT – III Neurogenetic disorders: CharcotMarieTooth syndrome, Spinal muscular atrophy. Syndromes due to triplet nucleotide expansion: Alzheimer's disease. Muscle genetic disorders: Dystrophies (Becker Muscular Dystrophy) myotonias, myopathies.

UNIT – IV Genetic disorders of Haemopoitic systems: Overview of Blood cell types and haemoglobin, Sickle cell anemia, Thalassemia, Hemophilia. Genetic disorders of Eye: Colour Blindness, Retinitis pigmentosa, Glaucoma, Cataracts.

UNIT – V Complex polygenic syndromes: Hyperlipidemia, Atherosclerosis, Diabetes mellitus. Mitochondrial syndromes.Management of genetic disorders.

REFERENCE

1. Clinical Genetics, A short course by Wilson, 2000
2. Principle and Practice of Medical Genetics, Rimoinet al., 2002.
3. Genes in Medicine, Rasko and Doumes, 1995.
4. An introduction human molecular genetics, Pasternack, 2000.

Course Outcome:

- The Core objective of studying the Medical genetics paper is to understand the uniqueness of disorders and syndromes at the molecular level.

- In depth knowledge in intellectual and technical part of the Medical Genetics, will help the students to take a career in the field of Medical Genetics.
- Overall, studying this paper will enable the students to educate the society about the genetic disorders and syndromes, which will help to eradicate genetic disorders in near future.

Course prepared by: Dr. R. SIVASAMY

Course verified by: Dr. A. VIJAYAANAND

Title of the Subject: CORE–VII: DEVELOPMENTAL AND BEHAVIORALGENETICS
No. of Credits: 4
Code No.: 23C
No. of Teaching hours: 4

Course Objectives:

- To study the basic developmental stages of the animal development and its associated internal cellular changes.
- To understand the developmental morphogenetic and gene expression pattern in Drosophila models.
- To reveal the information on behavioral changes and its associated disorders in human being.

UNIT – I
Early development, fertilization, types of cleavage, gastrulation: Cell movement and formation of germ layers in frog, chick and mammals. Concept of determination, Competence and differentiation. *Drosophila*: Maternal genes and formation of body axes and signaling pathways in development, segmentation genes, homeotic genes function, imaginal disc development and sex determinations.

UNIT – II
Differentiation of germ cells and gametogenesis, fertilization and implantation, development of vertebrate nervous system, formation of neural tube, formation of brain regions, Axes formation and HOX genes, genetic determination of sex in mammals, stages of human embryonic development. Genetic basis of male and female infertitility and Assisted Reproductive technology

UNIT – III
Programmed rearrangements in genes, chromatin diminution, endoreplication cycles, gene amplification, genome imprinting, congenital malformations and teratogenesis, epigenetic regulation. Regeneration, Senescence, Embryonic stem cells and their applications.

UNIT – IV
Nature and behavior, Genetic experiments to investigate animal behavior, identifying genes for behavior, investigating the genetics of human behavior, Twin and adoption study designs, interpreting heritability, Linkage and association studies.

UNIT – V
Neurogenetic study designs: Genetic and environmental manipulations, learning and memory. Psychopathology, dementia, schizophrenia, mood disorders, anxiety disorders. Disorders of childhood personality and personality disorders, antisocial personality, criminal behavior. cognitive disabilities, mental retardation, learning disorders, Communication disorders.

REFERENCES

1. Scott F. Gilbert, Developmental Biology, VIII edition, Sinauer Associates Inc.,
2. Publishers, Sunderland, Massachusetts USA (2006).
3. Bruce Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, P. Walter (2008). Molecula
4. Biology of the cell, V edition, John Wiley and sons Inc., 2008.
5. Benjamin Lewin (2010), Genes X, Jones and Bartlett Publishers, England

Course Outcome:

- Developmental and Behavioral Genetics (DBG) deals with the basic developmental aspects of living organism and studying them by using Drosophila model.
- Drosophila models, due its unique genetics construction, is the best suitable genetic model for studying the neurodegenerative disorders, cancer and obesity. It will help the PG students to understand its usage in research and thereby chance to establish new avenues in research in their research career.
- DBG provide enough information on behavioral changes and its associated disorders. It helps students to overcome the basic and essential knowledge about disorders of behaviors and its genetic basis.

Course Prepared by: Dr. P. VNAYAGA MOORTHI

Course Verified by: Dr. A. VIJAYA ANAND

Title of the Subject: CORE–VIII: BIOSTATISTICS AND BIOINFORMATICS
No. of Credits: 4
Code No.: 23D
No. of Teaching hours: 4

Course Objectives:

- The role of Biostatistics is tremendous in all branches of life sciences. It serves as the base to analyze and understand the sample outcomes with comparative and probability based studies.
- Bioinformatics helps the learners to learn about the biological databases such as GenBank, NCBI etc., and searching the sequence for alignment using BLAST.
- This course will provide the basic knowledge on essential research works to learners.

UNIT – I Statistical population and sample in biological studies, variables, qualitative and quantitative measures, discrete and continuous series. Sampling methods: probability and non–probability methods, classification of data, representation of data, frequency distribution, tables, diagram and graph.

UNIT – II Measures of central tendency: mean, median and mode. Measures of dispersion: range, mean deviation, quartile deviation, standard deviation, variance, standard error. Probability, addition and multiplication rules, Bayes theorem, Probability distribution: binomial, poisson and normal distribution.

UNIT – III Correlation: types, methods of correlation, graphic method, Karl Pearson's correlation, Spearman Rank correlation. Regression analysis, equation, estimation of unknown value from known value. Chi–square test, test of independence, test for goodness of fit and homogenecity.

UNIT – IV Testing of hypothesis: Null and alternate hypothesis, test for significance for large samples and test for significance for small samples. ANOVA: One way and two way classification.Statistical analysis of Duncan's multiple range test, weighted pair group method with arithmetic mean and unweighted pair group method with arithmetic mean methods.

UNIT – V Introduction to databases: database, searchsequence and search engines. Database tools: NCBI, FASTA, BLAST, CLUSTAL–W, PUBCHEM and CHEMSKETCH. Introduction to Dendrograms. Phylogenetics: ultrasonic trees, parsimony, ultrametric problem–perfect phylogeny, phylogenetic alignment, multiple alignment and tree construction, PHYLogeny inference package programs. Next Generation Sequencing.

REFERENCES

1. Statistical Methods (44th edition) by Gupta S.P, 2014. Sulton Chand and Sons Publishers, New Delhi.
2. Introduction to Bioinformatics by Attwood T.K. and Parry D.J, Smith D.J, 2009. Pearson Education (Singapore) Pvt. Ltd.
3. Biostatistics : A foundation for Analysis in the Health Sciences (10th edition) Wayne W. Daniel, 2013 Published by Wiley Series in Probability and Statistics.
4. Introductory Statistics (7thEdition) by Prem S. Mann, 2010. Published by John Wiley and Sons (ASIA) Pte Ltd.
5. Basic Statistics–Aprimer for Biomedical Sciences (4th edition) by Olive Jean Dunn, 2009. Published by Willey.
6. PC Organisation by S.K.Chauhan, 2008. Published by S.K.Kataria and Sons, Delhi.

Course Outcome:

- Biostatistics is the tool to analyze and interpret the results of the biological research. This course helps the students to understand the role of biostatistics.
- The various methods of analysis have also been dealt in this course, which helps the students to get clear informations regarding the biostatistical analysis.
- This course also deals with the computational tools of analysis for biological research.

Course Prepared by: Dr. A. VIJAYA ANAND

Course Verified by: Dr. A. VIJAYA ANAND

PRACTICAL– II (23P): HUMAN CYTOGENETICS, MEDICAL GENETICS, DEVELOPMENTAL AND BEHAVIORAL GENETICS, BIOSTATISTICS AND BIOINFORMATICS

HUMAN CYTOGENETICS

1. Problems related to Mendelianlaws
2. Peripheral blood leukocyte culture for chromosomalstudies
3. Sister chromatid exchange
4. Blood Micronucleustest
5. Chromosomal disorders: Numerical andStructural
6. COMET assay
7. Lymphoblastic stem cells

MEDICAL GENETICS

1. Gene polymorphism study using RAPD
2. Mutation identification by RFLP
3. DNA fragmentation Assay
4. ELISA
5. Western blotting analysis
6. PCR detection of mutation using specific primers

DEVELOPMENTAL AND BEHAVIORAL GENETICS

1. Live Observation of *Drosophilla melanogaster* embryo
2. Study of gene expression during development with Lac–Z reporter gene in embryos
3. Live Observation of Chick embryo
4. Dissection and mounting of Imaginal discof*Drosophila melanogaster*
5. Study of behavior in *Drosophila* model: 1. Climbing assay and 2. Flight assay
6. Dissection of brain of *Drosophila melanogaster*
7. Dissection and Visualization of Mitochondria in flight muscles
8. Case studies, learning disorders, Mental retardation

BIOSTATISTICS AND BIOINFORMATICS

1. Learning of SPSS software
2. Database and Searching tools

Title of the Subject: ELECTIVE–II: BIOINSTRUMENTATION
No. of Credits: 4
Code No.: 2EB
No. of Teaching hours: 4

Course Objectives:

- To teach the techniques of biology, biotechnology and genetic engineering and cytogenetics.
- To study the principles, working mechanism and its application in different fields of biology.
- To understand the imaging techniques useful for all fields of sciences.

UNIT – I
Centrifugation:Principles of centrifugation, different types of instruments, rotors and its applications.Chromatography: Principles and application of adsorption, partition and ion,exchange chromatography, gel filtration, affinity, high performance liquid chromatography and gas liquid chromatography.

UNIT – II
Electrophoresis: Moving boundary and zonal electrophoresis, gel electrophoresis (Native PAGE, SDS PAGE, agarose gel electrophoresis, Real Time PCR), isoelectric focusing technique. Immunoelectrophoresis, ELISA and RIA. Sequencing: NGS and Sanger sequencing.

UNIT – III
Radioactivity: Disintegration of radionuclides, half–life of radioactive compounds, determination of radioactivity by Geiger Muller counter and scintillation counting, isotopic tracer techniques and autoradiography. Applications of radio isotopes in biological and medical sciences.

UNIT – IV
Spectrophotometry: Beer,Lamberts law, extinction coefficient and its importance, design of colorimeter and spectrophotometer. Principles of atomic absorption spectrophotometry andits application in Biology. Principles and applications of x–ray diffraction and NMR in structure determination.

UNIT – V
Principles and Applications of Light, Phase Contrast, Fluorescence Microscopy, Scanning and Transmission Electron Microscopy, Confocal Microscopy, Cytophotometry and Flow Cytometry, advances of microscopy.

REFERENCES

1. Skoog, D.A. *et al.,* “Principles of Instrumental Analysis”, 5th Edition, Thomson / Brooks,Cole, 1998.
2. Braun, R.D. “Introduction to Instrumental Analysis”, Pharma Book Syndicate, 1987.

3. Biophysical chemistry,Upadhyay, Upadhyay and Nath.
4. Instrumental methods of chemical analysis,P.K. Sharma.
5. Handbook of Biomedical Instrumentation,R.S. Khandpur, Tata McGraw Hill.

Course Outcome:

- Bioinstrumentation (BI) deals with techniques of biology, biotechnology and genetic engineering and cytogenetics.
- It is one of the very important subject for students to learn the basic principles, structural architecture, working mechanism and its application in different fields of biology.
- This syllabus enhance the quality of the students to get involved in knowing the exact information of the instruments and support their career.

Course Prepared by: Dr. P. VNAYAGA MOORTHI

Course Verified by: Dr. A. VIJAYA ANAND

Title of the Subject: ELECTIVE–II: NANOBIOLOGY
No. of Credits: 4
Code No.: 2EC
No. of Teaching hours: 4

Course Objectives:

- To understand the origin, development and application of Nanotechnology.
- To measure the level of development of Nanotechnology in healthcare sectors.
- To estimate the dispersal and cause of nanoparticle in the environment and associated health hazards.

UNIT – I
Scientific revolution, atomic structures, molecular and atomic size, emergence of Nanotechnology, carbon age, new form of carbon, Challenges in Nanotechnology.

UNIT – II
Carbon nanotubes, metals (Au, Ag) and Metal oxides (TiO_2, CeO_2, ZnO). Physicochemical characteristics of nanomaterials. Infra red spectroscopy (IR), UV–visible, Absorption and Diffraction analyses X–ray diffraction. Scanning Electron Microscope (SEM), Transmission Electron Microscopy (TEM).

UNIT – III
Nanomolecular diagnostics and Biosensor. Nanodiagnostics*:* Nanoparticles for molecular diagnostics, DNA nanomachines, Nanobiosensor, CNT biosensor, DNA nanosensor, Nanowire biosensor, application of nanodiagnostics.

UNIT – IV
Nanopharmaceutical:Nanobiotechnology for drug discovery, protein and peptide based compounds for cancer and diabetes, drug delivery, nanoparticle based drug delivery, lipid nanoparticles, vaccination, cell therapy, Gene therapy.

UNIT – V
Health impact of Nanomaterials: Source of nanoparticles, Handling of Nanomaterials, entry routes into the human body: Lungs, inhalation, deposition and translocation, intestinal tract, skin and eye. Nanoparticle interaction with biological membrane, Neurotoxicology.

REFERENCES

1. M. Wilson, K. Kannangara, G Smith, M. Simmons, B. Raguse, Nanotechnology: Basic science and Emerging technologies, Overseas Press India Pvt Ltd, New Delhi, First Edition, 2005.

2. C.N.R. Rao, A. Muller, A.K. Cheetham (Eds), The chemistry of nanomaterials: Synthesis, properties and applications, Wiley VCH Verlag Gmbh and Co, Weinheim, 2004.
3. Kewal K. Jain, The Hand book of Nanomedicine, Humana Press, Springer 2008.
4. Dr. Parag Diwan and Ashish Bharadwaj (Eds), Nano Medicines, Pentagon Press, 2006.
5. Challa S.S.R. Kumar, Nanomaterials for medical diagnosis and therapy, Viley, VCH, 2007.

Course Outcome:

- Nanobiology, most essential subject in terms its broader application in n number of fields and most importantly in healthcare sectors.
- It is giving enough information on the synthesis and its application.
- It deals with basic information on nanotechnology origin and till its advancements. It will establish basic understanding on the nanotechnology and its supports the students to start their career in nanotechnology.

Course Prepared by: Dr. P. VNAYAGA MOORTHI

Course Verified by: Dr. A. VIJAYA ANAND

Title of the Subject: SUPPORTIVE–II: PRINCIPLES OF GENETICS
No. of Credits: 2 Code No.: 2GS89
No. of Teaching hours: 2

Course Objectives:

- To study the development of human genetics
- To study the genetic techniques as to gain the knowledge in the field of basic medical genetics.
- To get updated with the knowledge on genetic diseases and the research approaches

UNIT – I

Mendelian principles*:* Dominance, segregation, independent assortment, deviation from Mendelian inheritance, Concept of gene, Allele, multiple alleles, pseudoallele, complementation tests.

UNIT – II

Extensions of Mendelian principles, Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy.

UNIT – III

Extensions of Mendelian principles, sex linkage, sex limited and sex influenced characters. Extra chromosomal inheritance, Inheritance of mitochondrial and chloroplast genes, maternal inheritance.

REFERENCES

1. Genetics, A Conceptual Approach, 4th ed., B.A. Pierce, Palgrave Macmillan, 2012.
2. Genetics: A molecular perspective,1st edition W.S. Klug and M.R. Cummings, Benjamin Cummings,2002.
3. Principles of Genetics, 6th ed. (Course Smart), D.P. Snustad and M.J. Simmons, John Wiley and Sons, 2012.

Course Outcome:

- The principles of human genetics will help the students in obtaining the knowledge on fundamentals of genetics and the study pattern.
- Students will have an idea on identifying the genetic disease and the pattern of analyzation.
- The course would be helpful for the students by getting placed in government hospitals (cytogenetics and medical genetics lab) and private medical laboratories.

Course Prepared by: Dr. V. BALACHANDAR

Course Verified by: Dr. A. VIJAYA ANAND

Title of the Subject: CORE–IX: IMMUNOGENETICS
No. of Credits: 4
Code No.: 33A
No. of Teaching hours: 4

Course Objectives:

- To understand the basics of immune cells, development and maturation.
- To study the types of Immunoglobulins and role of antibodies in transplantation.
- To study the basics of vaccines, development, uses and the techniques to measure the quantity in clinical diagnosis.

UNIT – I
Historical perspective, lymphoid organs, lymphocytes. Cells of immune system, T and B cell activation and maturation, Haematopoiesis, Haematopoitic stem cells, programmed cell death and necrosis. Immunoglobulins, Class switching, Antigens. The molecular basis of antigen and antibody interactions. Types of immunity and immune responses.

UNIT – II
Cytokines, interleukins, complement system, the classical pathway, alternate pathway and the membrane attack pathway. Immunostimulation, Immunosupression and its clinical significance, Immunopotentiation, adjuvants.

UNIT – III
MHC gene in man and mouse, Genomic map, gene expression, antigen presentation and processing by MHC class I and class II molecules. Tissue typing and organ transplantation, HLA assays, Immunoinformatics. Autoimmune diseases, Transplantation Immunology, Tumour Immunology, Immunobiology of HIV infection.

UNIT – IV
Immunization, active and passive. Vaccines*:* whole organism vaccine, synthetic peptide vaccine, multivalent subunit–vaccine, anti idiotype vaccine, designer vaccine, edible vaccine, DNA vaccine, recombinant vector vaccine. Production and applications of monoclonal antibodies, genetically engineered monoclonal antibodies, Abzymes.

UNIT – V
Radioimmuno Assay, ELISA, Immunofluoresence technique, Immune–histochemistry, Karyotyping. Molecular medicines in cancer therapy. Microarray as a tool for detection of human genetic disorders.

REFERENCES

1. Kuby, J., 2008, Immunology, W.H. Freeman and Co., New York.
2/ Roit, I.N., Brostaff, J.J. and Male, D.K., 2007, Immunology, C. Mosby, St. Louis.
3/ Van Dam, Mieras, M.C.E., de Jeu, W.H., de Vries, J., Currell, B.R., James, J.W., Leach, C.K.

and Patmore, R.A., 20044, Technological Applications of Immunochemicals, Butterworth, Heineman Ltd., Oxford.
4. Lewin, Genes IX, 9th Edition Jones and Bartlett 2007.

Course Outcome:

- Immunogenetics (IG) is a very important and inevitable subject of all times since it is having information on basic immunological structure, function and it different applicable technologies.
- The recent additions on immunoinformatics have added extra strength to this subject. It makes students to realize what basically need to be understood in view of disease and vaccine preparation.
- IG is also give information on the constraints exists in developing novel medicine/vaccine for disease of life threatening. It helps students to realize the concept behind the disease and look into the matters essential for their work.

Course Prepared by: Dr. P. VNAYAGA MOORTHI

Course Verified by: Dr. A. VIJAYA ANAND

Title of the subject: CORE–X: CANCER GENETICS
No.of Credits: 4
Code No: 33B
No.of Teaching hours: 4

Course Objectives:

- To understand the various types of cancers and their prevalance
- To understand the molecular basisand functional aspect of various genes involved in progression of cancer
- To make them find out various pathways involved in various cancers and to equip the students with the existing and novel therapeutic approaches for controlling cancer growth

UNIT – I History, scope and current scenario of cancer research. Cancer:Types and their prevalence,Carcinoma, Lymphoma and Malignancy. Classification based on tissue types. Molecular biology of tumor invasion and metastasis.

UNIT – II Cell transformation andtumourigenesis, oncogenes, tumour suppressor genes, DNA repair genes and genetic instability, epigenetic modifications, telomerase activity, centrosome malfunction. Tumour progression: angiogenesis and metastasis.

UNIT – III

Oncogenes and human cancers: 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, tumour suppressor genes . Cell cycle and Cancer , Knudson's two hit hypothesis.

UNIT – IV

Non–random chromosome abnormalities in hematologic neoplasms: Chronic myeloid leukemia, Chronic lymphocytic leukemia, Acute myeloid leukemia, Acute lymphoblastic leukemia, Myelodysplastic syndromes, Myeloproliferative disorders, Hodgkin's disease, non Hodgkin's lymphoma, Burkitt's lymphoma.

UNIT – V

Familial cancers: Retinoblastoma, Wilm'stumour, Li–Fraumeni syndrome, Colorectal cancer and Breast cancer. Cancer therapy: At cellular, gene and protein level. Stages of cancer–TNM classification. Principles of cancer biomarker and their applications, chemotherapeutics for cancer, Phytotherapy for cancer.

REFERENCE

1. The Biology of Cancer, R.A. Weinberg, Garland Science, Taylor and Francis Group, 2007.
2. Cancer Biology, 3rd ed., R.J.B. King and M.W. Robbins, Pearson Education Ltd., 2006.
3. Cancer cytogenetics,chromosomal and molecular genetic aberrations of tumor cells,3rd ed., S.Heim and F. Mitelman, Wiley,Blackwell Inc., 2009.

4. Human cytogenetics: malignancy and acquired abnormalities,a practical approach,3rd ed., D.E. Rooney, Oxford University Press, 2001.
5. ISCN 2013 An International System for Human Cytogenetic Nomenclature (2013),Recommendations of the International Standing Committee on Human Cytogenetic Nomenclature, L.G. Shaffer, J. McGowan,Jordan and M. Schmid, S. Karger, 2013.
6. Introduction to the Cellular and Molecular Biology of Cancer,4th ed., M.A. Knowles and P.J. Selby, Oxford University Press, 2005.

Course Outcome:

- Worldwide, Cancer is the most important life threatening disease.
- Understanding the basis of cancer will aid the students to gain knowledge in cancer and their progression in their future research
- Understanding the molecular mechanism of cancer will help the students to develop a technology to identify the cancer at the earliest. Deep knowledge in Cancer Genetics is important for the student community to create awareness in the society.

Course prepared by: Dr. R. SIVASAMY

Course verified by: Dr. A. VIJAYAANAND

Title of the Subject: CORE–XI: NEUROGENETICS AND EPIGENETICS
No. of Credits: 4
Code No.: 33C
No. of Teaching hours: 4

Course Objectives:

- Neuroscience is the scientific study of the brain and nervous system, whose ultimate goal is to understand higher brain function at a variety of levels.
- This course provides the learners with current knowledge about common neuro diseases and disorders from both a basic research and a clinical perspective.
- Epigenetics explain the key concepts of what epigenetics is, types of epigenetic modifications, the importance of epigenetics and how it can be related to disease. It also discusses how diet can have an impact on health and disease through epigenetics.

UNIT – I Organization of the nervous system. Histology of the nervous tissue: supporting cells and neurons. Neurophysiology: Resting membrane potential, Membrane potentials and signals. synapse, postsynaptic potentials and synaptic integration. Neurotransmitters and receptors. Neuroendocrine system.

UNIT – II

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).Diagnostic procedures for assessing neurogenetic diseases.

UNIT – III

Degenerative brain diseases: Cerebrovascular accidents,stroke, Parkinson disease and Alzheimer's disease:history, causes, signs, symptoms, pathophysiology, diagnosis, preventions and management. Therapeutics and movel therapeutics

UNIT – IV

Epigenetics:Mechanisms of DNA methylation, histone modifications, chromosomal position effect and gene variegation, epigenetic control of gene activity, analysis of gene–specific DNA methylation, methods of assessing genome–wide DNA methylation. Model organism of epigenetics: Drosophila

UNIT – V

Effects of diet and environmental agents on epigenetic processes. Role of epigenetic in immune diseases and disorders.Imprinting disorders in humans. Epigenetic therapy.

REFERENCES

1. Human Anatomy and Physiology by Elaine N. Marieb and Katja Hoehn, 2012.Published by Pearson Publisher.
2. Textbook of Medical Physiology (11th edition) by Arthur C Guyton and John E Hall, 2006. Published byElsevier Publications.
3. NeurogeneticsA Guide for Clinicians by Nicholas Wood, 2012. Published by Cambridge University Press.
4. Practical Guide to Neurogenetics by Thomas T. Warner and Simon R. Hammans, 2009. Published byElsevier Ltd.
5. Handbook of Epigenetics by Tollefsbol T, 2011. Published by Elsevier Publications.
6. Epigenetics by David C. Allis, Marie–Laure Caparros *et al.,* 2015. Published by Cold Spring Harbor Laboratory Press.

Course Outcome:

- Being a human genetics student, it is necessary for them to learn about nervous systems and their functions, which has clearly been discussed in this course.
- The disorders associated with nervous systems and their associated complications are discussed clearly in this course which will help the students to know about it.
- The epigenetic basis of the nervous disorders is discussed along with the associated risks that help the students to attain knowledge regarding the same.

Course Prepared by: Dr. A. VIJAYA ANAND

Course Verified by: Dr. A. VIJAYA ANAND

Title of the Subject: CORE–XII: BIOETHICS AND BIOSAFETY
No. of Credits: 4
Code No.: 33D
No. of Teaching hours: 4

Course Objectives:

- To study about the details about the equipment to acquire the basic knowledge of handling instruments.
- To acquire the knowledge about the biosafety levels.
- To know the procedure of obtaining ethical clearance.

UNIT – I
Introduction to bioethics in biotechnology, Positive effects, Negative effects, Toxic soils, Biological Pest Controls. Fast Growing Trees, Fast Growing fish,food safety, Environmental concerns and Economic and Social Concerns.

UNIT – II BiosafetyRegulations*:*
National and International Guidelines.Introduction,Regulation framework in various countries,USA,European Union,Canada,Australia,South Africa,Asian Region.

UNIT – III
CPCSEA Guidelines for Laboratory AnimalFacility.Goal,Veterinary care,Animal procurement,Quarantine, Sterilization and separation,Surveillance, Animal care and technical personnel, Personal hygiene,Animal experimentation involving hazardous agent,Multiple surgical procedures on single animal,Duration of experiments, Physical facilities,Environment,Animal husbandry,Activity,Food,Bedding,Water,Sanitation and cleanliness,Assessing the effectiveness of sanitation,Waste disposal,Pestcontrol,Emergency.

UNIT – IV GLP
and Bioethics,Introduction,National Good Laboratory Practice (GLP) Programme,The GLP authority functions,quality standards for Clinical Trials,Clinical Trials worldwide.

UNIT – V Intellectual
Property Rights,An introduction, Origin of the Patent Regime,Early patterns Act and History of Indian Patent System*:*The Present Scenario,Basis of Patentability,Patent Application Procedure in India,Patent Granted Under Convention Agreement,Patent Procedure.

REFERENCES

1. Bioethics, by Shaleesha A. Stanley (2008). Published by Wisdom Educational Service, Chennai.
2. Bioethics and Biosafety by M.K.Satheesh (2008). I. K. International Pvt Ltd

3. IPR, Bioethics and Biosafety by Deepa Goel, Shomini Parashar. Pearson Education

India

Course Outcome:

- The course helps the students in understanding the ethical guidelines and biosafety procedures when handling human or animal models.
- The importance of bioethics will be acknowledged during the course.
- The students will get well-trained in operating instruments and handling of human samples.

Course Prepared by: Dr. V. BALACHANDAR

Course Verified by: Dr. A. VIJAYA ANAND

PRACTICAL– III (33P): IMMUNOGENETICS, CANCER GENETICS, EPIGENETICS, BIOETHICS AND BIOSAFETY

IMMUNOGENETICS

1. Serum antigen antibody interaction
2. Blood grouping test
3. Electrophoretic separation of serum proteins
4. Complement mediated haemolysis
5. Isolation and enumeration of lymphocytes from human blood
6. Determination of lymphocyte viability by Trypan blue dye exclusion test
7. Estimation of serum lysozyme and total peroxidase secretion
8. Detection of Antibody using ELISA

CANCER GENETICS

1. Preparation of Culture room and Media preparation.
2. Human Blood Lymphocyte Culture
3. Cell Proliferation Assay (MTT)
4. Isolation of DNA from Tissues
5. cDNA Synthesis for MMP2 gene
6. MAP Kinase activity (Demonstration)
7. Sequence similarity analysis for protein and nucleic acid using online bioinformatics tools
8. Topoisomerase relaxation assay
9. Telomerase enzyme activity

EPIGENETICS

1. DNA methylation analysis
    a. Bisulfide conversion
    b. High resolution melt analysis
    c. Examination of different DNA methylation condition using Restriction assay

BIOETHICS AND BIOSAFETY

1. Visit to Research institutes holding animal housefacility
2. Visit to medical hospitals and reportsubmission
3. IPR, Group discussion, report submission
4. Obtain human ethical committee clearance
5. Tribal visit

Title of the Subject:ELECTIVE–III: STRESS AND BIOMARKERS
No. of Credits: 4
Code No.: 3EC
No. of Teaching hours: 4

Course Objectives:

- The topics are introductory in nature and build the ability to learn how human system works in stressed conditions under the influence of various internal and external stimuli.
- The curriculum of pathology aims at preparing the learners in basic understanding of diseases and their pathogenesis with reference to stress by using biomarkers.
- Toxicology is a vast, multidisciplinary subject encompassing various other basic fields of science. Not all toxicity effects are well understood, many of them unpin themselves into stress. Hence, it allows the learners to gain basic knowledge on toxicology effects.

UNIT – I

Factors contributing to stress, physiological systems respond to stress. Principle pathways linked to steroidal hormones. Biomarkers: Introduction and types of biomarkers acting based on organ and tissue specific and non–specific.

UNIT – II

Methods for identifying biomarkers: Biomarker selection and development. Significance of biomarkers in oxidative stress, metabolic biomarkers, immunological biomarkers and physiological biomarkers. Blood chemistry and histopathology. Heat shock proteins.

UNIT – III Neuroendocrine biomarkers: The primary physiological factor that determine the neuroendocrine stress response, Stress relaxation and receptors, arterial pressure and regulation, functions of cortisol in stress and inflammation, methodological and procedural factors that influence the measurement and assessment of circulating hormone levels in the blood

UNIT – IV

Promising new vistas for chronic stress characterization, metabolomics, ultrastructure modifications in mitochondria. Neuroanatomy changes seen under stressed conditions. Neuropsychic disorders characteristic features, disease progression, treatment and control.

UNIT – V

Toxins and stress: Introduction, definition, sub disciplines, environmental toxicants, routes of entry of xenobiotics. Toxicity tests: Bioassay, basic requirements, test organisms, test procedures and data analysis joint toxicity. Types of acute toxicity tests and chronic toxicity tests, terminologies used in toxicity tests and need for conducting toxicity tests.

REFERENCES

1. Textbook of Medical Physiology (11^{th} edition) by Arthur C Guyton and John E Hall, 2006. Published byElsevier Publications.
2 Principles of Ecotoxicology (4^{th} edition) by C.H. Walker, S.P. Hopkin, R.M. Sibly and D.B.

Peakall, 2012. Published by CRC Press.
3. Principles of Biochemical Toxicology (4th edition) by J.A. Timbrell. Taylor and Francis, 2008. Published by CRC Press.
d4. Biological Markers of Environmental Contaminants by McCarthy, J.F., Shugart, L.R., 1999. Published by Lewis Publishers.
5. Animal Biomarkers as Pollution Indicators, Ecotoxicological Series by Peakall, D.B, 1992. Published by Chapman and Hall, London.
6. Biomarkers of Chronic Stress by Laalithya Konduru, 2008.

Course Outcome:

- Next to neurology, it is necessary for the human genetics student to learn about the substances produced by the nervous system; this has been discussed in this course.
- The functions of the substances produced by the nervous system have also been discussed in this course which helps the students to obtain clear knowledge on the same.
- The biomarkers that indicates the malfunctioning of the body parts has to be known by the life science students, which has also been discussed by this course.

Course Prepared by: Dr. A. VIJAYA ANAND

Course Verified by: Dr. A. VIJAYA ANAND

Title of the Subject: ELECTIVE–III: STEM CELL BIOLOGY
No. of Credits: 4
Code No.: –
No. of Teaching hours: 4

Course Objectives:

- To study about the basics of stem cell therapy.
- To gain the knowledge on stem cell assays.
- To provide the update on hiPSC and iPSC research studies.

UNIT – I Introduction and Scope of stem cells: definitions, Concepts of stem cells, differentiation, maturation, proliferation, self maintenance and self renewal,significations in measuring stem cells, preservation and storageprotocols.

UNIT – II
Pluripotency, totipotency, induced pluripotent stem cells, human induced pluripotent stem cells.

UNIT – III Culturing of embryonic stem cells in lab, laboratory tests to identify ES cells, stimulation ES cells for differentiation, properties of ES cells, human ES cells.

UNIT – IV Identification, Manipulating differentiation pathways, stem cell therapy Vs cell protection, stem cell in cellular assays for screening, stem cell based drug discovery platforms, drug screening and toxicology, stem cell banking.

UNIT – V Human induced pluripotent stem cells: Differentiation and transdifferentiation; Reprogramming; Transcriptional factors; induced pluripotent stem cells: stem cell differentiation specific culture system; Therapeutic applications of hiPSC and iPSC in genetics

REFERENCES

1. Embryonic Stem cells by Kursad and Turksen. 2002. HumanaPress.
2. Nuclear reprogramming and Stem Cells, 2011. Justin Ainscough and Shinya Yamanaka
3. Federico Calegari and Claudia Waskow (2014). Stem Cells: From basic Research to therapy, CRC Press, Taylor and Francis Group

Course Outcome:

- The basics of stem cell biology will help in acquiring more knowledge on stem cells and their treatment in genetic diseases.

- The significance of stem cells will enhance the students to think in wide area of research approach.
- Students with research motive will get wide opportunities to carry their research in India as well as Overseas.

Course Prepared by: Dr. V. BALACHANDAR

Course Verified by: Dr. A. VIJAYA ANAND

Title of the Subject: SUPPORTIVE–III: GENETIC TOXICOLOGY
No. of Credits: 2 Code No.: GS106
No. of Teaching hours: 2

Course Objectives:

- To study the environmental pollutions on genetic makeup of the organism.
- To understand the available pollutants and vulnerability of genetic materials.
- To study the methods that are available for measuring and monitoring the mutagens.

UNIT – I

General Principles of Mutagenicity, Testing and Regulatory Control of Environmental Chemicals. Monitoring of Chemical Mutagens in the environment, Classification of genotoxic agents.

UNIT – II

Genetic effects of environmental agents and genotoxic agents in various occupations. Various assay procedures to determine genotoxicity, Methods of evaluation of mutagens, Microbial to mammals.

UNIT – III

Epidemiological approach to evaluate genetic hazards: Occupational Epidemiology and Reproduction, Monitoring for genetic disease in the new born: Transplacental genotoxic agents

REFERENCES

1. Genetic Damage in Man, Caused by Environmental Agents. Berg. K (1979) Academic Press.
2. Principles of Genetic Toxicology. Brusick D (1980), Plenum Press.
3. Evaluation of Mutagenic and Carcinogenic Potential of Environmental Agents. (1982). Environmental Mutagen Society of India, Bombay.
4. Chemical Mutagens, Principles and Methods for their Detection. Hollaender. A, and Serres F.J., Volume 1– 10, Plenum Press.
5. Cytogenetic Assays of Environmental Agents. Hsu, T.C (1982), Oxford and IBH, New Delhi.
6. Handbook of Mutagenicity Test Procedures. Kilbey, B.J., Lehgator, M., Nichols, W and Ramel, C (1984) Elsevier.

Course Outcome:

- Genetic Toxicology (GT) is one such important subject in our curriculum teaching the effect of environmental pollutions on genetic makeup of the organism.
- It is giving overview of available pollutants that are harmful and vulnerability of genetic materials to it.
- It also emphasize the methods that are available for measuring and monitoring the mutagens. These information en-light our students to get aware of the harmful agents and materials and its irreversible impact in its genetic materials.

Course Prepared by: Dr. P. VNAYAGA MOORTHI

Course Verified by: Dr. A. VIJAYA ANAND

Title of the Subject: CORE–XIII: GENETIC COUNSELING (SELF STUDY)
No. of Credits: 4
Code No.: 43A
No. of Teaching hours: 4

Course Objectives:

- The main objective provides learners with the appropriate knowledge, experience and skills to become motivated genetic counselors.
- This course provides exposure to coursework, including: clinical training, hospital visits, case studies and seminars, to develop their personalized skills towards understanding and handling of genetically inherited disorder subjects.
- The course promotes graduates prepared to work in a variety of interdisciplinary clinics as well as in areas of research or commercial genetics laboratories relevant to genetic counseling and human genetics.

UNIT – I
History of Human Genetics: Pedigrees, gathering family history, Pedigree symbols, Construction of pedigrees, Presentation of molecular genetic data in pedigrees, Pedigree charts for different inheritance patterns.

UNIT – II
Complications to the basic pedigree patterns: Genomic imprinting and uniparental disomy, Spontaneous mutations, Mosaicism and chimerism, Male lethality, X–inactivation, Consanguinity and its effects in the pedigree pattern.

UNIT – III
Monozygotic and dizygotic twins and adoption studies, Polygenic inheritance of continuous (quantitative) traits, normal growth charts, Dysmorphology, Polygenic inheritance of discontinuous (dichotomous) traits,Genetic susceptibility in complex traits.

UNIT – IV
Genetic counseling: Historical overview and components of genetic counseling. Indication for and purpose, Information gathering and construction of pedigree Medical genetic evaluation (Basic components of medical history, past medical history, social and family history).

UNIT – V
Components of genetic counseling, Physical examination,Patterns of inheritance, risk assessment and counseling in common Mendelian and multifactor syndromes.Prenatal and postnatal screening: noninvasive methods and invasive methods.Indications for chromosomal testing.

REFERENCES

1. Genetics,A Conceptual Approach, 4th ed., B.A. Pierce, Palgrave Macmillan, 2012.
2. Emery's Elements of Medical Genetics, 14th ed., P.D. Turnpenny and S. Ellard, 2012.
3. Introduction to Genetics, A Molecular Approach, 1st ed., T.A Brown, Garland Science, 2012.4. Human Molecular Genetics, 4th ed., T. Strachan and A. Read, Garland Science, Taylor

and Francis Group, 2011.

5. A Guide to Genetic Counseling,2nd ed., W.R. Uhlmann, J.L. Schuette and B.M. Yashar, Wiley, Blackwell, 2009.

6. Practical Genetic Counseling– 7th ed., P. S. Harper, CRC Press., 2010.

Course Outcome:

- This course provides learners: advice, guidance and information about genetics and genetic inherited conditions by giving brief lectures on pedigree analysis and genetic mapping.
- This course will enable you to obtain a broader view of clinical practice and helps students to interact and guide patients suffering from genetic disorders in the future.
- Learners develop skills to understand the medical, psychological, social and reproductive implications of various family genetic and congenital conditions through this course.

Course Prepared by: Dr. P. VNAYAGA MOORTHI

Course Verified by: Dr. A. VIJAYA ANAND