ADIKAVI NANNAYA UNIVERSITY: RAJMAHENDRAVARAM
Single Major B.Sc. Human Genetics (w.e.f:2023-24A.B)

Programme: B.Sc. Human Genetics (Major)

w.e.f. AY 2023-24

COURSE STRUCTURE

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
I	I	1	Introduction to Classical Biology	3+2	4
		2	Introduction to Applied Biology	3+2	4
	II	3	Principles of Genetics	3	3
			Principles of Genetics Practical Course	2	1
		4	Human Genetics and Cytogenetics	3	3
			Human Genetics and CytogeneticsPractical Course	2	1
II	III	5	Human Molecular Genetics	3	3
			Human Molecular Genetics Practical Course	2	1
		6	Recombinant DNA technology	3	3
			Recombinant DNA technology Practical Course	2	1
		7	Molecular Techniques in Genetic Engineering	3	3
			Molecular Techniques in Genetic Engineering Practical Course	2	1
		8	Molecular Pathology in human diseases	3	3
			Molecular Pathology in human diseases Practical Course	2	1
	IV	9	Statistics and Informatics in HumanGenetics	3	3
			Statistics and Informatics in HumanGenetics Practical Course	2	1
		10	Clinical genetics and Genetic Counselling	3	3
			Clinical genetics and Genetic Counselling Practical Course	2	1
		11	Developmental and behavioural genetics	3	3
			Developmental and behavioural genetics Practical Course	2	1
III	V	12	Human Genome Project and Genome	3	3
			Human Genome Project and GenomePractical Course	2	1
		13	Cellular and Molecular Immunology	3	3

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Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
			Cellular and Molecular Immunology Practical Course	2	1
		14 A	Stem cell technology	3	3
			Stem cell technology Practical Course	2	1
		OR			
		14 B	Microbial genetics	3	3
			Microbial genetics Practical Course	2	1
		15 A	Forensic science		
			Forensic science Practical Course		
		OR			
		15 B	DNA forensics and Serology		
			DNA forensics and Serology Practical Course		
	VI	**Internship**			
IV	VII	16 A	Cell Biology	3	3
			Cell Biology Practical Course	2	1
		OR			
		16 B	Ecology and ConservationGenetics	3	3
			Ecology and ConservationGenetics Practical Course	2	1
		17 A	Biomolecules	3	3
			Biomolecules Practical Course	2	1
		OR			
		17 B	Human Embryology and Developmental Genetics Practical Course	3	3
			Human Embryology and Developmental Genetics Practical Course	2	1
		18 A	Human Anatomy	3	3
			Human Anatomy Practical Course	2	1
		OR			
		18 B	Cell Culture and TissueEngineering Technology	3	3
			Cell Culture and TissueEngineering Technology Practical Course	2	1
		SEC			
		19 A	Medical Genetics	3	3
			Medical Genetics Practical Course	2	1
		OR			
		19 B	Biochemical Genetics	3	3
			Biochemical Genetics Practical Course	2	1
		20 A	Clinical Hematology	3	3
			Clinical Hematology Practical Course	2	1
		OR			

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Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
		20 B	Applications of Human Genetics	3	3
			Applications of Human Genetics Practical Course	2	1
	VIII	21 A	Cancer Genetics	3	3
			Cancer Genetics Practical Course	2	1
		OR			
		21 B	Evolutionary and Quantitiative Genetics	3	3
			Evolutionary and Quantitiative Genetics Practical Course	2	1
		22 A	Metabolism	3	3
			Metabolism Practical Course	2	1
		22 B	Reproductive Genetics	3	3
			Reproductive Genetics Practical Course	2	1
		23 A	Population Genetics	3	3
			Population Genetics Practical Course	2	1
		OR			
		23 B	Recent Advances in HumanGenetics	3	3
			Recent Advances in HumanGenetics Practical Course	2	1
		SEC			
		24 A	Fundamentals of Physiology	3	3
			Fundamentals of Physiology Practical Course	2	1
		OR			
		24 B	Analytical Techniques	3	3
			Analytical Techniques Practical Course	2	1
		25 A	Immunogenetics	3	3
			Immunogenetics Practical Course	2	1
		OR			
		25 B	Genetic Toxicology	3	3
			Genetic Toxicology Practical Course	2	1

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Single Major B.Sc. Human Genetics (w.e.f:2023-24A.B)

SEMESTER-I

COURSE 1: INTRODUCTION TO CLASSICAL BIOLOGY

Theory | Credits: 4 | 5 hrs/week

Learning objectives

The student will be able to learn the diversity and classification of living organisms and understand their chemical, cytological, evolutionary and genetic principles.

Learning Outcomes

1. Learn the principles of classification and preservation of biodiversity
2. Understand the plant anatomical, physiological and reproductive processes.
3. Knowledge on animal classification, physiology, embryonic development and their economic importance.
4. Outline the cell components, cell processes like cell division, heredity and molecular processes.
5. Comprehend the chemical principles in shaping and driving the macromolecules and life processes.

Unit 1: Introduction to systematics, taxonomy and ecology.

1.1. Systematics – Definition and concept, Taxonomy – Definition and hierarchy.

1.2. Nomenclature – ICBN and ICZN, Binomial and trinomial nomenclature.

1.3. Ecology – Concept of ecosystem, Biodiversity and conservation.

1.4. Pollution and climate change.

Unit 2: Essentials of Botany.

2.1. The classification of plant kingdom.

2.2. Plant physiological processes (Photosynthesis, Respiration, Transpiration, phytohormones).

2.3. Structure of flower – Micro and macro sporogenesis, pollination, fertilization and structure of mono and dicot embryos.

2.4 Mushroom cultivation, floriculture and landscaping.

Unit 3: Essentials of Zoology

3.1. The classification of Kingdom Animalia and Chordata.

3.2 Animal Physiology – Basics of Organ Systems & their functions, Hormones and Disorders

3.3 Developmental Biology – Basic process of development (Gametogenesis, Fertilization, Cleavage and Organogenesis)

3.4 Economic Zoology – Sericulture, Apiculture, Aquaculture

Unit 4: Cell biology, Genetics and Evolution

4.1. Cell theory, Ultrastructure of prokaryotic and eukaryotic cell, cell cycle.

4.2. Chromosomes and heredity – Structure of chromosomes, concept of gene.

4.3. Central Dogma of Molecular Biology.

4.4. Origin of life

Unit 5: Essentials of chemistry

5.1. Definition and scope of chemistry, applications of chemistry in daily life.

5.2. Branches of chemistry

5.3. Chemical bonds – ionic, covalent, noncovalent – Vander Waals, hydrophobic, hydrogen bonds.

5.4. Green chemistry

References

1. Sharma O.P., 1993. Plant taxonomy. 2nd Edition. McGraw Hill publishers.

2. Pandey B.P., 2001. The textbook of botany Angiosperms. 4th edition. S. Chand publishers, New Delhi, India.

3. Jordan E.L., Verma P.S., 2018. Chordate Zoology. S. Chand publishers, New Delhi, India.

4. Rastogi, S.C., 2019. Essentials of animal physiology. 4th Edition. New Age International Publishers.

5. Verma P.S., Agarwal V.K., 2006. Cell biology, genetics, Molecular Biology, Evolution and Ecology. S. Chand publishers, New Delhi, India.

6. Sathyanarayana U., Chakrapani, U., 2013. Biochemistry. 4th Edition. Elsevier publishers.

7. Jain J.L., Sunjay Jain, Nitin Jain, 2000. Fundamentals of Biochemistry. S. Chand publishers, New Delhi, India.

8. Karen Timberlake, William Timberlake, 2019. Basic chemistry. 5th Edition. Pearson publishers.

9. Subrata Sen Gupta, 2014. Organic chemistry. 1st Edition. Oxford publishers.

ACTIVITIES:

1. Make a display chart of life cycle of nonflowering plants.
2. Make a display chart of life cycle of flowering plants.
3. Study of stomata
4. Activity to prove that chlorophyll is essential for photosynthesis
5. Study of pollen grains.
6. Observation of pollen germination.
7. Ikebana.
8. Differentiate between edible and poisonous mushrooms.
9. Visit a nearby mushroom cultivation unit and know the economics of mushroom cultivation.
10. Draw the Ultrastructure of Prokaryotic and Eukaryotic Cell
11. Visit to Zoology Lab and observe different types of preservation of specimens
12. Hands-on experience of various equipment – Microscopes, Centrifuge, pH Meter, Electronic Weighing Balance, Laminar Air Flow
13. Visit to Zoo / Sericulture / Apiculture / Aquaculture unit
14. List out different hormonal, genetic and physiological disorders from the society

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SEMESTER-I

COURSE 2: INTRODUCTION TO APPLIED BIOLOGY

Theory | Credits: 4 | 5 hrs/week

Learning objectives

The student will be able to learn the foundations and principles of microbiology, immunology, biochemistry, biotechnology, analytical tools, quantitative methods, and bioinformatics.

Learning Outcomes

1. Learn the history, ultrastructure, diversity and importance of microorganisms.
2. Understand the structure and functions of macromolecules.
3. Knowledge on biotechnology principles and its applications in food and medicine.
4. Outline the techniques, tools and their uses in diagnosis and therapy.
5. Demonstrate the bioinformatics and statistical tools in comprehending the complex biological data.

Unit 1: Essentials of Microbiology and Immunology

1.1. History and Major Milestones of Microbiology; Contributions of Edward Jenner, Louis Pasteur, Robert Koch and Joseph Lister.

1.2. Groups of Microorganisms – Structure and characteristics of Bacteria, Fungi, Archaea and Virus.

1.3. Applications of microorganisms in – Food, Agriculture, Environment, and Industry.

1.4. Immune system – Immunity, types of immunity, cells and organs of immune system.

Unit 2: Essentials of Biochemistry

2.1. Biomolecules I – Carbohydrates, Lipids.

2.2. Biomolecules II – Amino acids & Proteins.

2.3. Biomolecules III – Nucleic acids -DNA and RNA.

2.4. Basics of Metabolism – Anabolism and catabolism.

Unit 3: Essentials of Biotechnology

3.1. History, scope, and significance of biotechnology. Applications of biotechnology in Plant, Animal, Industrial and Pharmaceutical sciences.

3.2. Environmental Biotechnology – Bioremediation and Biofuels, Bio fertilizers and Bio pesticides.

3.3. Genetic engineering – Gene manipulation using restriction enzymes and cloning vectors; Physical, chemical, and biological methods of gene transfer.

3.4. Transgenic plants – Stress tolerant plants (biotic stress – BT cotton, abiotic stress – salt tolerance). Transgenic animals – Animal and disease models.

Unit 4: Analytical Tools and techniques in biology – Applications

4.1. Applications in forensics – PCR and DNA fingerprinting

4.2. Immunological techniques – Immunoblotting and ELISA.

4.3. Monoclonal antibodies – Applications in diagnosis and therapy.

4.4. Eugenics and Gene therapy

Unit 5: Biostatistics and Bioinformatics

5.1. Data collection and sampling. Measures of central tendency – Mean, Median, Mode.

5.2. Measures of dispersion – range, standard deviation and variance. Probability and tests of significance.

5.3. Introduction, Genomics, Proteomics, types of Biological data, biological databases- NCBI, EBI, Gen Bank; Protein 3D structures, Sequence alignment

5.4. Accessing Nucleic Acid and Protein databases, NCBI Genome Workbench

REFERENCES

1. Gerard J., Tortora, Berdell R. Funke, Christine L. Case., 2016. Microbiology: An Introduction. 11th Edition. Pearson publications, London, England.

2. Micale, J. Pelczar Jr., E.C.S. Chan., Noel R. Kraig., 2002. Pelczar Microbiology. 5th Edition. McGraw Education, New York, USA.

3. Sathyanarayana U., Chakrapani, U., 2013. Biochemistry. 4th Edition. Elsevier publishers.

4. Jain J.L., Sunjay Jain, Nitin Jain, 2000. Fundamentals of Biochemistry. S. Chand publishers, New Delhi, India.

5. R.C. Dubey, 2014. Advanced Biotechnology. S. Chand Publishers, New Delhi, India.

6. Colin Ratledge, Bjorn, Kristiansen, 2008. Basic Biotechnology. 3rd Edition. Cambridge Publishers.

7. U. Sathyanarayana, 2005. Biotechnology. 1st Edition. Books and Allied Publishers pvt. ltd., Kolkata.

8. Upadhyay, Upadhyay and Nath. 2016. Biophysical Chemistry, Principles and Techniques. Himalaya Publishing House.

9. Arthur M. Lesk. Introduction to Bioinformatics. 5th Edition. Oxford publishers.

10. AP Kulkarni, 2020. Basics of Biostatistics. 2nd Edition. CBS publishers.

ACTIVITIES

1. Identification of given organism as harmful or beneficial.
2. Observation of microorganisms from house dust under microscope.
3. Finding microorganism from pond water.

4. Visit to a microbiology industry or biotech company.
5. Visit to a waste water treatment plant.
6. Retrieving a DNA or protein sequence of a gene'
7. Performing a BLAST analysis for DNA and protein.
8. Problems on biostatistics.
9. Field trip and awareness programs on environmental pollution by different types of wastes andhazardous materials.
10. Demonstration on basic biotechnology lab equipment.
11. Preparation of 3D models of genetic engineering techniques.
12. Preparation of 3D models of transgenic plants and animals.

[**NOTE**: In the colleges where there is availability of faculty for microbiology and biotechnology, those chapters need to be handled by microbiology and biotechnology faculty. In other colleges, the above topics shall be dealt by Botany and Zoology faculty]

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Course – I & II Model Paper (70 Marks)

SECTION A (Multiple Choice Questions) ***30 x 1 = 30 M***

30 Multiple Choice Questions (Each Unit 6 Questions)

SECTION B (Fill in the blanks) ***10 x 1 = 10 M***

10 Fill in the Blanks (Each Unit 2 Questions)

SECTION C (Very short answer questions) ***10 x 1 = 10 M***

10 Very short answer questions (Each Unit 2 Questions)

SECTION D (Matching) (From 5 Units) ***2 x 5 = 10 M***

1 A
B
C
D
E

2 A
B
C
D
E

SECTION E (True or False) ***10 x 1 = 10 M***

10 True or False (Each Unit 2 Questions)

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SEMESTER-II

COURSE 3: PRINCIPLES OF GENETICS

Theory Credits: 3 3 hrs/week

I. LEARNING OUTCOMES

Upon successful completion, each student will have the basic knowledge:
1. Historical overview and laws of Inheritance
2. Understand Mendel's principles and deviations
3. Gene interactions and their outcome through gene mapping
4. Understand the mitochondrial inheritance in different organisms
5. Understand the variance and heritability of traits

II. Syllabus

UNIT-1 HISTORY OF GENETICS

1. Pre-mendelian Genetic concepts, Heredity, and environment, the concept of phenotype and genotype, pure lines and inbred lines
2. Biography of Mendel and his experiments on pea plants. Mendel laws
3. Deviations of Mendelism (Incomplete dominance and codominance; Multiple alleles, Lethalalleles, Pleiotropy, Penetrance, and Expressivity, Epistasis, and non-epistasis)

UNIT- 2 Sex Linked Inheritance and Sex Determination

1. Chromosome theory of Sex determination: XX- XY, XX-XO, ZZ-ZW, Genic balance theory of Bridges, Intersexes and Super sexes in Drosophila,
2. Sex differentiation in Drosophila and Man, Sex limited and Sex influenced inheritance
3. Sex determination in mammals- and role of human Y chromosome

UNIT-3 LINKAGE, CROSSING OVER, AND GENE MAPPING

1. Linkage - Definition, Linkage group- Drosophila and man; Types of linkage-complete linkage and incomplete linkage, Significance of linkage.
2. Crossing over - definition; recombination and recombination frequency, Mechanism of crossing over: Chiasma Interference and coincidence; Coupling and Repulsion hypothesis.
3. Gene Mapping – physical mapping and genetic mapping, mapping in eukaryotes and prokaryotes

UNIT – 4 EXTRACHROMOSOMAL INHERITANCE

1. Characteristic features of Cytoplasmic Inheritance; Inheritance of- Mitochondrial DNA, Chloroplast DNA, Kappa particles in Paramecium, Shell coiling in snail.
2. Infective heredity -Drosophila, petite mutations and mitochondrial inheritance in man
3. Epigenetics and genome imprinting in humans

UNIT -5 INHERITANCE OF QUANTITATIVE TRAITS

1. Continuous and Discontinuous variation
2. Polygenic Inheritance and Multifactorial Inheritance
3. Genetic Variance, Heritability (narrow sense and Broad sense)

III . Skills Outcome

On Successful Completion of this Course, Student shall be able to

1. Study the Mendel Laws and their Deviations
2. Study the Chromosomal Recombination's
3. Study the Genetic Disorders
4. Identification of the Blood Groups

SEMESTER-II

COURSE 3: PRINCIPLES OF GENETICS

Practical | Credits: 3 | 3 hrs/week

IV .

1. Mendel's laws through seed ratios& Drosophila mutants
2. Study of linkage, recombination, and chromosome mapping using test cross data.
4. Pedigree analysis for dominant and recessive autosomal and sex-linked traits.
5. Study of human genetic traits: Sickle cell anemia, Xeroderma Pigmentosum, Albinism.
6. Tests for red-green Colour blindness, Widow's peak, Rolling of the tongue, Hitchhiker's thumb, and Attached ear lobe.
7. Incomplete dominance and gene interaction through seed ratios
8. Blood Typing: ABO groups & Rh factor.
9. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes.
10. Mitosis &Meiosis through temporary squash preparation.
11. Smear technique to demonstrate sex chromatin buccal epithelial cells

V. REFFERENCES

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, JohnWiley & sons, India.8th edition.

2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & SonsInc., India.5th edition.

3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. BenjaminCummings, U.S.A. 10th edition.

4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction toGenetic

Analysis. W. H. Freeman and Co., U.S.A. 10th edition

VI. Co-Curricular Activities

a) Suggested C0-Curricular Activities

1. Assignments
2. Seminars, Group Discussions on related topics
3. Preparation of mitosis and meiosis slides
4. Pedigree preparations based on community5.Colur blindness study in a community
6. Blood group Studies

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SEMESTER-II

COURSE 4: HUMAN GENETICS & CYTOGENETICS

Theory Credits: 3 3 hrs/week

I. LEARNING OUTCOMES

Upon successful completion, each student will have the basic knowledge:1.On Pedigree symbols
2. Understand the types of Inheritance patterns
3. On Twin Studies
4. On Mapping Techniques
5. Understand the chromosome and their anomalies

II. Syllabus

Unit 1 Basic Human Genetics – Monogenic Traits

1. History of Human Genetics. Pedigrees – family history, symbols, construction of a pedigree
2. Monogenic traits - autosomal inheritance, sex-linked inheritance, sex-limited and sex-influenced inheritance, mitochondrial inheritance
3. Complications in pedigree patterns – non-penetrance, expressivity, pleiotropy, genetic heterogeneity, uniparental disomy, male lethality, X inactivation, consanguinity

Unit 2 Basic Human Genetics – Complex traits

1. Twin Studies - monozygotic and dizygotic twins
2.Polygenic inheritance of continuous traits – normal growth charts, dysmorphology
3.Polygenic inheritance of discontinuous traits – threshold model, liability and recurrence risk

Unit 3 Genetic Mapping of Mendelian and Complex characters

1. Identifying recombinants and non-recombinants in pedigrees
2. Two-point mapping – LOD score analysis, multipoint mapping, homozygosity mapping
3. Genetic mapping of complex traits – difficulties in mapping, allele sharing methods, sib-pairanalysis, allelic association, linkage disequilibrium mapping

Unit 4 Human Chromosomes

1 History of human cytogenetics
2. Human karyotype – banding, the nomenclature of banding
3. Nomenclature of aberrant karyotypes

Unit 5 Chromosome anomalies

1. Common syndromes due to numerical chromosome changes
2. Common syndromes due to structural alterations (translocations, duplications, deletions, microdeletions, fragile sites)
3. Common chromosome abnormalities in cancer

III Skill Outcomes

On successful completion of practical course students shall be able to
1. Barr Body Analysis
2. Dermatoglypics
3. Karyotyping
4. Chromsomal Abnormal Studies
5. Metaphase Chromosome Preparations of leucocyte culture

SEMESTER-II

COURSE 4: HUMAN GENETICS & CYTOGENETICS

Practical | Credits: 1 | 3 hrs/week

IV. Practical's Syllabus

1. Preparation of pedigree charts for blood group, tongue rolling, ear lobes and colour-blindness
2. Genetics of codominant genes – blood groups.
3. Barr Body analysis.
4. Dermatoglyphics
5. Polygenic inheritance – fingerprint ridge count
6. Preparation of metaphase chromosome spread using peripheral blood sample.
7. Preparation of metaphase plates and their staining and analysis
8. Human karyotyping – numerical on chromosome number.
9. Camera-lucida drawing of chromosomes.
10. Study of various abnormal karyotypes observed in humans.
11. G- banding of metaphase plates and their analysis
12. Sister Chromatid exchange analysis from peripheral blood

V. SUGGESTED READINGS:

1. Human Genetics: Concept and Application by Ricki Lewis 10th Edition
2. Vogel and Motulsky's Human Genetics: Problems and Approaches
3. The Principles of Clinical Cytogenetics by Steven L. Gersen, Martha B. Keagle 3rd edition.
4. Human Cytogenetics: Constitutional Analysis: a Practical Approach by Denise E.Rooney.

VI. Co-curricular Activities

a) Suggested Co-curricular Activities

1. Assignments
2. Group Discussions and Seminar On Related Topics
3. Karyotype Preparation
4. Dermatoglypics

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Single Major
Model Question Paper
SEMESTER-II
Human Genetics

PRINCIPLES OF GENETICS

Time:3hrs ***MAX MARKS: 70 M***

Section A

I. Answer any FIVE questions. All questions carry equal marks. 5X4 = 20

1. Incomplete dominance &codominance
2. Epistasis
3. Haemophilia
4. Heterogametic female
5. Kappa particles
6. Crossing over
7. Petite mutations
8. Recombination

Section B

II. Answer ALL Questions. All questions carry equal marks 5X10 = 50

9. (a) Explain law of independent assortment with suitable examples.
(or)
(b) Write an essay on pre Mendelian genetic concepts

10. (a) Explain the mechanism of sex-determination in Humans
(or)
(b) Write about sex-linked inheritance in humans.

11. (a) Write an essay on linkage
(or)
(b) Explain in detail about genetic mapping

12. (a) Write an essay on Infective heredity
(or)
(b). Explain in detail about epigenetics and genomic imprinting in humans

13. (a) Write about quantitative trait loci
(or)
(b) Explain in detail about multi factorial inheritance

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Single Major
Model Question Paper
SEMESTER-II
Human Genetics

HUMAN GENETICS & CYTOGENETICS

Time:3hrs ***MAX MARKS: 70 M***

Section A

Answer any FIVE questions. All questions carry equal marks. 5X4 = 20

1. Holandric inheritance

2. Pleiotropy

3. Concordance and Discordance

4.Polygenic inheritance

5. Sib pair analysis

6. Banding

7. Turner's syndrome

8. Robertsonian translocation

Section B

II. Answer ALL Questions. All Questions carry equal marks 5X10 = 50

9. (a) Write about the inheritance of monogenic characters
(or)
(b) Write an essay on pedigree

10. (a) Explain the role of twin studies in understanding complex traits
(or)
(b) Write about genetic susceptibility of multifactorial disorders

11. (a) Write an essay on two-point mapping.
(or)
(b) Explain in detail about genetic mapping of complex traits.

12. (a) Write an essay on nomenclature of abnormal chromosomes
(or)
(b). Explain the different events in the history of human genetics

13. (a) Write about autosomal chromosomal abnormalities.
(or)
(b) Explain in detail about chromosomal abnormalities of cancer.

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SEMESTER-III

COURSE 5: HUMAN MOLECULAR GENETICS

Theory Credits: 3 3 hrs/week

I. LEARNING OUTCOMES

Upon successful completion, each student will have the basic knowledge:
1. On Nucleic Acids and Proteins
2. On Gene Expression
3. On DNA Replication and Their Mechanism
4. On Chromosomal Organization Of DNA
5. On Mitochondrial Genome and Nuclear Genome

II. Syllabus (Total Teaching Hours: 45hr)

Unit 1 DNA, RNA and Protein Structure

1.1 Building blocks and chemical bonds in DNA, – structure of DNA, A-B-Z and triplex DNA,

1.2 Building blocks and chemical bonds in RNA – Structure of RNA

1.3 Building blocks and chemical bonds in peptides- primary, secondary, tertiary and quaternary structure of proteins

Unit 2 Gene expression

2.1 Central dogma of molecular biology

2.2 RNA transcription, and RNA Processing

2.3 Translation, post-translation processing

Unit 3 DNA replication, Mutagenesis and DNA repair

3.1 DNA replication – modes of Replication, DNA replication machinery and mechanism

3.2 DNA mutagenesis

3.3 DNA repair

Unit 4 Human Chromosome Organization

4.1 Packaging of DNA – multiple hierarchies of DNA folding

4.2 Chromosomes as functional organelles –origins of replication, telomeres, centromeres

4.3 Heterochromatin and euchromatin

Unit 5 Human Genome organization

5.1 Mitochondrial genome – replication, genes, genetic code

5.2 Nuclear genome – protein coding genes RNA genes

5.3 Nuclear genome – highly repetitive DNA, heterochromatin and transposon repetitive

III. SKILL OUTCOMES

On successful completion of practical course students shall be able to

1. Learn The Extractions Of DNA From Various Sources
2. Learn The Chromatographic Techniques
3. Learn The Electrophoresis Techniques
4. Learn DNA Damage By Various Assays

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SEMESTER-III

COURSE 5: HUMAN MOLECULAR GENETICS

Practical | Credits: 1 | 2 hrs/week

IV. PRACTICAL Hours

1. Extraction of DNA from human lymphocytes
2. Paper chromatography of amino acids
3. Electrophoresis: agarose gel electrophoresis, PAGE
4. Study of isozymes by PAGE
5. Comet assay to measure DNA damage
6. Problem-based on homologous and site-specific recombination
7. Effects of mutagens and repair deficient *E.coli* strains.
8. Preparation of Human chromosome spread and banding

V .Suggested Readings :

1. Human Molecular Genetics by T. Strachan
2. Human Molecular Genetics by Gerard Meurant
3. Human Molecular Genetics by Christopher G Mathew.
4. Human Molecular Genetics by Sudbury
5. Human Genetics: From Molecules to Medicine by Christian Patrick Schaaf, JohannesZschocke.

VI. Co-curricular Activities

a) Suggested Co-curricular Activities

1. Assignments
2. Group Discussions and Seminar On Related Topics
3. Genomic Isolation Techniques
4. Molecule Separation Techniques

SEMESTER-III

COURSE 6: RECOMBINANT DNA TECHNOLOGY

Theory Credits: 3 3 hrs/week

I. LEARNING OUTCOMES

Upon successful completion, each student will have the basic knowledge:
1. Basics Of r-DNA Technology
2. On Types of Gene Cloning
3. Applications of r-DNA Technology
4. Concepts of Stem Cells
5. Applications of Stem Cells

II. Syllabus

Unit 1 Cell Based Cloning

1. Restriction endonucleases and other enzymes used in manipulating DNA molecules
2. Cloning vectors – plasmid vectors, lambda and cosmid vectors, P1 phage vectors, YAC,BAC, M13 or phagemid vectors, expression vectors
3. Introducing recombinant DNA into recipient cells, DNA libraries -generation of genomicand cDNA libraries

Unit 2 Cloning Human disease genes

1. Cloning human disease genes- functional candidate gene cloning, positional candidate genecloning
2. Detection of mutations in human genes –SSCP analysis, DGGE, chemical mismatch cleavage
3. Detection of mutation in human gene – DNA sequencing, heteroduplex analysis, proteintruncation

Unit 3 Applications of rDNA technology

1. DNA fingerprinting – use of mini-satellites for DNA fingerprinting, single locus probes,STRs
2. Genetic testing – prenatal testing, neonatal screening, diagnosis of genetic disease in childrenafter birth, pre-symptomatic testing.
3. In vivo, in vitro gene therapy; vehicles for gene therapy; gene therapy for heritable and non- heritable genetic diseases.

Unit 4 Biology of stem cells

1. Historical perspectives, concept of stem cells
2. Cellular and molecular features of stem cells
3. Embryonic stem cells and germ stem cells
4. Fetal adult stem cells and cancer stem cells

Unit 5 Applications

1. Medical need for stem cells and preservation of stem cells
2. Genetically engineered stem cells for gene therapy
3. Stem cell therapy – neurodegenerative disorders, cardiovascular disorders, metabolic disorders, hematopoietic disorders, organ disorders, autoimmune disorders, reproductive failures

III. Skill Outcomes

On successful completion of practical course students shall be able to

1. Learn the Isolations Of Plasmid
2. Restriction Digestion
3. Blotting Techniques
4. Amplification Of DNA

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SEMESTER-III

COURSE 6: RECOMBINANT DNA TECHNOLOGY

Practical | Credits: 3 | 3 hrs/week

IV .PRACTICAL Hours

1. Isolation of plasmid DNA from *E. coli* cells.
2. Digestion of plasmid DNA with restriction enzymes.
3. Preparation of competent cells of *E.coli*
4. Transformation of competent *E.coli* cells with plasmid DNA
5. Amplification of a DNA fragment by PCR.
6. Complementation of beta−galactosidase for Blue and White selection.
7. Southern blotting
8. Western blotting.
9. Culturing cells – aseptic techniques, media
10. Subculturing and cell lines
11. Cryopreservation

V. Suggested Readings

1. Gene Cloning and DNA Analysis (2010) 6th ed., Brown, T.A., Wiley-Blackwell publishing(Oxford, UK), ISBN: 978-1-4051-8173-0.

2. Principles of Gene Manipulation and Genomics (2006) 7th ed., Primrose, S.B., and Twyman, R. M., Blackwell publishing (Oxford, UK) ISBN:13: 978-1-4051-3544-3.

3. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010) 4th ed., Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC), ISBN:978-1-55581-498-4 (HC).

4. Human Molecular Genetics by Sudbury.

VI .Co-curricular Activities

a) Suggested Co-curricular Activities

1. Assignments
2. Group Discussions And Seminar On Related Topics
3. Debate
4. Cloning Of Diseases

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SEMESTER-III

COURSE 7: MOLECULAR TECHNIQUES IN GENETIC ENGENEERING

Theory Credits: 3 3 hrs/week

I. LEARNING OUTCOMES

Upon successful completion, each student will have the basic knowledge:
1. on different methods of isolation of DNA
2. on PCR and types
3. on Hybridization methods
4. on sequencing of DNA
5. on protein isolation techniques

II. Syllabus

Unit-1 Nucleic Acid Isolation And Agarose Gel Electrophoresis

1. Conventional and kit method for isolation of nucleic acids-Plasmid DNA-Genomic DNAfrom Bacterial cells, Plant cells, animal cells
2. RNA isolation and m-RNA purification –Agarose purification
3. Agarose gel electrophoresis-Staining techniques –Pulse field gel electrophoresis

Unit-2 PCR Techniques

1. Principle of Polymerase Chain Reaction (PCR)-Components of PCR reaction and optimizationof PCR

2Gene-specificc primer- Inverse PCR, Hot-start PC , Loop-mediated

3.PCR – Reverse transcription PCR and Real time PCR. Chemistry of primer synthesis

Unit-3 Hybridization Methods

1. Probes –Labelling of probes

2.Radioactive and non-radioactive

probes

3.Detection techniques, Southern hybridization, Northern hybridization, Western blotting

Unit-4 DNA Sequencing and Gene Synthesis

1. Sangers's method of DNA sequencing – Manual and automated methods.2.Pyrosequencing-massive parallel 454-sequencing,
3. illumine sequencing, SOLID sequencing, single molecule sequencing

UNIT-5 Protein Techniques

1. Electrophoresis of protein –native and denaturing conditions, capillary
2. Gel electrophoresis, 3D gel electrophoresis, ELISA,
3. Yeast hybrid system-one hybrid system, Phage display

III. Skill Outcomes

On successful completion of the practical course students shall be able to

1. Different PCR Techniques
2. Primer Designing
3. Blotting Techniques

SEMESTER-III

COURSE 7: MOLECULAR TECHNIQUES IN GENETIC ENGENEERING

Practical | Credits: 1 | 2 hrs/week

IV. PRACTICAL

1. Primer designing
2. Insertion deletion polymorphism
3. DNA Fingerprinting – RFLPs and VNTRs
4. Amplification and purification of DNA fragments
5. ARMS-PCR
6. Multiplex PCR
7. Nested PCR
8. DNA sequencing methods
9. SDS-Gel electrophoresis
10. Southern blotting
11. Northern blotting
12. Western blotting

V. REFERENCES

1. Fredrick M.Ausubel.Roger Brent,Robert E Kingstone,David D. Moore,Seidman J. G,John A.Smith and Kevin Struhl, "Current Protocols in Molecular Biology",John Wiley & Son,Inc.2003.

2. Daniel C.Liebler "Introduction to Proteomics",Human Press,2002.

VI .Co-curricular Activities

a) Suggested Co-curricular Activities

1. Assignments
2. Group Discussions and Seminar on related topics
3. PowerPoint presentations on sequencing and PCR
4. Demonstrating of blotting technique

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SEMESTER-III

COURSE 8: MOLECULAR PATHOLOGY IN HUMAN DISEASES

Theory Credits: 3 3 hrs/week

I. LEARNING OUTCOMES

Upon successful completion, each student will have the basic knowledge:
1. On Genetically Inherited Diseases
2. On Epidemiology Of Diseases
3. Mode Of Transmission Of Diseases
4. Basic Instrumentation And Their Techniques
5. On Testing Of Infectious Diseases

II. Syllabus

Unit 1 Human diseases I

1. Etiology, pathology and symptoms of genetically inherited diseases – PKU, alkaptonuria, galactosemia, Von Gierke disease, LeschNyhan syndrome, Gout, sickle cell anaemia, betathalassemia, diabetes
2. Mode of infection, symptoms and epidemiology of disease causes by viruses (HIV, Hepatitis B, Rabies, HSV-1)
3. Mode of infection, symptoms and epidemiology of disease caused by bacteria – typhoid, syphilis, TB

Unit 2 Human diseases II

1. Mode of infection, symptoms and epidemiology of disease caused by fungi – aspergillosis,histoplasmosis.
2. Mode of infection, symptoms and epidemiology caused by protozoa – malaria,amoebiasis.
3. Cancer genetics - tumour suppressor genes, oncogenes, Molecular basis of oncogenesis

Unit 3 Basic Instrumentation principles and techniques

1. Principles of electrophoresis and immunoblotting

2. Principles of DNA sequencing and methods of genotyping and mutation analysis3 Principles and applications of PCR, In situ hybridization techniques – ISH, FISH

Unit 4 Genetic testing for hereditary disorders

1 Genetic testing for thalassemia
2 Genetic testing for familial colorectal cancer
3 Genetic testing for familial breast and ovarian cancer

Unit 5 Molecular diagnosis of infectious diseases

1. Principles of HPV testing and methods of genotyping
2. Hepatitis B virus infection – testing for viral load and HBV DNA mutants detection
3. Molecular techniques -Nested, Real Time PCR for different clinical applications

III. Skill Outcomes

On successful completion of the practical course students shall be able to1.Learn Isolation Of RNA /DNA
2. Karyotyping
3. Analyzing Of Electrophoretic Results
4. PCR Setup

SEMESTER-III

COURSE 8: MOLECULAR PATHOLOGY IN HUMAN DISEASES

Practical Credits: 1 2 hrs/week

IV. Practical

1. Extract and assess the purity of DNA.
2. Agarose gel electrophoresis
3. Set up PCR.
4. Evaluate Southern blot data
5. Analyze PCR product using agarose gel electrophoresis and interpret results
6. Demonstration of karyotyping
7. Isolate cellular RNA, purify mRNA
8. Set up RT-PCR using commercial kit
9. Analyze RT-PCR results by agarose gel.

V. References

1. Basic Concepts of Molecular Pathology Series: Molecular Pathology Library, Vol. 2Cagle, Philip T. Allen, Timothy C. (Eds.)Springer 2009
2. Molecular Pathology: The Molecular Basis of Human Disease; William B. Coleman,Gregory J. Tsongalis (Eds.);Academic Press;
3. Genomics and Personalized Medicine Huntington F. Willard, Geoffry S. Ginsburg;Elsevier2009
4. Medical Genetics, 4th Edition;Lynn B. Jorde, John C. Carey, and Michael J.Bamshad,Mosby
5. DNA from A to Z & Back Again; Carol A. Holland and Daniel H. Farkas; AACCPress2008
6. Molecular Genetic Pathology, 1st ed.; Liang Cheng and David Zhang; HumanaPress2008

VI. Co-curricular Activities

a) Suggested Co-curricular Activities

1Assignments
2. Group Discussions and Seminar on related topics
3. Power point presentation
4. Charts on life cycle of infectious Diseases

SEMESTER-IV

COURSE 9: STATISTICS AND INFORMATICS IN HUMAN GENETICS

Theory Credits: 3 3 hrs/week

I. LEARNING OUTCOMES

Upon successful completion, each student will have the basic knowledge:
1. on principles of statistics
2. on probability and their distribution
3. on correlation Analysis
4. on computers and operating systems
5. on Data bases and their alignment tools

II. Syllabus

Unit 1 Descriptive Statistics

1. Methods of presentation and interpretation of data – frequency distribution, graphical representation of data, histogram, frequency polygon, frequency curve.
2. Measures of Central tendency – mean, median, mode
3. Measures of Dispersion - standard deviation, variance, coefficient of variation.

Unit 2 Elementary Probability

1. Mathematical definition of probability of an event, Use of permutations and combinations in calculations of Probability
2. Conditional probability, Additive and Multiplication law of Probability, RandomVariables, Mathematical expectation and variances
3. Probability Distributions: Binomial, Poisson and normal distributions.
4. Bayes theorem

Unit 3 Correlation analysis, test of significance and ANOVA

1. Correlation and regression analysis— Relationship between variables
2. Test of significance – statistical and scientific hypothesis, null and alternative hypothesis,procedure of hypothesis testing,
3. Test of significance – student's t test, chi-square test, F test
4. ANOVA – general idea of one way and two way analysis

Unit 4 Computers, operating systems and Internet

1. Principles of computer operations –basic computer architecture, hardware architecture
2. Principles of computer operations – software architecture, operating systems, Programming languages –traditional and scripting languages, Java, markup languages, application programs
3. Communication and Networks – network architecture, standards for exchange of information, internet services - email, WWW search engines

Unit 5 Bioinformatics

1. History of Bioinformatics
2. Databases and search tools – NCBI, EBI, GenomeNet; Databasemining tools –BLAST
3. Database archives – nucleic acid sequence databases, genome databases and genome browsers, protein sequence databases, databases of protein families, databases of structures, expression and proteomic databases, bibliographic databases
4. Gateways to archives –ENTREZ, PIR, ExPASy

III. Skill Outcomes

On successful completion of practical course students shall be able to

1. Learn Frequency Distributions and Measures of Central Tendency
2. Learn The Hypothesis Regarding Mean
3. Learn Sequence Retrieval from Different Data Bases
4. Learn The Internet Basics

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COURSE 9: STATISTICS AND INFORMATICS IN HUMAN GENETICS

Practical Credits: 1 2 hrs/week

IV. PRACTICAL

1. Frequency distribution
2. Various types of graphs
3. Mean, Median, Mode
4. Standard deviation, variance and coefficient of variation
5. Testing of hypotheses regarding population mean
6. Testing of hypotheses about the difference between population means
7. Chi-square test
8. Testing of Correlation Coefficient
9. Fitting of simple linear regression
10. One-way ANOVA&Two-way ANOVA
11. Internet basics
12. Sequence retrieval (protein and gene) from NCBI, Structure download (protein and DNA) from PDB
13. Molecular file formats - FASTA, GenBank, Genpept, GCG, CLUSTAL, Swiss-Prot,FIR

V. Suggested Readings

1. Fowler, J., Cohen, L. and Jarvis, P. (1998). Practical Statistics for Field Biology. JohnWiley and Sons, 2nd ed. .
2. Bland, M. (2006). An Introduction to Medical Statistics. Oxford University Press, 3rded.
3. Finney, D.J. (1980). Statistics for Biologists.Chapman and Hall Ltd.
4. Wayne, W, Daniel (1999). Biostatistics: A Foundation for Analysis in Health Sciences. John Wiley and Sons, 7th ed.

VI. Co-curricular Activities

a) Suggested Co-curricular Activities

1. Assignments
2. Group Discussions and Seminar On Related Topics
3. Sequence Retrieval from Data Bases
4. Search Engines and Tools

SEMESTER-IV

COURSE 10: CLINICAL GENETICS & GENETIC COUNSELLING

Theory Credits: 3 3 hrs/week

I. LEARNING OUTCOMES

Upon successful completion, each student will have the basic knowledge:
1. On Single Gene Disorders
2. On Metabolic Disorders
3. On Genome Imprinting and Neurodegenerative Disorders
4. On Blood Disorders and Polygenic Syndromes
5. On Genetic Counselling and Their Risk Factors

II. Syllabus

Unit-1 Genetic Disorders I

1. Monogenic diseases – Cystic fibrosis, Tay-Sachs syndrome, Marfan syndrome
2. Inborn errors of metabolism – Phenylketonuria, Maple syrup urine syndrome, galactosemia
3. Genome imprinting syndromes –Prader Willi and Angelman syndrome

Unit-2 Genetic Disorders II

1. Genomic syndromes – Neurofibromatosis I
2. Neurogenetic disorders – Charcot Marie Tooth syndrome, spinal muscular atrophy, Alzheimer's diseases, syndromes due to triplet nucleotide expansion
3. Muscle genetic disorders – dystrophies, myotonias, myopathies

Unit-3 Genetic Disorders III

1. Genetic Disorders of Haemopoietic systems- sickle cell anemia, thalassemia's,haemophilia
2. Genetic disorders of eye – colour-blindness, retinitis pigmentosa, glaucoma
3. Complex polygenic syndromes – atherosclerosis, diabetes mellitus
4. Mitochondrial syndromes

Unit-4 Genetic Counselling

1. Role of genetic counselling
2. Causes and factors for seeking counselling
3. Dysmorphology
4. Prenatal and preimplantation diagnosis

Unit-5 Practical Genetic Counselling

1. Process of genetic counselling - Constructing a family tree, diagnostic information, risks and odds, estimation of risks
2. Genetic counselling in Mendelian disorders
3. Genetic counselling in non-Mendelian disorders
4. Ethical and legal issues in genetic counselling

III. Skill Outcomes

On successful completion of practical course students shall be able to

1. Learn Metaphase Chromosome Preparations
2. Learn Banding Techniques
3. Sex Chromatin Analysis from Different Sources
4. Learn Different Biochemical Tests

SEMESTER-IV

COURSE 10: CLINICAL GENETICS & GENETIC COUNSELLING

Practical | Credits: 1 | 2 hrs/week

IV. Practical

1. Metaphase chromosome preparations from bone marrow of mouse, rat, human
2. Chromosome preparation from lymphocyte culture
3. G-banding, C-banding, R-banding
4. Karyotyping
5. Meiosis in mouse testis
6. Sex chromatin (buccal mucosa, hair bud)
7. Micronuclei assay
8. Chromosome preparation from chorionic villi, stem cells, cell line
9. Sister Chromatid Exchange (SCE)
10. Molecular markers for tumour detection
11. Genetic counseling (pedigree analysis in disease conditions, risk calculation)
12. Y-chromosome microdeletion
13. Biochemical tests for sugar, albumin, Creatine phosphokinase-CPK, glucose 6 phosphate dehydrogenase-G6PD

V. SUGGESTED READINGS

1. Chen, Harold Atlas of Genetic Diagnosis and Counseling Springer 2012.
2. Thompson and Thompson & Thompson Genetics in Medicine, Robert L. Nussbaum, Roderick R. McInnes, Huntington F. Willard (eds)

VI. Co-curricular Activities

a) Suggested Co-curricular Activities

1. Assignments
2. Group Discussions and Seminar On Related Topics
3. Debate on Different Disorders
4. Visit to Near Genetic Counselling Center
5. Visit to Cytogenetic Labs

SEMESTER-IV

COURSE 11: DEVELOPMENTAL AND BEHAVIORAL GENETICS

Theory Credits: 3 3 hrs/week

I. LEARNING OUTCOMES

Upon successful completion, each student will have the basic knowledge:
1. On Germ Cells and Fertilization
2. On Different Development Genes
3. On Basic Concepts of Development
4. Embryonic Development of Drosophila
5. Flower Development of Arabidopsis
6. On Genetic Control of Behavior

II. Syllabus

UNIT-1: Germ Cells and Fertilization

1. Germ Cells

2. Spermatogenesis,

Oogenesis3.Fertilization

and Gastrulation

UNIT-2: Basic & Molecular Aspects of Development

1. Potency, commitment, specification, induction ,

competence2.Maternal effect gene Gap gene, Pair rule gene

3. Segment polarity genes, Homeotic genes

UNIT-3: Genetics of Embryonic Development in Drosophila

1. Overview of Drosophila development

2. Zygotic genes

3. Segment formation

UNIT- 4: Flower Development in Arabidopsis

1. Development of Arabidopsis

2. Role of Homeotic Selector Gene

3. ABC model of Arabidopsis

UNIT-5: Genetic Control Of Behavior

1. Introduction, Behavior in Invertebrates, Honeybee,
2. Drosophila – Genetic basis of alcoholism, genetic basis for sexual orientation.
3. Courtship behavior in various animals.

III. Skill Outcomes

On successful completion of the practical course students shall be able to

1. Learn Dissection of Drosophila Larvae
2. Development of Chick Embryo
3. Role of SHH Signaling

SEMESTER-IV

COURSE 11: DEVELOPMENTAL AND BEHAVIORAL GENETICS

Practical | Credits: 1 | 2 hrs/week

IV. Practical Syllabus Hours

1. Study of development in chick embryo
2. Dissection of the imaginal disc in Drosophila larvae
3. Life cycle of drosophila, husbandry and handling.
4. Role of SHH signaling in chick development
5. Observation of living and plastic embedded chick embryos6.The maternal effect gene in drosophila

V. REFERENCES

1. The cell – Bruce Alberts
2. Emery's Elements of Medical Genetics- Robert. F. Mueller, Ian. D. Young.
3. Principles of Development - Wolpert
4. Principles of Genetics – Snustad, Simmons, Jenkins.

Co-curricular Activities

a) Suggested Co-curricular Activities

1. Assignments
2. Group Discussions and Seminar On Related Topics
3. Power Point Presentation on Developmental Genes

SEMESTER-V

COURSE 12: HUMAN GENOME PROJECT AND GENOMES

Theory Credits: 3 3 hrs/week

I. LEARNING OUTCOMES

Upon successful completion, each student will have the basic knowledge:
1. On Genome Organization
2. On Different Mapping Techniques
3. On Human Genome Project
4. On Genome By Understanding The Function Of Genes
5. On Molecular Phylogenetics

II. Syllabus

UNIT 1 GENOME ORGANIZATION AND STUDY
1. Genome – general features, features of eukaryotic nuclear genomes
2. Genomes, transcriptomes and proteomes
3. Genome diversity – significance of genomes – bacteria, yeast, Caenorhabditis, Homo sapiens, Arabidopsis.

UNIT 2 MAPPING GENOMES
1. Genetic mapping – pedigree analysis, DNA markers – RFLPs, SSLPs, SNPs
2. Physical mapping – restriction mapping, FISH, radiation hybrid mapping, STS mapping
3. Sequencing genome- assembly of contiguous DNA sequence, shotgun method, clonecontigmethod, whole-genome shotgun sequencing

UNIT 3 GENOME PROJECTS
1. Human genome project, HapMap Project, 1000 genome project, ENCODE project
2. Other genome projects.
3. Applications and proposed benefits of HGP –ELSI.

UNIT 4 UNDERSTANDING GENOME SEQUENCE
1. Locating the genes in a genome sequence
2. Determining the functions of individual genes
3. Transcriptome – microarrays, Proteome – protein profiling

UNIT 5 MOLECULAR PHYLOGENETICS
1. Phenetics and cladistics
2. Reconstruction of DNA based phylogenetic tree
3. Applications of molecular phylogenetics – evolutionary relationship betweenhumans and primates; origin of AIDS; human pre - history.

III . Skill Outcomes

On successful completion of practical course students shall be able to1.Purification Techniques

2. PCR
3. Sequence Alignment Techniques
4. Gene Finding Tools
5. Proteomics

SEMESTER-V

COURSE 12: HUMAN GENOME PROJECT AND GENOMES

Practical | Credits: 1 | 2 hrs/week

IV . PRACTICAL

1. Isolation and purification of genomic DNA.
2. Detection of SNPs using SNP specific primers and PCR.
3. Study of VNTR's in human genome as the polymorphic loci.
4. Design primers for PCR based detection of the gene and mapping primers on the genome
5. Introduction to NCBI websites
6. Introduction to databa se: protein data bank, nucleic acid database, Genbank .
7. Web based analysis to retrieve a nucleotide sequence from NCBI ,
8. Sequence alignment using BLASTn, BLASTp, CLUSTALW.
9. Gene finding tools – GenScan, GLIMMER
10. Introduction to proteomics – Protparam, GOR, unPredict, SWISSMODEL .
11. Visualization software – Rasmol
12. Generating phylogenetic tree using PHYLIP

V. SUGGESTED READINGS

1. Human Genome Project by James Toriello .
2. Understanding the Human Genome Project by Michael A Palladino.
3. Human Genes and Genomes: Science, Health, Society by Leon E Rosenberge, DianeDrobnis Rosenberg.
4. From Genes to Genomes: Concepts and Applications of DNA Jeremy W Dale, Malcolm von Schantz, Nick Plant .
5. Genomes 3 by Terence A Brown.
6. Principles of Gene Manipulation and Genomics by Sandy B Primrose and RichardTwyman.

VI. Co-curricular Activities

a) Suggested Co-curricular Activities

1. Assignments
2. Group Discussions and Seminar On Related Topics
3. Visit to Bioinformatics Lab
4. Conduction of Workshop And Guest Lecture Related To Bioinformatics

SEMESTER-V

COURSE 13: CELLULAR AND MOLECULAR IMMUNOLOGY

Theory Credits: 3 3 hrs/week

I. LEARNING OUTCOMES

Upon successful completion, each student will have the basic knowledge:
1. On Vaccines
2. On Immunity
3. On Monoclonal Antibody
4. On Presentation And Processing Of Cells
5. On Immunological Techniques

II. Syllabus

Unit 1

I. Introduction to Immune System, types of immunity-innate and adaptive2.Cellular components of immunity — Lymphoid cells ,Myeloid cells

3. Lymphoid organs- Primary lymphoid organs (Bone marrow & thymus); secondary lymphoidorgans (lymph node and spleen)

Uint 2 :

1. Antigens- Immunogens, epitopes, Haptens and types of adjuvants
2. Humoral and MHC immune responses
3. Basic structure of Immunoglobulin- Immunoglobulin domains-variable region and constant region domains; isotypes, allotypes, idiotypes ,Immunoglobulin classes and its functions- IgG, IgM, IgA, IgD, Ig E

Unit -3

1. Polyclonal antibodies, Monoclonal antibodies- its production and applications2.Structure and organization of MHC class I and class II molecules.
3. Cell-mediated Immunity ,Hypersensitivity- Types (I, II, III & IV)
4. Immunodeficiency disorders- primary immunodeficiency disorders (SCID), secondary immunodeficiency disorders (AIDS)

Unit -4

1. Vaccines- historical background and principle; passive & active immunization.attributes of effective vaccines
2. Types of vaccines- live attenuated and inactivated killed vaccines. sub-unit vaccines, DNA vaccines, edible vaccines

Unit-5

1.General features of ag-ab reactions- Agglutination, neutralization, complement fixation, opsonisation. Immunoprecipitation, immunoelectrophoresis, immunodiffusion Tests

2 ELISA — Types , Immuno fluorescence assays (direct & indirect) Principle and applications

3. Western blot -Principle, procedure and applications , Flow cytometry -Principle, methodologyand applications

III .Skill Outcomes

On successful completion of the practical course students shall be able to

1. Blood Grouping
2. Immunological Technique

SEMESTER-V

COURSE 13: CELLULAR AND MOLECULAR IMMUNOLOGY

Practical | Credits: 1 | 2 hrs/week

IV Practical's

1. ABO blood typing
2. Differential count of lymphocytes
3. Single Radial Immunodiffusion
4. ELISA
5. Agglutination
6. Haemagglutination test
7. Coomb's test
8. Western Blot

V . References

1. Essential Immunology by I.Roitt,Publ:Blackwell
2. Immunology by G. Reever & I.Todd,Publ:Blackwell
3. Immuno diagnostics by S.C. Rastogi, Publ:NewAge
4. Immunology by Richard A.Golds by, Thomas J Kindt, Barbaraa. Osborne,
5. Janiskuby
6. Fundamental immunology by WilliamE.Paul
7. Basic Immunology by Bhoosreddy G.L. and WadherB.J.
8. Text book of immunology by BarujBenacerraf
9. Immunology by Kuby:Publ:Freeman

VI .Co-Curricular Activities

1. Assignments.
2. Charts on complement pathway, MHC I & II
3. Group discussions and Student seminars.
4. Visit to diagnostic labs

SEMESTER-V

COURSE 14 A: INTRODUCTION TO STEM CELL TECHNOLOGY

Theory Credits: 3 3 hrs/week

I. LEARNING OUTCOMES

Upon successful completion, each student will have the basic knowledge:

1. Familiarize the students with stem cell technology and its applications for betterment of thesociety.
2. Designed to give a broad view of mammalian stem cells, reviewing where they are found inthe body, the different types and how they are cultured.
3. Will cover the basic biology of these stem cells
4. In bioengineering and application of these stem cells to potential treatments of human diseases.
5. Understanding preservation of cells using cryoprotectants

II. Syllabus

UNIT-I

1. Introduction to stem cells Definition, properties, proliferation, culture of stem cells,
2. Medical applications of stem cells, ethical and legal issues in use of stem cells. Types of stem cells. Stem Cell biology and therapy, types embryonic stem cell, Adult stem cell, Stem Cell Biology and Therapy
3. Embryonic Stem Cells, culture and the potential benefits of stem cell technology

UNIT-II

1. Isolation of human Embryonic stem cells, generation of human induced pluripotent stem cells.
2. History of human pluripotent stem cell development.
3. Methodologies for pluripotent stem cell culture, characterization of pluripotency and differentiation into different lineages.

UNIT-III

1. Ethical and regulatory issues affective pluripotent stem cell-based cell replacement therapies.
2. Technological challenges towards development of pluripotent stem cells
3. Cell replacement therapies.

UNIT-IV

1. Principles of cell replacement therapy and application of pluripotent stem cells in cell replacement therapy.
2. Application of pluripotent stem cells in neuronal disease management and treatment.
3. Application of pluripotent stem cells in ocular and cardiovascular diseases management and treatment.
4. Application of pluripotent stem cells in treatment of autoimmune complications and cancer management and treatment.

UNIT-V

1. Introduction and Historical Background of Cryopreservation
2. Liquefaction systems, ideal, Cascade, Linde Hampsonand Claude cycles and their derivatives; Refrigerators: Stirling, Gifford-McMahon cycles and their derivatives. Cryogenic Insulations: Foam, Fibre, powder and Multilayer.
3. Principles of Cryopreservation, Effects of Freezing on Cells, Thawing & amp; Post Thaw Handling, Cryoprotectants

III. Skill Outcomes

On successful completion of the practical course students shall be able to

1. Learn isolation of stem cells from different tissues/ organs
2. Learn about stem cell counting
3. Learn *in-vitro* fertilization techniques

SEMESTER-V

COURSE 14 A: INTRODUCTION TO STEM CELL TECHNOLOGY

Practical | Credits: 1 | 2 hrs/week

IV. PRACTICAL

1. Isolation of stem cell from cord blood /bone marrow /adipose tissue /cord tissue
   /endometrial tissue
2. Stem cell counting and viability checking
3. Cell proliferation assay
4. Growth curve and PDT analysis
5. Characterization of stem cells
6. Embryo culture and in-vitro fertilization techniques
7. Embroid body formation
8. Differentiation of stem cells into various lineages
9. Cancer stem cell- isolation
10. Case studies of stem cell therapy for various diseases

V .REFERENCES

1. "Stem cell basics and application" Ed. By K. D. Deb and S. M. Totey, Tata McGrawHill

Pvt. Ltd, 2011.

2. "Hand book of Stem Cells" Edited by RoberLanza, Elsevier, Academic Press, 2011.

3. "Stem Cells Handbook", Edited by Stewart Sell, Human Press, 2010.

4. "Human embryonic stem cells", Edited by Arlene Y. Chiu, MahendraRao,

Human5. Press, 2011.

6. "Stem cell therapy for organ failures", Edited by S. Indumathi, Springer Verlag, 2015

7. Human Pluripotent Stem Cells: Methods and Protocols (Methods in Molecular Biology) 2011th Edition by Philip H. Schwartz (Editor), Robin L. Wesselschmidt.

8. Atlas of Human Pluripotent Stem Cells: Derivation and Culturing (Stem Cell Biology andRegenerative Medicine) 2011 by Michal Amit and Joseph Itskovitz-Eldor.

9. Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine, Alexander Battler,

VI .Co-Curricular Activities

1. Assignments.
2. charts on types of stem cells
3. Group discussions and Student seminars.
4. Power point presentation

SEMESTER-V

COURSE 14 B: MICROBIAL GENETICS

Theory Credits: 3 3 hrs/week

I. LEARNING OUTCOMES

Upon successful completion, each student will have the basic knowledge:
1. On Cell Organelles And Cell Division
2. Concept Of Gene , Operons
3. On Principles Of Genetic Engineering
4. Concepts Of Mutations
5. Gene Cloning Methods

II. Syllabus

UNIT -1

1. Overview of prokaryotic and eukaryotic cells, cell size and shape, Eukaryotic and prokaryoticCell organelles, Cell division (mitosis and Meiosis)
2. Fundamentals of genetics - Mendelian laws, alleles, crossing over, and linkage. DNA andRNA as genetic materials.
3. Structure of DNA — Watson and Crick model. Extrachromosomal genetic elements —Plasmids and transposons. Replication of DNA — Semiconservative mechanism.

UNIT -II (9hr)

1. Brief account on horizontal gene transfer among bacteria — transformation, transduction andconjugation.
2. Mutations — spontaneous and induced, base pair changes, frameshifts, deletions, inversions,tandem duplications, insertions. Physical and chemical mutagens.
3. Outlines of DNA damage and repair mechanisms.

UNIT – III

1. Concept of gene — Muton, recon and cistron. One gene-one enzyme, one gene-one polypeptide, one gene-one product hypotheses.
2. Types of RNA and their functions. Outlines of RNA biosynthesis in prokaryotes.
3. Genetic code. Structure of ribosomes and a brief account of protein synthesis.

UNIT -IV

1. Types of genes — structural, constitutive, regulatory. Operon concept.
2. Regulation of gene expression in bacteria — Lac operon
3. Tryptophan operon and Arabinose operon

UNIT-V

1. Basic principles of genetic engineering - restriction endonucleases, DNA polymerasesand ligases, vectors.
2. Outlines of gene cloning methods. Genomic and cDNA libraries.
3. General account on application of genetic engineering in industry, agriculture andmedicine.

III. Skill Outcomes

On successful completion of the practical course students shall be able to

1. Isolation of DNA
2. Quantifications of DNA/RNA
3. Problems related to Mendelian disorders

SEMESTER-V

COURSE 14 B: MICROBIAL GENETICS

Practical | Credits: 1 | 2 hrs/week

IV .Practical

1. Estimation DNA by diphenylamine (DPA) method.
2. Estimation of RNA by orcinol method
3. Study of cell division in onion root tip (mitotic divisions)
4. Isolation of DNA from bacteria.
5. Isolation of mutants of bacteria by UV exposure.
6. Problems related to Mendelian laws mono and dihybrid cross (problems)
7. Problems related to gene interactions
8. Problems related to DNA and RNA characteristics, Transcription and Translation.

V .References:

1. Genes XI, Author- B. Lewin.
2. Principles of Genetics, Authors- Gardner, Simmons and Snustad.
3. Concepts of Genetics, Authors- Klug and Cummings.
4. Microbial Genetics, Authors- Freifelder.
5. Genetics, Authors- Arora and Sandhu.
6. Text of Microbiology, Authors- Ananthanarayanan and Paniker.
7. S R Maloy, D Freifelder and J E Cronan. Microbial Genetics. Jones and Barlett

VI .Co-curricular Activities

a) Suggested Co-curricular Activities

1. Assignments
2. Group Discussions and Seminar on related topics
3. Power point presentation on protein synthesis , replication , transcription
4. Charts on operon concept

SEMESTER-V

COURSE 15 A: FORENSIC SCIENCE

Theory Credits: 3 3 hrs/week

I. Learning Outcomes

Upon successful completion, each student will have the basic knowledge: 1: Understand the underlying principles of DNA for use in forensic studies2: Develop scientific temper on DNA
3: Analyse and evaluate forensic problems using biochemical methods4: Identify and suggest means for forensic problems
5. In Techniques in forensic Analysis

II. Syllabus

Unit I Introduction

1. Basic principles and their significance. Branches of forensic Science. History &development of Forensic science.
2. Nature and scope of forensic science.
3. The organizational structure of Forensic Science Laboratories at the central & State level.Ethics in Forensic science.

Unit II DNA Biology

1. Principles of DNA structure - DNA in the cell, Organisation of Information in the cell,
2. Identification of DNA information, DNA variation (SNP), Short Tandem Repeat (STR) Markers
3. Position of Forensic STR Markers on Human Chromosomes, paternity testing, DNA evidence.

Unit III DNA technology in Forensic Science

1. Introduction, individual Variation in DNA, DNA Typing- Genetic basis of DNA typingstructure and function of DNA,
2. technological basis of DNA typing - Restriction Fragment Length Polymorphisms,
3. PCR-based typing methods such as RAPD, AFLP, STR.

Unit IV Forensic Analysis

1. Enzymes used in Forensic Science -Restriction enzymes, Phosphatases, DNA polymerases, andDNA ligases, and their forensic significance.

2. Forensic Serology –Blood, Saliva, Urine, Bone, Teeth, Hair, and other body fluids.
3. Forensic Immunology– ELISA, Blood group-specific ABO substances.

Unit V Techniques used in Forensic Analysis

1. Use of Thin-layer chromatography -TLC, Gas Chromatography (GC), High-Performance Liquid Chromatography (HPLC).
2. Ultraviolet and visible spectrophotometer.
3. Immunoassays in Forensic analysis.

III. Skill Outcomes

On successful completion of the practical course students shall be able to

1.Apply the different types of techniques that make use of DNA for analysing Forensic sample2: Analysis of sample found as evidence.

SEMESTER-V

COURSE 15 A: FORENSIC SCIENCE

Practical | Credits: 1 | 2 hrs/week

IV. Practical

1. Extraction and purification of DNA from various samples - Hair, Saliva, dried blood samples
2. Analysis of DNA sample – RFLP
3. Demonstration of DNA Amplification technique – AFLP.
4. Determination of Blood group substances in body fluids.
5. Radio Immunoassay

V .References

1. Essential Forensic Biology, Second Edition, Alan Gunn, Wiley-Blackwell, 2009.
2. Ethics in Forensic Science: Professional Standards for the
Practice ofCriminalistics by Peter D. Barnett.
3. The Biological Evidence Preservation Handbook: Best Practices for
EvidenceHandlers. Susan Ballou Mark Stolorow Melissa Taylor.
4. Nelson, D. L. & Cox, M. M. Lehninger Principles of Biochemistry. Freeman,
5thed, 2008.
5. Principles of Forensic Medicine and Toxicology by Rajesh Bardale.

VI.Co-Curricular Activities

a. Suggested Co-curricular Activities

1. Assignments.
2. Chart preparations.
3. Group discussions on case studies.
4. Student seminars

SEMESTER-V

COURSE 15 B: DNA FORENSICS AND SEROLOGY

Theory Credits: 3 3 hrs/week

1. Learning Outcomes:

Upon successful completion, each student will have the basic knowledge:

1. The significance of biological and serological evidence.
2. The forensic importance of hair evidence.
3. The importance of biological fluids – blood, urine, semen, saliva, sweat and milk – incrime investigations.
4. The importance of bloodstain patterns in reconstructing the crime scene.
5. On parentage testing

II. Syllabus

Unit 1: Biological Evidence

1. Nature and importance of biological evidence. Significance of hair evidence. Transfer, persistence and recovery of hair evidence. Structure of human hair. Comparison of hair samples. Morphology and biochemistry of human hair.
2.. Types and identification of microbial organisms of forensic significance.
3. Identification of wood, leaves, pollens and juices as botanical evidence. Diatoms and their forensic significance.

Unit 2: Forensic Importance of Body fluids I

1. Identification of body fluids. Composition and functions and forensic significance of Blood <Semen ,saliva, sweat, milk and urine. Tests for their identifications
2. Collection and preservation of blood evidence. Distinction between human and non-humanblood. Determination of blood groups.
3. Semen - Composition, functions and morphology of spermatozoa. Collection, evaluation andtests for identification of semen. Individualization on the basis of semen examination

UNIT-3 Bloodstain Pattern analysis

1. Bloodstain characteristics. Impact bloodstain patterns. Cast-off bloodstain patterns. Projectedbloodstain patterns. Contact bloodstain patterns.

2. Blood trails. Bloodstain drying times. Documentation of bloodstain pattern evidence.3.Crime scene reconstruction with the aid of bloodstain pattern analysis

UNIT-4 Genetic Marker Analysis

1. Cellular antigens. ABO blood groups.
2.Extracellular proteins and intracellular enzymes.
3. Significance of genetic marker typing data. Sexual assault investigations

UNIT-5 FORENSIC DNA TYPING AND PARENTAGE TESTING

1. Collection of specimens, Extraction of DNA For analysis
2. Polymerase chain reaction, sequence polymorphisms, individualization of evidence, Restriction fragment length polymorphism (RFLP) – genetic markers used in RFLP, typing procedure and interpretation of result.
3. DNA Testing in disputed Paternity, Mendelian laws of parentage testing.

III. Skill Outcomes

On successful completion of the practical course students shall be able to

1. Learn How To Collect And Store Blood Samples
2. Blood Grouping
3. Learn Gel Plates Preparation

SEMESTER-V

COURSE 15 B: DNA FORENSICS AND SEROLOGY

Practical | Credits: 1 | 2 hrs/week

IV. Practical's

1. To carry out the separation of amino acids by thin layer chromatography.
2. To carry out extraction of DNA from body fluids.
3. To preparation of gel plates for electrophoresis.
4. To prepare a report on the role of DNA typing in solving paternity disputes
5. To determine blood group from fresh blood samples.
6. To determine blood group from dried blood sample.
7. To carry out the crystal test on a blood sample.
8. To identify blood samples by chemical tests.
9. To identify the given stain as saliva.
10. To identify the given stain as urine.

V. References

1.W.G. Eckert and S.H. James, Interpretation of Bloodstain Evidence at Crime Scenes, CRCPress, Boca Raton (1989).
2. G.T. Duncan and M.I. Tracey in Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert(Ed.), CRC Press, Boca Raton (1997).
3. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004).
4. T. Bevel and R.M. Gardner, Bloodstain Pattern Analysis, 3rd Edition, CRC Press, Boca Raton(2008)

VI .Co-Curricular Activities

1. Assignments.
2. Visit to Forensic Laboratory
3. Group discussions and Student seminars.
4. Power point presentation

SEMESTER-VII

COURSE 16 A: CELL BIOLOGY

Theory Credits: 3 3 hrs/week

Learning Outcomes:
Students after successful completion of the course will be able to

LO1: Understand the chemical constituents of cell
LO2: Understand cell structure and organization
LO3: Apprehend various functions carried out by cell organelles which are necessary to maintain the homeostasisin the cell
LO4: Perceive cellular communications and different phases of cell cycle and cell death
LO5: Appreciate the ways by which cell transmits signals with itself and with the environment

Unit 1 Introduction
Origin and development of cell biology; Dimensions of size and weight - Micron to angstrom, Microgram to picogram; Ultra structure and organization of prokaryotic and eukaryotic cells; Unicellular eukaryotic model organisms – Yeast, Chlamydomonas reinhardtii, Plasmodium

Unit 2 Cell Structure and Organization
Structure and functions of plasma membrane; Types of membrane transport – Simple diffusion, Facilitated diffusion, Active transport, Mechanism of endocytosis and exocytosis; Cytoskeleton- Structural and functional organization of Microfilaments, Microtubules, Intermediate filaments.

Unit 3 Intracellular Cell Organelles
Structural organization and function of cell wall, Nucleus, Mitochondria, Golgi bodies, Endoplasmic reticulum, Ribosomes, Lysosomes, Peroxisomes, Vesicles, Chloroplasts, Plastids, Vacuoles

Unit 4 Cell Communication
Types of cell junctions – Occluding junctions, Anchoring junctions, Communicating junctions; Cell adhesion molecules – Cadherins, Selectins, Integrins, Extra cellular matrix; Neurotransmission and its regulation; Cell division; Regulation of cell cycle; Apoptosis

Unit 5 Cell Signaling
Forms of cell signaling; Types of receptors - Cell surface receptors; Enzyme linked receptors, G-protein linked receptors; Second messengers; Signal transduction pathways; Regulation of signaling pathways

Suggested Readings

1. Alberts B, Breyer D, Hopkin K, Johnson AD, Lewis J, Raff M, Roberts K and Watter P, (2014), *EssentialCell Biology*, 4th edition, Garland publishers, New York
2. Sharp D, Ploppe G and Sikorski E, (2015), *Lewin's Cells*. 3rd edition. Viva Books, New Delhi
3. Cooper GM, Hausman RE, (2013), *The Cell – A Molecular Approach*. 6th edition, Sinauer Associates,Incorporated, USA
4. Cowling G, Allen T, (2011), *The Cell*. *A very Short Introduction*, Oxford University Press, USA
5. Lodish H, Berk A, Kaiser CA, Kreiger M, Scott P M, Bretcher A, Ploegh H, Matsudaira P,(2004), *Molecular Cell Biology*, 5th edition, W. H. Freeman and Company, New York
6. Kleinsmith LJ and Kish VM, (1995), *Principles of Cell and Molecular Biology*, 2nd edition, Harper CollinsCollege Publishes, New York, USA
7. Purohit S.S Powar, (2008), *The Cell and the Molecular Biology*
8. Mousami Debnath, (2014), *Cell and Molecular Biology*, Shashi Jain Publ. Jaipur
9. Bruce Alberts et.al., (2014), *Molecular Biology of the Cell*, 6th edition, Taylor & Francis Group
10. Gerald Karp, *Cell and Molecular Biology: Concepts and Experiments*, 8th edition

SEMESTER-VII

COURSE 16 A: CELL BIOLOGY

Practical Credits: 1 2 hrs/week

Learning Outcomes:
Students after successful completion of the practical course will be able to

LO1: Differentiate between prokaryotic and eukaryotic cell
LO2: Understand the importance of the proteins which give shape and structure to the cells
LO3: Identify all the cell organelles
LO4: Apprehend the different stages in mitosis
LO5: Realize how haploid cells are formed during meiosis

1. Electron microscope pictures of prokaryotic and eukaryotic cells
2. Images of cytoskeleton
3. Electron microscope pictures of chloroplast and mitochondria
4. Electron microscope pictures of endoplasmic reticulum, golgi apparatus
5. Preparation of slides and identification of different stages of mitosis (root tips)
6. Preparation of slides and identification of different stages of meiosis

Suggested Readings

1. Atlas R.L, (2010), *Handbook of Microbiological Media*, 4th edition
2. Lennettee E.H, (1985), *Manual of Clinical Microbiology*, 4th edition
3. Murray PR, (2003), *Manual of Clinical Microbiology*, 8th edition
4. Harry W and Seeley Jr.,(1991), *A Laboratory Manual of Microbiology: Microbes in action*, 4th edition
5. Celis JE (ed) ,(2006), *Cell Biology–A Laboratory Hand Book*, 3rd edition, Elsevier, USA

SEMESTER-VII

COURSE 16 B: ECOLOGY AND CONSERVATION GENETICS

Theory Credits: 3 3 hrs/week

Learning Outcomes:
Students after successful completion of the course will be able to

LO1: Acquire knowledge about the types of ecosystem
LO2: Understand the process of bioremediation and phytoremediation
LO3: Understand the micro evolution forces that influence genetic change in populations
LO4: Apprehend strategies of biodiversity conservation
LO5: Appreciate genetic management of wild populations

Unit 1 Ecosystem Ecology
Ecology- Habitat and Niche, Species interaction; Ecosystem - Components, Types, Functions, Energy flow,Biogeochemical cycles (Carbon cycle, Nitrogen cycle, Phosphorous cycle, Sulfur cycle).

Unit 2 Community Ecology
Ecological genetics; Gene flow; Landscape genetics; Sewall wright effect; Neutral vs adaptive genetic variation;Bioremediation and phytoremediation; Nature and structure of community ecology; Edges and ecotones.

Unit 3 Biodiversity Conservation
Principles and strategies of biodiversity conservation; In-situ and ex-situ conservation; Biodiversity hot spots; Biospheres; National parks and wildlife sanctuaries; Gene bank; Genetic bottlenecks and founder effects; Minimum effective population sizes and conservation of genetic diversity.

Unit 4 Population Fragmentation and Loss of Genetic Diversity Genetic management of population fragmentation and loss of genetic diversity - Genetic viability, Metapopulation, Introgression and hybridization, Impacts of hybridization; Genetic issues in reserve design, Importance of corridors.

Unit 5 Genetic Management of Wild Populations Genetic adaptation - Success and management in reintroduction and translocation; Taxonomic unit vs management units; Diagnosing genetic problems and recovery measures; Supportive breeding polymorphism and population survival, Polymorphic nucleotide markers and small RNA based taxonomic distinction.

Suggested Readings

1. Richard Frankham, Jonathan D. Ballou, David Anthony Briscoe, Karina H. McInnes , (2004), *A Primer ofConservation Genetics* , Cambridge University Press
2. Richard Frankham, David Anthony Briscoe, Jonathan D. Ballou, Karina H., (2002), *Introduction toConservation Genetics*, Cambridge University Press
3. By Charles W. Fox, Jason B. Wolf, (2006), *Evolutionary Genetics: Concepts and Case Studies*, OxfordUniversity Press US
4. Smith, TM and Smith RL, (2015), *Elements of Ecology*, 9th edition, Pearson Education

SEMESTER-VII

COURSE 16 B: ECOLOGY AND CONSERVATION GENETICS

Practical | Credits: 1 | 2 hrs/week

Learning Outcomes:
Students after successful completion of the practical course will be able to

LO1: Determine diversity indices in plant communities
LO2: Construct ecological pyramids of populations in different trophic levels of an ecosystem
LO3: Determine chlorophyll content and harvest method from plant species
LO4: Identify plant species basing on the anatomical and morphological clues
LO5: Plot biosphere reserve on India map

1. Determination of diversity indices in plant communities
2. To construct ecological pyramids of population sizes in ecosystem
3. Determination of chlorophyll content from plant species
4. Determination of harvest method from plant species
5. Prepare a map of India, showing bio-geographical zones and expanse of territorial waters
6. Identification and description of plant species
7. To plot biosphere reserve on a map of India
8. Prepare a document of endemic and exotic species of plants and animals for a selected PAN

Suggested Readings

1. P.R.Sreemahadevan Pillai, (2009), *A comprehensive Laboratory Manual for Environmental Sciences andEngineering*, New Age International Publishers.
2. Dennis L. Murray, Brett K. Sandercock, (2020), *Population Ecology in Practice*
3. Timothy J. M, Nyree Z, Hugh Cross, (2006), *Darwin;s Harvest :New Approaches to the Origins,Evolution*
4. Anna Lawrence and William Hawthorne, (2006), *Plant Identification*
5. S.S. Negi, (1996), *Biosphere reserves in India*
6. Sekhar Ghosh, (1988), Law *of the Territoril Sea:Evolution and Development*

SEMESTER-VII

COURSE 17 A: BIOMOLECULES

Theory Credits: 3 3 hrs/week

Learning Outcomes:
Students after successful completion of the course will be able to

LO1: Acquire an insight into various biomolecules which constitute the living organisms
LO2: Learn the structure and properties of carbohydrates
LO3: Grasp the structure, properties, transport and function of lipids
LO4: Perceive the structure of proteins and nucleic acids
LO5: Gain knowledge about enzymes, their activity and applications

Unit 1 Carbohydrates
Configurational and conformational aspects of carbohydrates (Asymmetry, Optical isomerism, Mutarotation); General structure of monosaccharides, Disaccharides, Oligosaccharides (N-linked, O-linked and GPI linked), Homo polysaccharides (Starch, Glycogen, Cellulose, Chitin), Hetero polysaccharides (Glycosaminoglycans, Peptidoglycans), Glycoproteins.

Unit 2 Lipids
Classification, Structure and chemical properties; Saturated and unsaturated fatty acids; Structure and functions of triacylglycerol, Phospholipids, Glycolipids, Sphingolipids; Structure and functions of eicasanoids (Prostaglandins, Prostacyclins, Thrombaxanes, Leukotriens); Lipoproteins types, Transport and functions; Biological functions of steroids and carotenoids.

Unit 3 Amino acids and Proteins
Configurational and conformational properties of amino acids; Classification of amino acids (Standard and non– standard); Levels of protein organization (Primary, Secondary, Tertiary, Quaternary); Sequence determination - Ramachandran plot; Fibrous and globular proteins (Collagen, Elastin, Keratins, Myoglobin, Hemoglobin); Protein folding and dynamics - Molecular chaperones; Protein denaturation (pH, Temperature, Chaotropic agents).

Unit 4 Nucleicacids
Double helical structure of DNA (Watson-Crick model), Factors affecting DNA stability, Various forms of DNA; Thermal denaturation of DNA; Structure and types of RNA (Ribosomal RNA, Transfer RNA, Messenger RNA, Small nuclear RNA); DNA-RNA hybrid helices.

Unit 5 Enzymes
Classification and nomenclature; Role of enzymes as biocatalysts; Specificity and kinetics; Assay and inhibition of enzyme activity; Mechanism of action; Regulation of enzyme activity; Coenzyme and cofactors; Active site mapping; Allosteric enzyme; Isoenzymes; Multienzyme systems; Industrial and clinical applications of enzymes; Immobilised enzymes; Enzyme engineering; Zymogen; Ribozymes.

Suggested Readings

1. E.S.West, W.R.Todd et al, (1966), *Text book of Biochemistry*, 4th edition
2. D.L.Nelson, M.M.Cox, *Principles of Biochemistry Lehninger*, 8th edition
3. Thomas M.Devlin, (2010), *Text book of Biochemistry with Clinical Correlations*, 7th edition
4. D.W. Martin ,*Harper's review of Biochemistry*, 19th edition
5. J.M.Berg, J.L.Tymockzo, L.Stryer, (2002), *Biochemistry*, 5th edition
6. Reginald H. Garret, Charles M.Grisham, (2017), *Biochemistry*, 6th edition
7. R.W.McGilvery, (1970), *Biochemistry*
8. J.David Rawn, (1989), *Biochemistry*
9. U.Satyanarayana, (1960), *Biochemistry*, 7th edition.

SEMESTER-VII

COURSE 17 A: BIOMOLECULES

Practical | Credits: 1 | 2 hrs/week

Learning Outcomes:

Students after successful completion of the practical course will be able to

LO1: Extract biomolecules from different sources
LO2: Estimate the amount of protein in a sample
LO3: Estimate the total carbohydrates in a sample
LO4 :Separate and identify a combination of amino acids
LO5: Separate and identify lipids

1. Extraction of starch from potato
2. Extraction of casein from milk
3. Extraction of oil from oil seeds
4. Estimation of protein by Lowry's method
5. Estimation of total carbohydrates by anthrone method
6. Estimation of reducing sugars by Benedict's titrimetric method
7. Separation of amino acids by paper chromatography
8. Separation of sugars by thin layer chromatography
9. Separation of lipids by thin layer chromatography

Suggested Readings

1. B.Sashidhar Rao, Vijay Deshpande, (2005), *Experimental Biochemistry*
2. Wilson and Walker, (2018), *Principles and Techniques of Practical Biochemistry*, 8th edition
3. Oser, (1965), *Hawk's Physiological Chemistry Ed*, 14th edition, Mc Graw Hill
4. David T.Plummer, (2017), *An Introduction to Practical Biochemistry*, 3rd edition
5. J.Jayaraman,(2011), *Laboratory Manual in Biochemistry*, 2nd edition
6. Ed.Bryan, L.Willians & Keith Wilson (Edward Arnold), (1975), *A Biologists Guide to Principles andTechniques of Practical Biochemistry*
7. Becker JM, (1996), *Biochemistry-A Laboratory Course*, 2nd edition, Academic Press
8. Sadasivam and Manikam, (1986) , *Biochemical Methods*, Wiley Eastern Limited

SEMESTER-VII

COURSE 17 B: HUMAN EMBRYOLOGY AND DEVELOPMENTAL GENETICS

Theory Credits: 3 3 hrs/week

Learning Outcomes:
Students after successful completion of the course will be able to

LO1: Learn basic concepts of development
LO2: Distinguish the stages of pre implantation embryonic development
LO3: Explain the formation of placenta and organogenesis
LO4: Have an insight into the genes involved in embryonic development
LO5: Understand what are embryonic stem cells and their applications

Unit 1 Concepts of Development
Potency, Commitment, Specification, Induction, Competence, Determination and differentiation; Morphogenetic gradients - examples; Pattern formation, Cell fate, Cell lineages; Cytoplasmic determinants role; Cell division; Mosaic versus regulative development; Genomic imprinting - Molecular mechanism ; Developmental significance .

Unit 2 Reproductive Endocrinology and Early Embryogenesis Human reproductive organs - Structure and functions; Reproductive endocrinology; Early Embryogenesis - Differentiation of germ cells, Gametogenesis; Fertilization, and molecular events during fertilization; Cleavage, blastocyst development and implantation.

Unit 3 Embryogenesis
Gastrulation - Types, Formation of germ layers and significance; Neurulation - Different stages, Primary andsecondary neurulation, Rastro-caudal events; Placentation - Placenta development, Types, Function, Significance; Organogenesis mechanism; Stages of pregnancy.

Unit 4 Gene Expression Regulation During Development Role of key developmental genes - Polycomb gene, P granules, SOX, BMP, HOX and PAX; Control of embryonic gene expression and epigenetics; Epigenetic regulation, Regeneration and senescence; Teratogenesis; Congenital malformations**;** Sex differentiation and its errors; Genetic basis of male and female infertility and assisted reproductive technology.

Unit 5 Embryonic Stem Cells
Embryonic stem cells - Characterization and differentiation; Genetic modifications of human embryonic stem cells; Applications of embryonic stem cells - Regenerative medicine, Drug discovery, Modeling genetic diseases; Pros and cons of embryonic stem cell research.

Suggested Readings

1. Wolpert L etal., (2002), *Principles of Development*, Oxford University Press
2. Forgacs G & Newman S.A., (2005), *Biological Physics of the Developing Embryo*, Cambridge Univ.Press
3. Gilbert S.F ,(2013), *Developmental Biology*, 10th edition
4. Moody A.A., (2014), Principles of Developmental Genetics, 2nd edition
5. E J Mange and A P Mange, (1995), *Basic Human Genetics*
6. John R Masters et al.,(2007), *Embryonic Stem Cells*
7. National Research Coucil, (2002), *Stem Cells and the Future of Regenerative Medicine,PMID: 25057576 Bookshelf ID: NBK223695 DOI: 10.17226/10195*
8. Nancy A. Pachana, Ken Laid Law, (2014), *The Oxford Handbook of Clinical Genopsychology*
9. Gilbert S.F and Sunderland, (2000), *Developmental Biology*, 6th edition

SEMESTER-VII

COURSE 17 B: HUMAN EMBRYOLOGY AND DEVELOPMENTAL GENETICS

Practical | Credits: 1 | 2 hrs/week

Learning Outcomes:
Students after successful completion of the practical course will be able to

LO1: Understand the structure and function of the reproductive organs
LO2: Identify the stages of gamete development
LO3: Describe the formation of germ layers and the differentiation of their cells into organs
LO4: Apprehend the week - by week changes of the pregnancy
LO5: Understand post natal development and identify birth defects which result due to inborn errors ofdevelopment

1. Structure and functions of male and female reproductive organs
2. Identification of stages of gamete development through permanent slides.(T.S of ovary and T.S oftestis).
3. T.S of blastula through permanent slides.
4. Demonstration of embryology models/specimens to observe embryogenesis.
5. Fetal development in terms of stages of pregnancy (Ultrasound pictures).
6. Postnatal development of structure and identification of birth defects.

Suggested Readings

1. Alex C. Vergheses, Ashok Agarwal. Zsolt Peter Negy, (2013*), Clinical Embryology*, A Practical Guide.
2. Ashok Agarwal Brig RK Sharwa VSM, (2012) , *Manual of Assisted Reproductive technologies ClinicalEmbryo*.
3. Amilava Pal, Rupali model, (2013), *Practical manual of Gynaecology*.
4. Lawrence Impey, Tim child, (2017), *Obstetrics and Gynecology*
5. Eliezer Girish ,(2021), *A text Book of Clinical Embryology*

SEMESTER-VII

COURSE 18 A: HUMAN ANATOMY

Theory Credits: 3 3 hrs/week

Learning Outcomes:
Students after successful completion of the course will be able to

LO1: Understand the structure and classification of bones and muscles
LO2: Acquire knowledge regarding the structure of heart and blood circulation
LO3: Gain factual knowledge on respiratory and gastrointestinal system
LO4: Get an insight of structure and components of reproductive, excretory and endocrine systems
LO5: Familiarize with parts of nervous system and sensory organs

Unit 1 Anatomy of Musculoskeletal System
Classification and histology of bones; Ossification, Structure and classification of joints; Classification of muscles, Structure of smooth, cardiac, skeletal muscle, neuromuscular junction. Integumentary system: Thick Skin, Thin skin, Layers of dermis, and epidermis, Skin appendages; Types of connective tissue.

Unit 2 Anatomy of Circulatory System
Morphology and classification of blood vessels, Blood capillaries; Blood circulation and composition; Lymphaticsystem - Lymph-nodes, Thoracic duct and spleen; Structure of heart, Cardiac cycle, Systemic and pulmonary circulation.

Unit 3 Anatomy of Respiratory and Gastrointestinal System Anatomical description of respiratory system; Role of hemoglobin in respiration; Anatomy of Gastrointestinal system - Digestive system, Innervation of gastrointestinal tract, Accessory organs of digestion, Gastrointestinal hormones, Major digestive glands.

Unit 4 Anatomy of Excretory, Reproductive and Endocrine System Anatomical description of excretory system; Brief anatomical description of male and female reproductive systems; Endocrine system- Structure and functions of hypothalamus, Pituitary, Thyroid, Parathyroid, Thymus, Pancreas, Adrenal glands, Pineal gland.

Unit 5 Anatomy of Nervous System and Sense Organs Gross anatomy of brain and spinal cord; Cranial nerves, Spinal nerves, Autonomic nervous system, Nerve fibres; Anatomy of Eye, Ear, Nose, Skin and Touch receptors

Suggested Readings

1. J. Matthew Neal, (2001), *How the Endocrine System Works,* Blackwell Science
2. Gerard J. Tortora, (2014), *Principles of Anatomy and Physiology*, 14th edition
3. Melmed et al., (2015), *William's Textbook of Endocrinology*, 13th edition
4. Inderbir Singh, (2017), *Human Embryology*, 11th edition
5. Drake, R., Vogl, W. and Mitchell, A., (2015), *Gray's Anatomy for Students*, 4th edition. Churchill,Livingstone,USA
6. Standring, S, (2015),*Gray's Anatomy*. 42nd edition, Churchill Livingstone, USA

SEMESTER-VII

COURSE 18 A: HUMAN ANATOMY

Practical | Credits: 1 | 2 hrs/week

Learning Outcomes:
Students after successful completion of the practical course will be able to

LO1: Identify different tissues using a microscope
LO2: Identify the bones in skull
LO3: Identify vertebrae
LO4: Identify appendicular bones
LO5: Understand the different types of joints in human body

1. Identification of tissue slides- Epithelial tissue, Neuron, Muscular tissue, Cardiac tissue, blood
2. Identification of tissue slides – Cross section of an artery, Lung, Pancreas, Liver, Esophagus, Stomach andintestine
3. Identification of axial bones
4. Identification of appendicular bones
5. Overview of types of joints and movements at joints

Suggested Readings

1. Bhise S B, Yadav AV and Prakashan N, (2005), *Human Anatomy and Physiology*
2. Chaurasia BD, (1996), *Handbook of General Anatomy*, 3rd edition
3. Ramesh K Goyal , *Elements of Human Anatomy Physiology and Health Education*
4. Krishna Garg, Medha Joshi, *Practical Anatomy Workbook*, 3rd editon, CBS publishers
5. D.J.Cunningham, G.J.Romanes, (2016), *Cunningham's Mannual of Practical Anatomy*, 15th edition,Oxford

SEMESTER-VII

COURSE 18 B: CELL CULTURE AND TISSUE ENGINEERING TECHNOLOGY

Theory Credits: 3 3 hrs/week

Learning Outcomes:
Students after successful completion of the course will be able to

LO1: Understand the basic requirements for cell culturing
LO2: Have theoretical knowledge about cell culturing techniques
LO3: Gain knowledge regarding the types and properties of tissues and tissue repair
LO4: Understand the key components and strategies employed in tissue engineering
LO5: Apprehend recent advances in tissue engineering and its applications

Unit 1 Fundamentals of Cell Culture
History of cell culture; Types of cell culture; Morphology of cells in cell culture; Equipment and materials for cellculture technology; Basic requirements for culture medium; Isolation of cells and culture conditions; Cell culture procedures.

Unit 2 Techniques in Cell Culture
Cell viability assays; Cell synchronization techniques; Maintenance and preservation of cell cultures; Cell line cross contamination; Decontamination of equipment; Disposal methods; Applications of cell culture.

Unit 3 Overview of Tissues
Tissue characteristics - Appearance, Cellular component, ECM component, Mechanical and physical properties; Tissue types; Tissue damage; Tissue repair.

Unit 4 Tissue Engineering
History of Tissue Engineering; Fundamentals of tissue engineering: Tissue engineering triad-Cells, Scaffold, Biofactors; Strategies in tissue engineering; In vitro control of tissue development; In vivo synthesis of tissues and organs.

Unit 5 Applications of Tissue Engineering
Recent advances in tissue engineering; Applications of tissue engineering; Challenges in tissue engineering; The future of tissue engineering.

Suggested Readings

1. Gersen, S.L. and Keagle, M.B., (2005), *The Principles of Clinical Cytogenetics*. Humana Press,2nd edition
2. Karp, G., (2014), *Cell Biology*. Wiley, 7th edition
3. Rooney, D.E. and Czepulkowski, B.H., (1992), *Human Cytogenetics: A Practical Approach*. IRL Press,Vol. 1&2, 2nd edition
4. Stoddart, M.J., (2011), *Mammalian Cell Viability: Methods and Protocols*. HumanaPress, New York
5. Karp John Wiley, (2002), *Cell and Molecular Biology*
6. Celis, (1994), *Cell Biology - A Laboratory Manual (Vol. I - III)*Academic Press, USAFreshney I, (2005), *Culture of Animal Cells: A Manual of Basic Technique*, 5th editionPublisher: Wiley-Liss, ISBN: 0471453293
7. Nigel Jen, (2007), *Animal Cell Biotechnology:Methods and Protocols*, Humana Press
8. R.Ian Freshney, (2011), *Culture of Animal Cells: A Manual of Basic Technique and SpecializedApplications*, 6th edition
9. Robert Lanza et al ., *Principles of Tissue Engineering*, 5th edition

SEMESTER-VII

COURSE 18 B: CELL CULTURE AND TISSUE ENGINEERING TECHNOLOGY

Practical | Credits: 1 | 2 hrs/week

Learning Outcomes:

Students after successful completion of the practical course will be able to

LO1: Understand the different cell culture techniques
LO2: Prepare single cell suspension from different tissues
LO3: Prepare cell culture media
LO4: Culture animal cells
LO5: Assay cell viability and growth

1. Demonstration of different types of cell culture techniques (Primary, infinite/secondary,Immortal / cell line)
2. Preparation of single cell suspension from spleen and thymus
3. Preparation of animal cell culture media and membrane filtration
4. Animal cell culture – Chick embryo
4. MIT assay for cell viability and growth

Suggested Readings

1. Ed. John R.W. Masters, (2000), *Animal Cell Culture-A Practical Approach,* 3rd edition (IRL press)
2. Ed. Martin Clyenes, (2012), *Animal Cell Culture Techniques* ,Springer
3. John M. Davis, (2011), *Animal Cell Culture - Essential Methods*
4. Cornelia K, Verena C, Antonina L ,(2008), *Cell Culture Technology*

SEMESTER-VII

COURSE 19 A: MEDICAL GENETICS

Theory | Credits: 3 | 3 hrs/week

Learning Outcomes:
Students after successful completion of the course will be able to

LO1: Understand the scope of Medical Genetics and able to differentiate between hereditary and multifactorialdiseases .
LO2: Identify various diseases associated with different parts of human body
LO3: Obtain knowledge on wide range of neurological disabilities
LO4:Gain knowledge on the risk factors of different life style disorders and how to prevent them
LO5: Get deep insight into different autoimmune diseases

Unit 1
Scope of Medical Genetics; Skin- Ichthyosis, Ectodermal dysplasia, Eczema; Skeletal system – Ankylosing spondylitis, Osteogenesis imperfecta, Osteoporosis, Marfans syndrome; Muscle – Muscular dystrophies, Myopathies; Endocrine system Thyroid diseases, Cushing's disease, Acromegaly.

Unit 2
Eye – Leber congenital amaurosis, Ocular albinism, Aniridia, Glaucoma, Retinoblastoma; Mouth – Hare Lip and cleft palate, Periodontitis, Amelogenisis imperfecta; Ears – Deafness, Usher syndrome, Otitis media, Otosclerosis; Respiratory system – Cystic Fibrosis; Asthma.

Unit 3
Cardiovascular System – Congenital heart disease; Cardiomyopathies, Familial hypercholesterolemia; Blood disorders- Anemias, Hemophilia, Blood cancers; Digestive System – Crohn's Disease, Ulcerative colitis, Irritable bowel syndrome, Hypertrophic pyloric stenosis; Reproductive system- Polycystic ovary disease, Endometriosis, Gonadal dysgenesis.

Unit 4
Kidney and urogenital system – Chronic kidney disease, Nehpronophthisis, Polycystic kidney disease; Central nervous system – Spina bifida, Anencephaly; Neurodegenerative disorders- Parkinson's disease, Alzheimer's disease, Spinocerebellar ataxias; Neurocutaneous disorders- Multiple neurofibromatosis, Tuberous sclerosis; Neuromuscular disorders- Amyotrophic lateral sclerosis, Myasthenia gravis, Myotonia; Neurodevelopmental disorders - Autism, Attention deficit hyperactivity disorder.

Unit 5
Life style disorders- Diabetes, Hypertension, Hyperlipidemia, Coronary heart disease, Stroke, Obesity, Chronic obstructive pulmonary disease; Autoimmune disorders- Rheumatoid arthritis, Multiple sclerosis, Celiac disease, Systemic lupus erythematosus, Psoriasis, Vitiligo; Psychiatric disorders- Schizophrenia, Bipolar disorder.

Suggested Readings

1. Jorde et al., *Medical Genetics*
2. M.W. Thompson et al., (2015), *Genetics and Medicine*
3. A. Sorsby, (1973), *Clinical Genetics*
4. R. M. Goodman, (1970), *Genetic Disorders of Man*
5. Peter D Turnpenny, (2020), *Emery's Elements of Medical Genetics and Genomics* 16th edition
6. F. Vogel and A.G. Motulsky, (2009), *Human Genetics* , 4th edition

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SEMESTER-VII

COURSE 19 A: MEDICAL GENETICS

Practical | Credits: 1 | 2 hrs/week

Learning Outcomes:
Students after successful completion of the practical course will be able to

LO1: Identify muscular dystrophy cases
LO2: Distinguish thyroid diseases
LO3: Familiarize with the symptoms of diabetes and hypertension
LO4: Recognize the symptoms of rheumatoid arthritis, an autoimmune disorder
LO5: Differentiate between the different neurodevelopmental disorders

Case Study Analysis

1. Muscular dystrophies
2. Thyroid diseases
3. Hare lip and cleft palate
4. Polycystic ovary disease
5. Multiple neurofibromatosis
6. Diabetes
7. Hypertension
8. Rheumatoid arthritis
9. Autism
10. Attention deficit hyperactive disorder
11. Schizophrenia

Suggested Readings

1. Jorde et al., *Medical Genetics*
2. M.W. Thompson et al., (2015), *Genetics and Medicine*
3. A. Sorsby, (1973), *Clinical Genetics*
4. R. M. Goodman, (1970), *Genetic Disorders of Man*
5. Peter D Turnpenny, (2020), *Emery's Elements of Medical Genetics* 16th edition
6. F. Vogel and A.G. Motulsky, (2009), *Human Genetics* , 4th edition

Co-curricular activities :

A. Mandatory : (Training of students by Teacher on field related skills :)

1. For Teacher

1. Training of students by Teacher**,** in local hospitals on diagnosis of genetic diseases basing onsymptoms
2. Creating awareness on different types of disorders

2. For Student

1. Charts preparation for different disorders (on symptoms, diagnosis, prevention, management)
2. Individual visits to Government hospitals

B. Suggested co-curricular activities

1. To identify the genetic diseases from the given photographs
2. Interaction with patients and preparation of pedigree chart
3. Group discussion regarding management of genetic diseases
4. Invited lectures on related topics by Doctors and Genetic Counselors

SEMESTER-VII

COURSE 19 B: BIOCHEMICAL GENETICS

Theory Credits: 3 3 hrs/week

Learning Outcomes:
Students after successful completion of the course will be able to
LO1: Understand the concept of biochemical polymorphism
LO2: Understand the clinical importance of serum enzymes
LO3: Familiarize with different types of metabolic disorders
LO4: Get an insight into the concept of oxidative stress and related disorders
LO5: Perceive knowledge about homeostasis related disorders

Unit 1 Biochemical Polymorphism
Biochemical polymorphism - Concept, Types of polymorphisms (Ttransient and balanced), Blood groups (ABO, Rh and MN) and protein polymorphisms (Haptoglobin, Vitamin D binding protein); Structure, synthesis and functions of haemoglobin; Hemoglobinopathies- qualitative (Sickle cell anemia) and quantitative (Alpha and beta thalassemias) hemoglobinopathies

Unit 2 Classification and Nomenclature of Enzymes Classification and nomenclature of enzymes; Enzyme kinetics, Clinical enzymology and its significance; Clinical importance of serum enzymes – Aspartate transaminase, Alanine transaminase, Alkaline phosphatase, Gamma- glutamyltransferase, Amylase, Lipase, Lactate dehydrogenase, Creatine phosphokinase and Acid phosphatase; Clinical importance of serum proteins- Albumin, Globulin, Transferrin and Ferritin.

Unit 3 Inborn Errors of Metabolism
Inborn errors of metabolism - Epidemiology, Pathogenesis, Characteristic features and classification; Galactosemia, Phenylketonuria, Alkaptonuria, Albinism, Tay Sach's disease, Mucopolysaccharidoses, Hyperlipoproteinemia, Lesch - Nyhan syndrome, Orotic Aciduria, Pharmacogenetics- G6-PD deficiency; Ecogenetics- Alpha – 1 - antitrypsin.

Unit 4 Antioxidants and Free Radicals
Characteristics and generalization of free radials and oxidants; Beneficial and deleterious activities of free radicals and oxidants; Enzymatic antioxidants – SOD, Catalase, Glutathione peroxidase.Gglutathione reductase; Non enzymatic antioxidants- Lipoic acid, Glutathione, Metabolic melatonin; Nutrient antioxidants- Vitamin_C, Vitamin-E, Carotenoids, Flavonoids, Trace metals; Oxidative stress; Oxidative stress induced diseases.

Unit 5 Biochemical Disorders
Functions and classification of hormones; Regulation of glucose metabolism by hormones; Acid base balance; Hydrogen ion homeostasis and related disorders; Blood gas parameters and clinical applications; Fluid and electrolyte balance; Regulation of osmolality and maintenance of fluids in the various body compartments and related disorders.

Suggested Readings

1. Shukla, A.N., (2009), *Elements of Enzymology*, Discovery Publishing. New Delhi, India
2. D. Voet and J.G Voet ,(2010), *Biochemistry,* 4th edition, John Wiley and Sons, USA
3. R.H. Garrett and C.M. Grisham, (1999) , *Biochemistry*, 2nd edition, Saunders College Publishers
4. Albert L. Lehninger, (2004), *Principles of Biochemistry,* 4th edition CBS Publishers, New Delhi

5. LubertStryer co-written by Jeremy Berg, John L. Tymoczko and Gregory J. GattoJr , (2015), *Biochemistry*
   8th edition ,Palgrave Macmillan

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SEMESTER-VII

COURSE 19 B: BIOCHEMICAL GENETICS

Practical | Credits: 1 | 2 hrs/week

Learning Outcomes:

Students after successful completion of the practical course will be able to:

LO1: Determine the blood group of individuals
LO2: Screen for sickle cell anemia and thalassemia
LO3: Determine serum levels of clinically important enzymes
LO4: Determine protein concentration
LO5: Estimate electrolytes in human serum

1. Determination of blood groups and Rh typing
2. Sickling test (slide method)
3. Screening test for beta thalassemia (NESTROFT method)
4. Quantitative determination of liver enzymes AST and ALT from serum by autoanalyzer
5. Determination of amylase and lipase
6. Quantitative determination of protein by spectrophotometry
7. Quantitative estimation of sodium, potassium, chloride in human serum.
8. Electrophoresis of hemoglobin by cellulose acetate membrane

Suggested Readings

1. Zall DM et al, (1956), *Anal Chem.*28,1665-1668
2. Ruth Bjorklund, (1997), *Sickle Cell Anemia*
3. Henry RJ et al.,(1974), *Clinical Chemistry Principle and Techniques,* 2nd edition Harper and Row,Hagerstown
4. Steven L. Jones, (2001), *Clinical Laboratory Pearls*
5. Hafiz Ahmed, (2017), *Principles and Reactions of Protein Extraction Purification*
6. Verma, Ashish S/Das S and Singh Anchal, (2014), *Laboratory Manual for Biotechnology*
7. Trinder P ,(1951), *Analyst*, 76:596-599
8. The Amylase Research Society of Japan, (1988), *Handbook of Amylase and Related Enzymes*
9. Geoff Daniels, (2013), *Human Blood Groups*
10. Barbara J. Bain, (2020) ,*Hemoglobinopathy Diagnosis*
11. Barbara J.Bain et al, (1991), *Dacie and Lewis Practical Haematology*. 7th edition , Elsevier

Co-curricular activities :

A. Mandatory (Training of students by Teacher on field related skills :)

1. For Teacher:

1. Training of students by Teacher, in the laboratory to determine blood groups
2. Special focus on important metabolic enzymes included in the syllabus

2. For Student

1. Determining blood groups of the family members and other friends
2. Case study of patients with sickle cell anemia and thalassemia

B. Suggested co-curricular activities

1. Seminars, Group discussions, Debates
2. Assignments on biochemical disorders
3. Invited lectures on related topics by experts in the specified area
4. Conduct awareness programs on screening for inborn errors of metabolism

SEMESTER-VII

COURSE 20 A: CLINICAL HEMATOLOGY

Theory Credits: 3 3 hrs/week

Learning Outcomes:

Students after successful completion of the course will be able to
LO1: Gain knowledge about hematopoiesis and management of inherited bleeding disorders
LO2: Compare components of complete blood count in normal and abnormal conditions
LO3: Know about disorders of erythrocytes and lymphocytes
LO4: Understand the process of platelet formation and platelet disorders
LO5: Have an insight in to the equipment used and safe work practice in hematology lab

Unit1 Introduction to Clinical Hematology

Basic morphology and basic concepts of hematopoiesis; Bone marrow structure and examination; Red blood cells
- Structure and function; Overview of normal hemostatic mechanism; Clinical evaluation and management ofinherited bleeding disorders; Diagnosis of leukemias.

Unit 2 Complete Blood Count

Components of complete blood count – Red blood cells , White blood cells , Platelets; RBC - Red blood cell indices, Identify polychromatophilic cells; Pathophysiology and clinical conditions that may lead to target cells, Spherocytes, Ovalocytes and Elliptocytes, Sickle cells, and Fragmented cells; WBC – Leukopenia, Leukocytosis; Platelets – Thrombocytopenia, Thrombocytosis.

Unit 3 Disorders of Erythrocytes and White Blood Cells Disorders of erythrocytes - Megaloblastic anemia; Hereditary spherocytosis, Red cell enzymopathies,Autoimmune hemolytic anemias, Anisocytosis, Poikilocytosis, Microcytosis, Macrocytosis; Disorders of whiteblood cells - Lymphocytosis, Acute leukemias, Lymphoblastic leukemia, Myeloid leukemia, Promyelocyticleukemia, Hairy cell leukemia, T cell lymphoproliferative disorders, Non Hodgkin's and Hodgkin’s lymphoma.

Unit 4 Disorders of Thrombocytes

Overview of Megakaryopoiesis; Disseminated intravascular coagulation; Disorders of thrombocytes - Quantitative and qualitative platelet disorders, Immune thrombocytopenia (ITP) and thrombotic thrombocytopenic purpura (TTP), Von Willebrand's disease, Dysfibrinogenemia, Lupus anticoagulant Bernard Soulier disease, Glanzmann's thrombasthenia, Hermansky Pudlak syndrome, Jacobsen syndrome.

Unit 5 Laboratory Methods in Hematology

Principles of automated cell counter and interpretation of results; Hemoglobin electrophoresis; HPLC use in hematology; Special stains and cytochemistry; Flow cytometry; Principles of nuclear medicine and its applications; The safe work practices; Personal protective equipment and disposal of biologic hazards in the hematology lab.

Suggested Readings

1. A.Victor Hoffbrandt. Paul A.H. Moss, (2016), *Hoffbrand's Essential Hematology*. 7th edition
2. Drew Provan, Trevor Baglin, Inderjeet Dokal and Johannes de Vos, (2015), *Handbook of ClinicalHematology* ,4th edition Oxford
3. Singh Tejinder,(2014), *Atlas and Textbook of Haematology*, 3rd edition, Avichal Publications
4. Mukherjee .L.K, (2017), *Medical Laboratory Technology*,Vol.1-3, 3rd edition, Tata Mcgraw Hill
5. Ramnik Sood,(2015), *Text book of Medical Laboratory Technology*, 2nd edition, Jaypee Publications

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SEMESTER-VII

COURSE 20 A: CLINICAL HEMATOLOGY

Practical | Credits: 1 | 2 hrs/week

Learning Outcomes:
Students after successful completion of the practical course will be able to

LO1: Determine hemoglobin
LO2: Determine red cell indices
LO3: Perform complete blood count
LO4: Carry out sickling test
LO5: Confirm sickle cell anemia by electrophoresis

1. Determination of haemoglobin by Sahli's method
2. Test for osmotic fragility of RBC
3. Determination of total RBC , WBC and total platelet count by hemocytometer
4. Determination of reticulocyte count.
5. Determination of differential leucocyte count
6. Determination of PCV and red cell indices by cell counter
7. Estimation of APTT, PT INR (Coagulation test)
8. Sickling test
9. Electrophoresis of hemoglobin by cellulose acetate membrane

Suggested Readings

1. Hoffbrand A.V, Moss.P.A.H and Pettit J.E, (2006), *Essential Haematology*, 5th edition
2. Barbara J.Bain et al, (1991), *Dacie and Lewis Practical Haematology*. 7th edition , Elsevier
3. E Simson, M G Gascon-Lema et al., (2010), *Diagnostic Techniques in Hematological Malignanacies*
4. Ramadas N, Sharada R, Astha G, (2012), *Essentials in Hematology and Clinical Pathology*
5. Gayatri Prakash, (2012), *Lab Manual on Blood Analysis and Medical Diagnostics*
6. Norman Beck, (2009), *Diagnostic Hematology*.
7. Isam J, Jaber Ai-Z, (2018), *Thalassemia and other Hemolytic Anemias*
8. Amer W, Jesse M, Jaso, Ashok T, (2017), *Hematopathology and Coagulation*
9. Douglas MacN, Surgenor, (1974), *The Red Blood Cell*, 2nd edition Vol-1
10. Rodak's, (2020), *Hematology Clinical Principles and Applications,* 6th edition
11. Jespersen,J,Bertina R.M et al.,(1999), *Laboratory Techniques in Thrombosis A* Manual. 2nd edition

Co-curricular activities :

A. Mandatory (Training of students by Teacher on field related skills :)

1. For Teacher:

1. Training of students by Teacher in laboratory on hematological investigations
2. Case studies on disorders of blood

2. For Student

1. Charts preparation for different hematological disorders (on diagnosis, prevention, management)
2. Collection of data about blood disorders

B. Suggested co-curricular activities

1. Group discussion and power point presentations on anemias, leukemias, thrombocyte disorders etc.
2. Visit to nearby diagnostic centres to have a demo of autoanalyzer
3. Invited lectures on related topics by Doctors

SEMESTER-VII

COURSE 20 B: APPLICATIONS OF HUMAN GENTICS

Theory Credits: 3 3 hrs/week

Learning Outcomes:
Students after successful completion of the course will be able to

LO1: Understand the role of a genetic counselor.
LO2: Get an insight into gene therapy for different genetic diseases
LO3: Familiarize with the importance of DNA profiling and its ethical concerns
LO4: Understand the advantages of using molecular diagnosis of infectious diseases
LO5: Understand the different techniques used for the molecular diagnosis of genetic diseases

Unit 1 Genetic Counseling
History and development of genetic counseling; Role of Clinicians, Genetic counselors and Psychiatrists in genetic counseling; Process of genetic counseling - Constructing a family tree, Diagnostic information, Estimation of risks; Genetic counseling for Mendelian and non Mendelian disorders; Counseling techniques; Prenatal, pediatric and adult genetic counseling strategies; Genetic counseling - Psychosocial aspects, Legal issues, Ethical issues, Contemporary issues.

Unit 2 Gene Therapy
Gene therapy – Principle, Risks and challenges, Applications; Vectors used in gene therapy; Gene transfer types; Types of gene therapy; Methods of gene therapy- Ex vivo, In vivo, In situ gene therapy; Gene therapy for familialhypercholesterolemia, Cystic fibrosis, Duchenne muscular dystrophy, Bleeding disorders, Severe combined immunodeficiency syndrome.

Unit 3 Forensic Sciences
DNA profiling; Applications in forensics – Personal identification, Disputed paternity cases, Child swapping; Legal standards for admissibility of DNA profiling; Procedural and ethical concerns; Status of development of DNA profiling in India and abroad; Limitations of DNA profiling; New and future technologies- DNA chips, SNPs.

Unit 4 Molecular Diagnosis of Infectious Diseases Introduction to molecular diagnostics; Advantages and disadvantages of molecular diagnostics; Molecular diagnosis of infectious diseases- Dengue, Malaria, Gonorrhoea, Nisseria, AIDS, Tuberculosis, Hepatitis, COVID-19.

Unit 5 Molecular Diagnosis of Genetic Diseases
Sickle cell anemia; Thalassemias; Cystic Fibrosis; Fragile-X syndrome; Alzheimer's disease Duchenne Muscular Dystrophy; Huntington's disease; Spinocerebellar ataxias; Neurofibromatosis; Genetic susceptibility test for multifactorial disorders - Neural Tube Defect, Cleft Lip and Palate, Cardio Vascular Disorder, Male infertility.

Suggested Readings:

1. David L Rimoin, (2018), *Principles and Practice of Medical Genetics*, Vol I and II, 7th edition
2. Harper PS (Ed), (2004), *Landmarks in Medical Genetics* , Oxford University Press
3. Norah Rudin and Keith Inman, (1997), *An Introduction to Forensic DNA Analysis*, CRC Press; Ny
4. John M. Butler, (2005), *Forensic DNA Typing: Biology, Technology, and Genetics of STR Markers,* 2nd edition Academic Press
5. Debra GB Leonard, (2006), *Molecular Pathology in Clinical Practice,* Springer Softcover ISBN:978038787373
6. George P. Patrinos and Wilhelm Ansorge, (Eds.), (2005), *Molecular Diagnostics, ,* 2nd edition, AcademicPress ISBN: 0125466617
7. Ross, (1994), *Introduction to Molecular Medicine,* 2nd edition
8. Daniel Scherman, (2020), *Advanced Text Book on Gene Transfer; Gene Therapy and GeneticPharmacology,* 2nd edition
9. Lemoine N.R, (2000), *Understanding Gene Therapy*

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SEMESTER-VII

COURSE 20 B: APPLICATIONS OF HUMAN GENTICS

Practical | Credits: 1 | 2 hrs/week

Learning Outcomes:
Students after successful completion of the practical course will be able to

LO1: Collect family history from the proband
LO2: Diagnose infectious disease like tuberculosis
LO3: Diagnose SARS-CoV-2
LO4: Detect sickle cell anemia using molecular method
LO5: Diagnose duchenne muscular dystrophy

1. Documentation of clinical history of a patient
2. Diagnosis of Mycobacterium tuberculosis by ELISA
3. Quantitative diagnosis of SARS-COV-2 by RT-PCR.
4. SNP genotyping by PCR amplification
5. Diagnosis of sickle cell anemia by PCR-RFLP
6. Diagnosis of duchenne muscular dystrophy using multiplex-PCR
7. Diagnosis of β-Thalasemia by ARMS PCR

Suggested Readings

1. Peter Harper, (2019), *Practical Genetic Counseling*, 8th edition
2. Keith Wilson and John Walker, (2010), *Principles and Techniques of Biochemistry and MolecularBiology*, 7th edition
3. Debra GB Leonard, (2009), *Molecular Pathology in Clinical Practice*, Springer 2009 Softcover ISBN:978038787373
4. P. Patrinos and Wilhelm Ansorge, (Eds.),(2005), *Molecular Diagnostics*; George Academic Press ISBN:0125466617
5. William B. Coleman and Gregory J. Tsongalis, (Eds.), (2005), *Molecular Diagnostics for the ClinicalLaboratorian*, 2nd edition; Humana Press
6. Subramani Mani and J.H. Weitkamp, (2022), *Textbook of SARS-COV-2 and Covid-19*
7. Phill Jones, (2008), *Sickle Cell Disease*
8. Kary B. Mullis er al, (2012), *The Polymerase Chain Reaction*
9. Rowa Yousef Alhabbab, (2018), *Basic Serological Testing*
10. Newton CR et al., (1989), *Analysis of any point Mutation in DNA. The Amplification Refractory MutationSystem (ARMS)*, Nucleic acids Res, 17(1), 2503-2516

Co-curricular activities :

A. Mandatory (Training of students by Teacher on field related skills :)

1. For Teacher

1. Training of students by Teacher**,** by conducting mock genetic counseling
2. Train the students to solve disputed paternity cases from the given DNA finger prints

2. For Student

1. Construction of pedigrees for patients with genetic diseases
2. Preparation of charts regarding the different types of techniques used for molecular diagnosis

B. Suggested co-curricular activities

1. Discussion regarding the scientific principles and techniques behind the work of forensic scientists andillustration with case studies
2. Collection of available information on gene therapy for various genetic diseases
3. Visit to forensic lab
4. Invited lectures on Foresnics by experts in the specified area

SEMESTER-VIII

COURSE 21 A: CANCER GENETICS

Theory | Credits: 3 | 3 hrs/week

Learning Outcomes:
Students after successful completion of the course will be able to

LO1: Acquire knowledge about cancer and the genes responsible for cancer
LO2: Understand the different kinds of carcinogens
LO3: Learn about chromosomal abnormalities associated with different cancers
LO4 : Apprehend different types of cancers
LO5: Understand prevention, diagnosis, and treatment of cancer

Unit 1 Genetics of Cancer
Introduction to cancer; Cell cycle regulation; Characteristics of cancer cells; Types of genes - Proto oncogenes, Oncogenes, Tumor Suppressor genes; Cancer as a genetic disorder; Inherited versus sporadic cancers; The role of epigenetics in cancer; Knudson's hypothesis.

Unit 2 Cancer and Environment and Apoptosis Cancer and environment - Physical, chemical and biological carcinogens; Apoptosis-Introduction, Caspases, Proand antiapoptotic genes, Fas mediated apoptosis; Mitochondria dependent pathways; Inhibitory pathways ofapoptosis; Regulation, Implication in diseases; Autophagy, Senescence.

Unit 3 Types of Cancers
Chromosomes in neoplasia; Chromosomal abnormalities associated with the specific malignancies - Acute Promyelocytic leukaemia (APL), Chronic myeloid leukaemia (CML) and Acute lymphoblastic leukaemia (ALL); Types of cancers – Retinoblastoma, Skin cancer, Lung cancer, Esophageal cancer, Colorectal cancer, Brain cancer, Breast cancer, Cervical cancer, Prostate cancer.

Unit 4 Cancer Stem cells
Cancer stem cells - Introduction to stem cells, Metastasis, Angiogenesis; Stochastic vs cancer stem cell model for cancer formation; Cancer stem cells in cancer initiation and progression; Cancer stem cell pathways; Regulation by microRNAs.

Unit 5 Cancer Prevention, Diagnosis, Treatment Cancer prevention; Diagnosis; Cancer therapies and Recent advances in cancer research - Traditionalchemotherapies, radiotherapy, Onco-surgery, Bone marrow transplantation, Immunotherapy, Combinational therapies, Natural products as therapeutics, Cancer vaccines, Gene therapies and delivery vehicles, Targetedanticancer therapies, Monoclonal antibody and Aadjuvant therapies.

Suggested Readings

1. Cowell , (2001), *Molecular Genetics of Cancer*, Bios
2. Ehrlich ,(2000), *DNA Alterations in Cancer,* Eaton
3. Robert A. Weinberg (Ed.),(2013) , *The Biology of Cancer,* Garland Sciences, 2nd edition.
4. Pelengaris S, Khan M (Eds.), (2013) *The Molecular Biology of Cancer*, 2nd edition Blackwell
5. Vogelstein &Kinzler, (2002), *The Genetic Basis of Human Cancer*, 2nd edition, McGraw-Hill
6. Wasserman, (2017), *Cancer Genetics E-book Cubocube* (Seid-Karbasi P, Ye XC, Zhang AW, Gladish N, Cheng SYS, Rothe K, et al. (2017) CuboCube: *Student creation of a cancer genetics e-textbook using open-access software for social learning*. PLoS Biol 15(3): e2001192. https://doi.org/10.1371/journal.pbio.2001192

SEMESTER-VIII

COURSE 21 A: CANCER GENETICS

Practical | Credits: 1 | 2 hrs/week

Learning Outcomes:
Students after successful completion of the practical course will be able to

LO1: Detect chromosomal changes in cervical caner
LO2: Identify the severity of the disease using micronuclei as biomarker
LO3: Detect chromosomal abnormalities associated with blood cancers
LO4 :Learn the technique for isolation of DNA from tissue
LO5: Test cell proliferative activity

1. DNA ploidy assessment in cervical cancer
2. Micronucleus assay in different types of cancers
3. Detection of chromosome anomalies in blood cancers
4. Experiments related to cell structure and function (Apoptosis, Signaling, Cancer, etc.)
5. Isolation of DNA from tissue
6. Cell proliferation assay (MTT)

Suggested Readings

1. Shirley V. Hodgson, William D. Foulkes,Charis Eng,Eamonn R. Maher, (2013), *A Practical Guide toHuman Cancer Genetics,* 4th edition
2. Sue Clark, (2009), *A Guide to Cancer Genetics in Clinical Practice*
3. George Z. Rolland, (2007*), New Research on Cervical Cancer*
4. Sverre Heim, Felix Miltelman, (2009), *Cancer Cytogenetics*, 3rd edition
5. P.V.G.K.Sarma, (2017*), Molecular Biology A Practical Manual*
6. Simon P.Langdon, (2003), *Cancer Cell Culture Methods and Protocols*
7. Dr.Riddhi Shukla, (2021) , *Manual of Practical Pharmacology*

SEMESTER-VIII

COURSE 21 B: EVOLUTIONARY AND QUANTITATIVE GENETICS

Theory | Credits: 3 | 3 hrs/week

Learning Outcomes:
Students after successful completion of the course will be able to

LO1: Acquire knowledge regarding the different evolutionary theories
LO2: Understand the origin of prokaryotes and eukaryotes
LO3: Familiarize with the concept of speciation and molecular evolution
LO4: Understand the concept of heritability
LO5: Distinguish the different types of genetic variations

Unit 1 Theories of Evolution
Evolutionary theories – Lamarckism, Darwin's theory of evolution; Limitations of Lamarckism and Darwin's theory; Natural selection- Fitness, Natural selection at the level of genes; Factors affecting gene frequencies- Natural selection, Genetic drift, Mutation.

Unit 2 Origin of Life
Origin of biomolecules- Spontaneous generation, Louis Pasteur's experiment, Oparin and Haldane's theory of origin of life, Miller-Urey Experiment; Origin of prokaryotes and eukaryotes; Evolutionary time scale- Eras, Periods and epoch; Major events in evolutionary time scale.

Unit 3 Speciation and Molecular Evolution
Speciation- Causes of reproductive isolation, Evidence for speciation. Mode of speciation- Allopatric, Parapatric, Sympatric; Co-speciation- Sexual selection, Co-evolution and convergent evolution; Molecular evolution- Concept of neutral theory of molecular evolution, Molecular divergence and molecular clocks; Molecular tools in phylogeny; Classification and Identification; Origin of new genes and proteins.

Unit 4 Quantitative Genetics
Quantitative Genetics: Quantitative traits and their characteristics, Threshold traits, Multiple factor hypothesis, Types of quantitative traits, Determining gene number for a polygenic trait, Components of phenotypic variation and genetic models for quantitative traits; heredity- Concept, Broad sense heritability, Narrow sense heritability; Predicting phenotypes; Artificial selection.

Unit 5 QuantitativeGenetic Analysis
Genetic variation and complex trait inheritance; Concepts of tag markers and haplotypes; Linkage disequilibrium. Quantitative genetic analysis- QTL and eQT;. Study of genetic variation and complex trait inheritance using next-generation sequencing; DNA micro -array.

Suggested Readings

1. D. Peter Snustad and Michael J Simmons, (1997), *Principles of Genetics*
2. Benjamin A. Pierce, (2008) , *Genetics: A Conceptual Approach*
3. Alan G. Atherly, Jack R. Girton, John F. McDonal, (1999), *The Science of Genetics*
4. Rosie S. Hails, (2003), *Genes in the Environment*, Wiley-Blackwell Publications
5. Jobling, M., Hollox, E., Hurles, M., Kivisild, T. and Tyler-Smith, C., (2013), *Human EvolutionaryGenetics,* Garland Science
6. Peter J. Russell, (2009), *IGENETICS: A molecular Approach with Study Guide and Solutions Manual* , 3rd edition

SEMESTER-VIII

COURSE 21 B: EVOLUTIONARY AND QUANTITATIVE GENETICS

Practical | Credits: 1 | 2 hrs/week

Learning Outcomes:

Students after successful completion of the practical course will be able to

LO1: Understand the inheritance of human skin color
LO2: Solve the problems on heritability
LO3: Understand how selection can affect a population
LO4: Construct phylogenetic trees
LO5: Familiarize with software for conducting the statistical analysis of molecular evolution

1. Study of quantitative inheritance of skin color in man (Chart)
2. Genetic problems on polygenic variance, heritability.
3. Experiments on natural selection, male selection, female selection, genetic drift-population size, samplingerror.
4. Genetic crosses of *Drosophila melanogaster* - a) Balanced lethal system and b) Linkage.
5. Exploring "Simple Phylogeny" tool to construct phylogenic tree in EMBL-EBI portal.
6. A brief overview on "MEGA (Molecular Evolutionary Genetics Analysis)" software.

Suggested readings:

1. Lynch. M and B. Walsh, (1997), *Genetics and Analysis of Quantitative Traits* , Senauer Associates,Sunderland
2. Life Robert E. Kohler, (1995), *Lords of the Fly Drosophila Genetics and the Experimental*
3. O'Halloran D, (2014), *A practical Guide to Phylogenetics for Non experts*. J Vis Exp.5;(84):e50975
4. Griffiths AJF, Gelbart WM, Miller JH et al., (1999), *Modern Genetic Analysis*, - Freeman
5. Sudhir Kumar, Masatoshi Nei, Joel Dudley, Koichiro Tamura, Volume 9, Issue 4, July 2008 *MEGA: Abiologist-centric software for evolutionary analysis of DNA and protein sequences, Briefings in Bioinformatics*, , Pages 299–306

SEMESTER-VIII

COURSE 22 A: METABOLISM

Theory Credits: 3 3 hrs/week

Learning Outcomes:
Students after successful completion of the course will be able to

LO1: Understand the digestion of macromolecules and regulation of glucose in body
LO2: Understand the Biosynthesis and oxidation of fatty acids
LO3: Apprehend the biosynthesis of nucleotides and their degradation
LO4: Understand the role of transaminase enzymes in the overall degradation of amino acids
LO5: Understand the mechanism of electron transport chain and its inhibitors

Unit 1 Carbohydrate Metabolism
Carbohydrate metabolism - Sequence and regulation of glycolysis, Citric acid cycle, Pentose-phosphate pathway, Entner-Doudoroff pathway; Glycogenesis; Glycogenolysis; Gluconeogenesis; Significance of Cori and glyoxylatecycle.

Unit 2 Lipid Metabolism
Lipid metabolism - Biosynthesis and oxidation of fatty acids; Utilization and synthesis of Ketone bodies and cholesterol; Metabolism of triglycerides, Phospholipids and sphingolipids; Role of liver and adipose tissue in lipidmetabolism.

Unit 3 Amino acid Metabolism
Amino acid Metabolism- An overview of source and utilization of amino acids in human body; Transamination and oxidative deamination; Urea cycle (complete reactions, regulation of the urea cycle); Amino acids as biosynthetic precursors (heme biosynthesis and degradation, Biosynthesis of epinephrine, Dopamine, Serotonin, GABA, Histamine, Glutathione).

Unit 4 Nucleic acids Metabolism
Nucleotide biosynthesis - De novo and salvage pathways for biosynthesis of purine and pyrimidine; Mechanism of feedback regulation; Biosynthesis of Ribonucleotides; Deoxyribonucleotides; Inhibitors of nucleic acid biosynthesis; Nucleotide degradation.

Unit 5 Bioenergetics
Bioenergetics - Overview of thermodynamics, Relationship between G and Keq; High energy compounds, Standard free energy of hydrolysis of ATP, Structural basis of the group transfer potential of ATP; Oxidation reduction potential; Different types of oxidation reduction reactions; Ultrastructure of mitochondria, Anatomy, Enzymes; Electron transport chain; Inhibitors of electron transport chain; Electrochemical proton gradient; Mitochondrial electron transporters and shuttle systems.

Suggested Readings

1. Reginald H. Garret, Charles M.Grisham, (2016), *Biochemistry* , 6th edition
2. Lehninger, (2021), *Principles of Biochemistry,* 8th edition
3. Skulachev Vladimir P, Alexander V. Bogachev et al.,(2012), *Principles of Bioenergetics*
4. White. A, Handler, P,Smith et al., (2013), *Principles of Biochemistry,* 6th edition
5. David E.Metzler, (2003), *Biochemistry* , 2nd edition
6. E.E. Conn, P.K. Stump, (1972), *Outlines of Biochemistry,* 3rd edition
7. Greenberg, (1954), *Chemical Pathways of Metabolism*
8. E.A. Munn, (2014), The *Structure of Mitochondria*
9. G.L.Zubay, (1993), *Biochemistry*, 4th edition

SEMESTER-VIII

COURSE 22 A: METABOLISM

Practical | Credits: 1 | 2 hrs/week

Learning Outcomes:
Students after successful completion of the practical course will be able to

LO1: Develop capability to quantify proteins and carbohydrates
LO2: Develop capability to quantify sugars and nucleic acids
LO3: Estimate cholesterol
LO4: Measure the enzymatic activity of amylase
LO5: Measure the enzymatic activity of trypsin

1. Estimation of proteins by Lowry method
2. Estimation of carbohydrates by Anthrone method
3. Estimation of reducing sugars by Benedict's titrimetric method
4. Estimation of cholesterol
5. Estimation of DNA by diphenyl amine method
6. Estimation of RNA by Orcinol method
7. Assay of salivary amylase activity.
8. Assay of trypsin enzyme activity.

Suggested Readings

1. B.Sashidhar Rao, Vijay Deshpande, (2005), *Experimental Biochemistry*
2. Wilson and Walker, (2010), *Principles and Techniques of Practical Biochemistry*, 7th edition
3. David T.Plummer, (2017), *An Introduction to Practical Biochemistry*, 3rd edition
4. J.Jayaraman ,(2011), *Laboratory Manual in Biochemistry*
5. Eds. Williams and Wilson, (2018), *Principles and Techniques of Practical Biochemistry*, 8th edition
6. Ed.Bryan, L.Willians & Keith Wilson (Edward Arnold), (1975), *A Biologists Guide to Principles andTechniques of Practical Biochemistry*
7. Sawhney SK and Singh R (2001) *Introductory Practical Biochemistry*, Narasa Publishing House

SEMESTER-VIII

COURSE 22 B: REPRODUCTIVE GENETICS

Theory | Credits: 3 | 3 hrs/week

Learning Outcomes:
Students after successful completion of the course will be able to

LO1: Learn about male and female reproductive systems
LO2: Understand the difference between spermatogenesis and oogenesis
LO3: Gain knowledge about different reproductive disorders
LO4: Understand the genetic basis of infertility
LO5:Gain knowledge about reproductive technologies

Unit 1 Male Reproductive System
Male reproductive system; Spermatogenesis - Process and hormonal control; Maturation of sperm; Semen - Constituents of semen, Coagulation of semen, Physiological significance of seminal plasma; Male hormones – Characteristics, Receptors, Target cells; Mechanism of hormone action; Sexual differentiation and behavior.

Unit 2 Female Reproductive System
Female reproductive system; Oogenesis - Process and hormonal control; Reproductive cycles - Estrous cycle and menstrual cycle; Parturition - Onset of parturition, The stage of labour, Ferguson's reflex, Hormonal control of parturition; Process of lactation.

Unit 3 Reproductive Disorders
Endometriosis; Uterine fibroids; Gynecologic cancer; Interstitial cystitis; Polycystic ovary syndrome; Hyperprolactinemia; Pre-eclampsia; Intrauterine growth restriction; Hermaphroditism; Gonadal dysgenesis; Anomalies of genital ducts; Sexually transmitted diseases - Human papilloma virus infection, Syphilis, Gonorrhea, HIV/AIDS

Unit 4 Infertility
Risk factors; Diagnosis; Genetic basis of male infertility; Genetic basis of female infertility; Recurrent pregnancy loss; Spontaneous abortions and still birth - Etiology, Pathogenesis, Genetic characteristics, Clinical notes, Diagnosis and management; Precocious; Sexual dysfunction; Cryptorchidism.

Unit 5 Reproductive Technologies
Assisted reproductive techniques; In vitro fertilization- Artificial insemination, Semen analysis, Ovulation induction, Oocyte retrieval, In vitro maturation, Intra-cytoplasmic sperm injection, Gamete intrafallopian transfer, Cryopreservation of gametes and embryos; Vitrification; Embryo biopsy; Embryo hatching; Embryo transfer; Pre-implantation genetic diagnosis.

Suggested Readings

1. Scott F. Gilbert, (2006), *Developmental Biology*, 8th edition, Sinauer Associates Inc., Publishers,Sunderland, Massachusetts USA
2. Bruce Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, P. Walter, (2008), *Molecular Biology of thecell*, 5th edition, John Wiley and sons Inc.
3. Benjamin Lewin, (2009), *Genes X*, Jones and Bartlett Publishers, England
4. Rimon et al, (2013), *Principles and Practice of Medical Genetics*, Vol I-III, 6th edition
5. Martin H. Johnson & Barry Everitt, (2000), *Essential reproduction*, 5th edition
6. Ramon Pinon, (2002), *Biology of Human Reproduction*, 2nd edition

SEMESTER-VIII

COURSE 22 B: REPRODUCTIVE GENETICS

Practical | Credits: 1 | 2 hrs/week

Learning Outcomes:
Students after successful completion of the practical course will be able to

LO1: Carry out IVF in mice
LO2: Perform intra-cytoplasmic sperm injection
LO3: Isolate pre-implantation embryo
LO4: Cryopeserve sperm, oocyte and zygote
LO5: Carry out semen analysis

In Vitro Fertilization (Mouse model)

1. Semen analysis – Manual and CASA
2. Super-ovulation
3. Isolation of oocytes and sperm from mice
4. Culture of zygote to blastocyst stage
5. Mating and checking copulation plug
6. Collection and isolation of pre-implantation embryo
7. Intra-Cytoplasmic Sperm Injection (ICSI)
8. Sperm / oocyte / embryo cryopreservation

Suggested Readings

1. JannHau and Gerald L.VanHoosier,jr., (2002), *Handbook Of Laboratory Animal Science*, 2nd edition
2. WHO, (2011), *Laboratory manual for the examination and processing of human semen* - 5th edition

SEMESTER-VIII

COURSE 23 A: POPULATION GENETICS

Theory Credits: 3 3 hrs/week

Learning Outcomes:
Students after successful completion of the course will be able to

LO1: Understand Hardy-Weinberg principle and its importance in population genetics
LO2: Understand the influence of mutation and selection on Hardy-Weinberg Equilibrium
LO3: Gain knowledge regarding the effect of migration on gene frequencies
LO4: Apprehend consanguinity and its consequences
LO5: Familiarize with origin of human races

Unit 1 Mendelian Population and Hardy-**Weinberg Equilibrium** History of human population genetics; Genetic constitution of a population; The Hardy-Weinberg Equilibrium(HWE) - Principle, Dynamics, Application; HWE and linkage disequilibrium; HWE extension to multiple alleles,Sex- linked alleles; Exceptions to HWE.

Unit 2 Factors affecting Hardy-Weinberg Equilibrium Factors affecting HWE; Impact of recurrent and non-recurrent mutations in a HWE population; Mutation pressureand estimation of mutation rates; Selection coefficient and fitness; Selection against recessive, dominant, partialdominant and overdominant genes; Heterozygote advantage; Populations in genetic equilibrium –Balancingselection, Mutation – selection balance, Mutation-Drift balance.

Unit 3 Effect of Migration on Hardy-Weinberg Equilibrium Genetic polymorphism, Types of genetic polymorphisms; Effect of migration and genetic drift on gene frequencies; Human migration and diseases – Founder effect, Bottle neck effect, Genetic effect.

Unit 4 Genetic Demography
Genetic demography- Effective size of the population, Index of opportunity for natural selection, Mating patterns,Consanguinity, Inbreeding coefficient, Genetic load; Wahlund effect, Biological consequences of inbreeding.

Unit 5 Origin of Human Races
Applications of population genetics; Genetic mechanisms of evolution of the human species; Races- Origin,Genetic differences between races, Future of human races

Suggested Readings

1. Hedrick P.W. Jones & Bartlett,(2011), *Genetics of Population*, 4th edition
2. Hartl D. L. and Clark A.G.Sinauer Associates,(1997), *Principle of Population Genetics*, 4th edition
3. Bhasker, H.V. and Kumar S ,(2008), *Genetics. Campus Books International*, New Delhi, India
4. Cavalli-Sforza, L.L. and Bodmer, W.F., (2013), *The Genetics of Human Populations*, DoverPublications.
5. Hedrick P.W.,(2011), *Genetics of Populations.* Jones and Bartlett Publishers, Massachusetts
6. Nielsen, R. and Slatkin, M., (2013), A*n Introduction to Population Genetics: Theory and Applications,*Sinauer Associates, Inc.
7. Relethford, J.H., (2012), *Human Population Genetics*, John Wiley & Sons
8. Snustad, D.P., Simmons, M. J., (2010), *Principles of Genetics*, John Wiley & Sons, New York
9. Surendranadha Reddy Katari, *Genetic Demoghrapgy*, Scholars' Press
10. Andrew G. Young, Geoffrey M. Clarke, (2000), *Genetics, Demography and Viability of FragmentedPopulations*, Cambridge University Press
11. Asis Kumar Chatterjee Anuj Kumar Saha, (2017) , *Demography Techniques And Analysis,*Viva Books
12. Peter R Cox, *Demography*, 5th edition, Cambridge University Press

SEMESTER-VIII

COURSE 23 A: POPULATION GENETICS

Practical | Credits: 1 | 2 hrs/week

Learning Outcomes:
Students after successful completion of the practical course will be able to

LO1: Calculate allele frequencies at a particular locus in a population
LO2: Estimate the proportion of heterozygotes in a population
LO3: Estimate the rate of mutation in a population
LO4: Calculate fitness value of the affected individuals in a population
LO5: Calculate population inbreeding coefficient

1. Calculation of allele frequencies
2. Estimation of heterozygotes in a population
3. Estimation of mutational rates in a population
4. Calculation of fitness value of the affected individuals
5. Estimation of inbreeding coefficient

Suggested readings

1. Hedrick P.W. -Jones & Bartlett, (2005) ,*Genetics of Population,*3rd edition
2. Hartl D. L. And Clark A. G. ,(1997), *Principle of Population Genetics*, Sinauer Associates
3. Falconer, D, (1995) ,*Introduction to Quantitative Genetics*, 4th edition, Longman, London
4. C C Lee,(1955) ,*Population Genetics*
5. Takeo Maruyama,(1977), *Stochastic Problems in Population Genetics*, Lecture Notes in Biomathematics

SEMESTER-VIII

COURSE 23 B: RECENT ADVANCES IN HUMAN GENETICS

Theory | Credits: 3 | 3 hrs/week

Learning Outcomes;
Students after successful completion of the course will be able to

LO1: Familiarize with various genome editing tools.
LO2: A theoretical knowledge about gene therapy done for various diseases
LO3: To know the applications of RNAi technology.
LO4: Understand the importance of biomarkers in personalized medicine.
LO5: Get insight in to the various epigenetic mechanisms which regulate gene expression

Unit 1 Genome Editing Tools
CRISPR locus in bacteria, Brief history, Mechanism of CRISPR pathway, CRISPR-Cas9 system for genome engineering in mammals, Plants and other organisms; Zinc finger nuclease- based engineering; Transcription activator-like effector - based nucleases(TALEN) in genome engineering; Synthetic RNA biology and engineering biological systems.

Unit 2 Gene Therapy
Genetic approaches in treating human diseases, Principles and applications of gene therapy, Gene transfer methods, Gene therapy for cystic fibrosis, Duchene muscular dystrophy, Bleeding disorders and severe combined immunodeficiency syndrome.

Unit 3 RNAi Technology
Discovery of RNA interference; Categories of small non-coding RNAs; Different components of gene silencing; Mechanism of RNA interference; RNAi and therapeutics in cancer; Infectious diseases; Cardiovascular and cerebrovascular diseases; Neurodegenerative disorder; Future of RNAi in biology and medicine.

Unit 4: Personalized medicine
Scope of personalized medicine; Pharmacogenomics/drug metabolism in relation to individual genetic makeup; Biomarkers; Molecular testing in personalized medicine- Hereditary diabetes, Neurological disorders; Uses of biomarkers in cancer research and cancer care; Surveillance of adverse drug reactions.

Unit 5 Epigenetics
Epignetics; Epigenetic modifications - Altered DNA methylation, Histone modifcation, Non-coding RNA and chromatin remodeling; Epigenetic analysis techniques- Methylation analysis, DNA-protein interaction analysis, Chromatin accessibility analysis; Epigenetic influences and diseases- Cancer, Adiposity, Alzheimer's disease, Mental retardation; Epigenetic therapies; Epigenetics in drug discovery

Suggested Readings

1. Fire A *et al.*(Eds.),(2005), *RNA Interference Technology: From Basic Science to Drug Developmen*t,Cambridge University Press
2. Gregory J and Hannon (Eds.), (2003), *RNAi: A Guide to Gene Silencing* CSHL Press
3. Strachan, T. and Read, A., (2010), *Human Molecular Genetics.* Garland Publishers, London, 4th edition
4. Fire et. al (Eds.), (2011), *RNA Interference Technology- From Basic Science to Drug Development,* Cambridge University Press
5. Ed. Gregory J. Hannon, (2003), *RNAi: A Guide to Gene Silencing* 2nd edition, CSHL Press
6. Ute Schepers, Wiley Ed., (2005), *RNA Interference in Practice* , VCH GmbH & Co. KGaA
7. Lewis ,(2006), *Human Genetics.* WCB
8. Maroni, (2001), *Molecular and Genetic Analysis of Human Traits.* Blackwell
9. Nussbaum et al, (2004),*Genetics in Medicine.* Saunders

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SEMESTER-VIII

COURSE 23 B: RECENT ADVANCES IN HUMAN GENETICS

Practical | Credits: 1 | 2 hrs/week

Learning Outcomes:
Students after successful completion of the practical course will be able to

LO1: Familiarize with the construction of various genome editing tools.
LO2: Have theoretical knowledge about gene therapy done for various diseases
LO3: Know the applications of RNAi technology.
LO4: Test for methylation in a particular gene
LO5:Understand the importance of panel tests in family members with positive family history of ovarian andbreast cancers

1. Genome editing tools Development of CRISPR/Cas9 Design and construction of ZFN Design and construction of TALEN
2. Case studies of gene therapyCystic fibrosis
   Duchenne muscular dystrophyBleeding disorders
3. Case studies of RNA i experiments
4. Methylation - specific PCR
5. Panel testing for hereditary breast and ovarian cancer predisposition

Suggested readings

1. Chomczynski P, Mackey K., (1995), *Short Technical Report. Modification of the TRIZOL Reagent Procedure for Isolation of RNA from Polysaccharide-and Proteoglycan-rich Sources.* Biotechniques19(6): 942-5
2. Robert et al., (2007) ,*Thompson and Thompson Genetics in Medicine* 7th edition.,Saunders
3. Coll-de la Rubia, E et al, *In silico Approach for Validating and Unveiling New Applications forPrognostic Biomarkers of Endometrial Cancer*. *Cancers* 2021, *13*, 5052. https://doi.org/10.3390/cancers13205052
4. Heigwer, F., Kerr, G. & Boutros, M. *E-CRISP: fast CRISPR target site identification. Nat Methods* 11,122–123 (2014). https://doi.org/10.1038/nmeth.2812
5. Kurdyukov S and Bullock M, (2016),*DNA Mehylation Analysis: Choosing the Right Method*, Biology(Basel), Mar 5 (1): 3 doi:10.3390/biology5010003, PMCID:PMC4810160
6. Gregory J. Hannon(Ed.), (2003),*RNAi: A Guide to Gene Silencing* ,CSHL Press
7. Gordon G. Carmichael(Ed)., (2005) ,*RNA Silencing: Methods and Protocols* , CSHL Press
8. Ute Schepers(Ed.), (2005), *RNA Interference in Practice* ,Wiley-VCH GmbH & Co. KGaA

SEMESTER-VIII

COURSE 24 A: FUNDAMENTALS OF PHYSIOLOGY

Theory | Credits: 3 | 3 hrs/week

Learning Outcomes:
Students after successful completion of the course will be able to

LO1: Know the physiological aspects of musculoskeletal and cardiovascular system of human body
LO2: Understand the basic concepts of physiology of respiratory system
LO3: Get knowledge about the physiology of gastrointestinal system and its disorders
LO4: Get knowledge about the physiology of excretory system
LO5: Understand nervous system and the concepts of human endocrinology

Unit 1 Physiology of Musculoskeletal and Cardiovascualr System Role of bone in calcium homeostasis; Physiology of muscle contraction; Hematopoiesis; Hemostasis and thrombosis; Hemorheology; Functions of lymph and lymph nodes; Physiology of heart and conduction system;Normal ECG; Cardiac cycle; Heart sounds; Cardiac output and blood pressure; Coronary circulation.

Unit 2 Physiology of the Respiratory System
Physiology of the respiratory system - Mechanism of breathing, Dead space, Surfactant, Dynamic and static lung volumes and capacities; Transport of oxygen and carbon dioxide; Regulation of respiration; Cyanosis ; Hypoxia; Artificial respiration.

Unit 3 Physiology of Gastrointestinal System
Regulation and mechanism of gastric and pancreatic secretion; Gastro-intestinal motility - stages of deglutitiion, Mechanism, Disturbances, Types of movement, Gastric emptying regulation; Gastro-intestinal hormones and their actions; Digestion and absorption of carbohydrates, Proteins, Vitamins, Water and electrolytes; Cholesterol homeostasis; Immune function of GI tract.

Unit 4 Physiology of Excretory system
Physiology of excretion and urine formation - Glomerular filtration, Tubular reabsorption and tubular secretion,Regulation of body fluid by kidneys, Formation of dilute and concentrated urine; Neural control of renal functions
- Distribution and functions of renal nerves, Autoregulation, Micturition and reflexes, Atonic bladder andincontinence.

Unit 5 Physiology of Sensory and Motor Nervous System
Action potential; Transmission at synapse; Sensory, motor and integrative functions of brain and limbic system;Types of reflex actions; Physiological function of eye, Ear, Nose, Skin and tongue; Functions of endocrineglands, Mechanisms of hormone action, Control of hormones secretion.

Suggested Readings

1. Guyton, A.C. and Hall, J.E., (2016*), Textbook of Medical Physiology*, Elsevier
2. Publications, New York
3. Tortora, G.J. and Henderson, S.R., (2013), *Principles of Anatomy and Physiology*, Harper Collins CollegePublishers
4. GK Pal, (2018), *Medical Physiology*, 13th edition, Orient Black Swan
5. K Sembulingam, (2019), *Essentials of Medical Physiology*, 8th edition, JAPI Brothers Medical Publishers
6. Guyton and Hall, (2019), *Text book of Medical Physiology*, 12th edition. Elsevier Saunders Publishers
7. D Venkatesh, HH Sudhakar ,(2018), *Text Book of Medical Physiology*, 2nd edition
8. Stuart I F, (2008), *Fundamentals of Human Physiology*
9. David W, (2004), *Human Physiology and Health*

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SEMESTER-VIII

COURSE 24 A: FUNDAMENTALS OF PHYSIOLOGY

Practical Credits: 1 2 hrs/week

Learning Outcomes:

Students after successful completion of the practical course will be able to
LO1: Able to use different instruments for measuring different parameters
LO2: Measure different physiological responses like heart rate, respiratory rate etc.
LO3: Carry out blood and urine analysis
LO4: Test vision, hearing, smell and taste
LO5: Assess the relationships between multiple environmental factors and human perceptions

1. Principles of instrumentation for measurement of different parameters.
2. Measurement of heart rate, pulse rate, respiratory rate
3. Measurement of temperature, blood pressure
4. Renal function test using autoanalyzer (Uric acid, Creatinine, Urea)
5. Complete urine examination by strip method (pH, Specific gravity, Ketone bodies,Blood,Protein,Glucose)
6. Experiments with vision and hearing, olfaction and taste.
7. Methods of measurements of illumination and noise levels, audiometry, olfactometer, taste acuity.

Suggested Readings

1. Best and Tailor Williams & Wilkins Co, (2011), *Physiological Basis of Medical Practice* 13th edition,Riverview, MI USA
2. Arthur C, Guyton and John. E.Hall, (2011), *Text Book of Medical Physiology*, 12th edit
3. Dr. C.C. Chatterrje, (2017), *Human Physiology (vol 1 and 2),* 11th edition, Academic Publishers Kolkata
4. G.K.Pal, Pravati pal, (2005), *Text book of Practical Physiology*, 2nd edition
5. Pallab Basu ,(2014), *Biochemistry Laboratoty manual.*

Co-curricular activities :

A. Mandatory : (Training of students by Teacher on field related skills :)

1. For Teacher

1. Training of students by Teacher**,** in laboratory to check the vital signs
2. Creating awareness on renal and liver functioning tests

2. For Student

1 Preparation of videos on different physiological processes
2 Charts preparation for synaptic transmission and mechanisms of hormone action

B. Suggested co-curricular activities

1. Visit to local diagnostic centres to familiarize with Treadmill test to know about cardiac function
2. Visit to vision and hearing centre for obtaining knowledge on the experiments to test vision andhearing (audiometry), olfaction (olfactometer) and taste
3. Invited lectures on related topics by subject experts
4. Visit to local diagnostic centres for demonstration on autoanalyzer

SEMESTER-VIII

COURSE 24 B: ANALYTICAL TECHNIQUES

Theory Credits: 3 3 hrs/week

Learning Outcomes:
Students after successful completion of the course will be able to

LO1: Understand different types of chromatography techniques
LO2: Decide the type of electrophoresis to be used basing on the kind of biomolecule to be analysed
LO3: Understand the importance of colorimetry and spectrophotometry in determining the concentration ofvarious biochemical compounds and biomolecules
LO4: Distinguish the different types of microscopic techniques
LO5: Familiarize with proper use of lab equipment

Unit 1 Centrifugation and Chromatographic Techniques
Centrifugation- Principle, Types of centrifuges, Different types of rotors and their applications, Ultracentrifugation; Chromatographic techniques - Principle, Procedure and applications of paper chromatography, Adsorption chromatography, Partition chromatography, Ion exchange chromatography, Gel filtration chromatography, Affinity chromatography, High performance liquid chromatography, Gas liquid chromatography.

Unit 2 Electrophoretic Techniques
Electrophoretic techniques - Agarose gel electrophoresis, Polyacrylamide gel electrophoresis (PAGE and SDS- PAGE), 2-Dimensional gel electrophoresis, Isoelectric focusing technique, Immuno-electrophoresis; Factors affecting electrophoresis; Errors in electrophoresis techniques; Determination of size and molecular weight.

Unit 3 Spectrophotometry
Design of colorimeter and spectrophotometer; Principle and applications of -UV spectroscopy; Atomic absorptionspectrophotometry, Circular dichroism spectroscopy; X–ray diffraction and NMR in structure determination.

Unit 4 Microscopy
Light microscopy; Phase contrast microscopy; Fluorescent microscopy; Scanning electron microscopy (SEM/FESEM); Transmission electron microscopy (TEM); Scanning-probe microscopy; Atomic force microscopy; Confocal laser scanning microscopy (CLSM); Cytophotometry; Flow Cytometry.

Unit 5 Maintenance of Laboratory Instruments
Maintenance and use of apparatus: Pipettes, Pipetting aids, Centrifuges, Ovens, Incubators, Sterilizers, Biologicalsafety cabinets, Thermal cyclers, Microscopes, Electrophoresis apparatus, Incinerators.

Suggested Readings:

1. 1. Wilson, K. and Walker, J., (2006), *Principles and Techniques of Biochemistry and MolecularBiology*, 6th edition, Cambridge University Press India Pvt. Ltd
2. Sawhney, S.K. and Singh, R, (2005), *Introductory Practical Biochemistry*. Narosa Publishing House, NewDelhi
3. Nelson, D. and Cox, M.M., (2009), .*Lehninger Principles of Biochemistry,* 8th edition, W.H. Freemanand Company, New York
4. Gupta, P.K, (2005), *Elements of Biotechnology*, Rastogi Publications, Meerut
5. Khandpur R.S, (2003), *Handbook of Biomedical Instrumentation* , Tata McGraw Hill
6. Rodney Boyer (eds.), (2012), *Biochemistry Laboratory: Modern Theory and Techniques* 2nd edition,Prentice Hall
7. Dunbar BS,(2012), *Two-dimensional Electrophoresis and Immunological Techniques*. Springer Science& Business Media

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SEMESTER-VIII

COURSE 24 B: ANALYTICAL TECHNIQUES

Practical | Credits: 1 | 2 hrs/week

Learning Outcomes:
Students after successful completion of the practical course will be able to

LO1: Separate the amino acids from a mixture
LO2: Master the technique of thin layer chromatography
LO3: Carry out different types of electrophoretic techniques
LO4: Determine the concentration of various biochemical compounds and biomolecules
LO5: Distinguish the different parts of microscope.

1. Separation of amino acids by paper chromatography
2. Separation of sugars by thin layer of chromatography
3. Separation of lipids by thin layer of chromatography
4. Agarose gel electrophoresis of DNA
5. Polyacrylamide gel electrophoresis of proteins
6. Molecular weight determination of proteins -SDS-PAGE
7. Determination of concentration of given sample by spectrophotometer
8. Study the different parts and working of microscope
9. Determination of iso electric point of glycine

Suggested Readings

1. B.Sashidhar Rao, Vijay Deshpande, (2005), *Experimental Biochemistry*
2. Wilson and Walker ,*(*2018), *Principles and Techniques of Practical Biochemistry*, 8th edition,
3. David T.Plummer, (2017), *An Introduction to Practical Biochemistry*, 3rd edition
4. J.Jayaraman ,*(*2011), *Laboratory Manual in Biochemistry*, 2nd edition,
5. Becker JM, (1996), *Biochemistry-A Laboratory Course, Academic Press*, 2nd edition
6. Sadasivam and Manikam, (1986) , *Biochemical Methods*, Wiley Eastern Limited
7. B.K. Sharma ,(2014), *Instrumental Methods of Chemical Analysis*. Goel Publishing House.
8. Mousumi Debnath,(2011), *Tools and Techniques of GENETICS*, Pointer Publishers.
9. Upadhyay and Nath, H, (2022), *Biophysical Chemistry-Principles and Techniques*, Upadhyay; HimalayaPublishing House, 4th Edition
10. David Freifelder, Freeman and Co ,(1982) , *Physical Biochemistry- Applications to Biochemistry andMolecular Biology*, 2nd edition

Co-curricular activities :

A. Mandatory (Training of students by Teacher on field related skills :)

1. For Teacher :

1. Training of students by Teacher regarding the proper handling of lab equipment
2. Conduct awareness programs on screening for inborn errors of metabolism

2. For Student

1. Preparation of charts on different microscopes
2. Case study of patients with sickle cell anemia and thalassemia

B. Suggested co-curricular activities

1. Organization of workshop on analytical techniques
2. Group discussion /seminars on different chromatography techniques
3. Invited lectures on related topics by experts in the specified area

SEMESTER-VIII

COURSE 25 A: IMMUNOGENETICS

Theory | Credits: 3 | 3 hrs/week

Learning Outcomes:
Students after successful completion of the course will be able to

LO1: Acquire knowledge on the basic concepts of immune system
LO2: Get deep insight into the structure and diversity of immunoglobulin molecules and the genetic basis ofantibody diversity
LO3: Apprehend the role of major histocompatability complex in organ transplantation
LO4: Familiarize with different immune disorders and immunodiagnostic techniques
LO5: Gain knowledge about different types of vaccines

Unit 1 Types and Organs of Immune system

Types of immunity; Innate immune system – Phagocytes, Complement system, Natural killer cells; Adaptive immune system – Cellular immune system, Humoral immune system; Organization and structure of lymphoid organs – Bone marrow, Thymus, Spleen and lymph nodes; Cells of the immune system – B Lymphocytes, T- Lymphocytes; T-cell receptor – Structure and function.

Unit 2 Immunoglobulins

Nature and properties of antigens; Antigen – antibody interactions; Immunoglobulins – Structure, Antigenic determinants on immunoglobulins, Function, Types, Genetic basis of diversity; Major Histocompatibility Complex (MHC) - Structure and Functions of Class I and Class II MHC Molecules

Unit 3 Immune Disorders

Immuno regulation; Immunodeficiency diseases - Agammaglobulinemia, Ataxia telangiectasia and severe combined immunodeficiency disease (Primary), Multiple myeloma and leukemia (Secondary); Autoimmune Disorders – Rheumatoid Arthritis, Myasthenia gravis, Hashimoto's thyroiditis, Graves disease; Immunity breakdown (AIDS); Immunotherapy (Monoclonal antibodies and cytokines)

Unit 4 Immunodiagnostic Techniques

Antigen - antibody interactions and techniques; Agglutination and haemagglutination assays; Radial immunodiffusion, Ouchterlony double diffusion; Immunoelectrophoresis and Immunoelectrophoretic procedures; Enzyme linked immunosorbent assay; Immunoblotting; Immunofluorescence; Immunoelectron microscopy.

Unit 5 Vaccines

Historical background of vaccination, Classification of vaccines, Vaccine preventable infectious diseases, Human vaccine manufacturers and licensed vaccines, Rationale vaccine design based on clinical requirements, Scope of future vaccine changes

Suggested Readings

1. Taylor & Francis, (2016), *Janeway &Traver's Immunobiology* , 9th edition

2. Abbas et al, (2017), *Cellular and Molecular Immunology*, *10th* edition, Saunders
3. Barrett ,(1988), *Text Book of Immunology*, Mosloy
4. Benjamin et al, (2012), *Immunology – A Short Course* 8th edition, Wiley-Liss
5. Kuby, (2013), *Immunology*, 7th edition, MacMillan
6. Roitt , (2017), *Essential Immunology* ,13th edition, Blackwell

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SEMESTER-VIII

COURSE 25 A: IMMUNOGENETICS

Practical | Credits: 1 | 2 hrs/week

Learning Outcomes:
Students after successful completion of the practical course will be able to

LO1: Carry out blood grouping
LO2: Conduct ELISA test which can be used to diagnose different diseases
LO3: Perform immunoelectrophoresis which is used for diagnostic purpose
LO4: Have hands on experience on serological diagnosis of HIV and Hepatitis
LO5: Carry out tests for detection, identification and quantification of antibodies and antigens

1. Blood grouping and Rh typing
2. Quantitative precipitin assay
3. Latex agglutination test
4. Immunofluorescence (ELISA)
5. Separation of proteins by immunoelectrophoresis
6. Radial Immunodiffusion (RID)
7. Ouchterlony double diffusion test
8. Immunodiagnostics-Detection of HIV antigen by Tri dot method
9. Detection of HCV by Tri dot method.
10. Antigen – Antibody Reaction test (WIDAL).

Suggested Readings

1. Clark W.R ,(1991), *The Experimental Foundations of Modern Immunology* 4th edition
2. Bradshaw LJ, (1992), *Laboratory Immunology*
3. Rose NR, (1997) ,*Manual of Clinical Laboratory Immunology* , 5th edition
4. Lefkovits, *(*1996), *Immunology Methods Manual- The Comprehensive Source Boo.*
5. D.Brooks and E.M.Dunbar, (1986) ,*Infectious Disease*
6. Fellisa.R and Lasley J.D. Durham, (2007), *Emerging Infectious Disease*, 2nd edition
7. A.S.Fauci and G.Pantaleo, (1997*), Immunopathogenesis of HIV infection*
8. Mitchell L.Shiffman, (2012), *Chronic Hepatitis C Virus*

Co-curricular activities :

A. Mandatory (Training of students by Teacher on field related skills :)

1. For Teacher :

1. Training of students by Teacher in laboratory on different immunodiagnostic techniques
2. Conduct awareness programs on vaccines

2. For Student

1. Preparation of charts on various autoimmune disorders
2. Seminar on organs of Immune system

B. Suggested co-curricular activities

1. Group discussion about the role of MHC and immunodeficiency diseases.
2. Assignments on Immune disorders
3. Invited lectures on related topics by experts in the specified area
4. Visit to local diagnostic centers for demonstration on Flourescence flow cytometry

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SEMESTER-VIII

COURSE 25 B: GENETIC TOXICOLOGY

Theory Credits: 3 3 hrs/week

Learning Outcomes:
Students after successful completion of the course will be able to

LO1: Gain knowledge on fundamentals and mechanism of genotoxicity
LO2: Gain knowledge about genotoxic agents and their metabolism
LO3: Have an idea about DNA damage and various repair mechanisms that occur in human body
LO4: Understand different toxicity testing methods
LO5: Apprehend the role of genotoxicity in cancer

Unit 1 Genetic Toxicity and its Mechanism
Origin of genetic toxicology; Historical prospective of genetic toxicology; Fundamentals of genetic toxicity; Mechanism of genotoxicity; Mechanism of induction of chromosomal alterations and sister chromatid exchanges; Chemical occupational hazards.

Unit 2 Classification of Genotoxic Agents and their Metabolism Classification of genotoxic agents; Routes and sites of exposure; Absorption, Distribution and excretion oftoxicants; Xenobiotic metabolism; Consequences of genotoxic effects in humans. Endogenous metabolism.

Unit 3 DNA Damage and Repair
DNA damage- Exogenous factors and endogenous factors; DNA lesions and genomic instability; DNA repair - Direct repair, Excision repair, Mismatch repair, Post replication repair; Diseases caused due to defective repair of DNA damage

Unit 4 Toxicity Tests
Toxicity tests- In-vitro testing methods - Bacterial reverse mutation test, Mammalian chromosome aberration test;In-vivo genotoxicity testing methods - Comet assay, Ames test, Sister chromatid exchange, Micronucleus assay.

Unit 5 Genetic Toxicology and Cancer Genetics Cell cycle regulation- Tumor suppressor genes, Oncogenes: Mechanism and activation, Proto oncogenes, DNArepair genes; Angiogenesis; Metastasis; Role of epigenetics in cancer; Epigenetic markers for early detection ofcancer; Genetic toxicology and cancer risk assessment Epigenetic therapies

Suggested Readings

1. Curtis D. Klaassen ,(2018), *Casarett &Doull's Toxicology: The Basic Science of Poisons,* 9th edition
2. James M.parry and Elizabeth M.Parry, *(*2012), *Genetic Toxicology: Principles and Methods*
3. Watson et al., (2013*), Molecular Biology of the Gene*.7th edition
4. Saura C. Sahu, (2012),*Toxicology and Epigenetics,*wiley-Backwell

5. Natalia Tretyakova and Yinsheng Wang, (2019), *Epigenetics in Toxicology*, Chemical Research inToxicology 32, 5, 793
6. Ning Ren, ManarAtyah et al, (2017),*The various aspects of genetic and epigenetic toxicology: testingmethods and clinical applications*, Journal of translational medicine 15(1):110.doi: 10.1186/s12967-017-1218-4
7. Trygve O Tollefsbol, (2017), *Handbook of Epigenetics*, 2nd edition, The New Molecular and MedicalGenetics
8. World Health Organisation, (2020), *Genotoxicity*
9. David Brusick, (2012), *Principles of Genetic Toxicology*, Springer
10. Rebecca Fry, (2020), *Environmental Epigenetics in Toxicology and Public Health*, TranslationalEpigenetics
11. Laura Robinson, (2018), *A Practical guide to Toxicology and Human Health Risk Assesment*

SEMESTER-VIII

COURSE 25 B: GENETIC TOXICOLOGY

Practical | Credits: 1 | 2 hrs/week

Learning Outcomes:
Students after successful completion of the practical course will be able to

LO1: Detect genotoxic agents
LO2: Detect the extent of DNA damage in cells
LO3: Identify agents that cause chromosome aberrations in mammalian cells
LO4: Assess genotoxicity of different physical and chemical factors
LO5: Find out epigenetic modifications in a gene

1. Short - term biochemical tests for genetic toxicity
2. Test for gene mutations in bacteria - Bacterial reverse mutation test
3. The in vivo comet assay test
4. The in vitro chromosome aberration test
5. Sister chromatid exchanges
6. Micronucleus assay
7. Methylation-specifc PCR
8. Chromatin immunoprecipitation

Suggested Readings

1. Ray Proudlock, (2016), *Genetic Toxicology Testing, A Laboratory Manual*
2. QSAR TOOLBOX, (2013),*User Manual Strategies for grouping chemicals to fill data gaps to assessgenetic toxicity and genotoxic carcinogenicity*
3. Ren N Manar A et al, (2017), REVIEW *The Various Aspects of Genetic and Epigenetic Toxicology:Testing Methods and Clinical Applications* J Transl Med, 15:110 DOI 10.1186/s12967-017-1218-4

Co-curricular activities :

A. Mandatory (Training of students by Teacher on field related skills :)

1. For Teacher :

1. Training of students by Teacher on different toxicity testing methods
2. Creating awareness programs on Occupation safety

2. For Student

1. Prepare charts on different DNA repair mechanisms which occur in human body
2. List out the different health hazards of chemicals

B. Suggested co-curricular activities

1. Seminars on epigenetic mechanisms
2. Group discussion/ Quiz on related topics
3. Invited