Avinashilingam
Institute for Home Science and Higher Education for Women
University
(Estd. u/s 3 of UGC Act 1956)

M.Sc. Biochemistry
(Two years programme with practicals)
Scheme of Instruction and Examination
(For students admitted from 2017-2018 and onwards)

Part	Subject code	Title of the paper	Hours of instruction /week		Scheme of Examination				
			T	P	Duration of exam	CIA	CE	Total	Credit
		First Semester							
I	**17MBCC01**	Biophysical Methodology	4	-	3	40	60	100	3
I	**17MBCC02**	Cell Biology and Microbial Biochemistry	4	-	3	40	60	100	3
I	**17MBCC03**	Intermediary Metabolism and Regulation	4	-	3	40	60	100	3
I	**17MBCC04**	Pharmaceutical and Hormonal Biochemistry	4	-	3	40	60	100	3
I	**17MBCC05**	Practicals I - Analytical Biochemistry	-	6	6	40	60	100	4
I	**17MBCC06**	Practicals II - Microbial Techniques	-	5	6	40	60	100	3
II		CSS	2	-	-				-
		Library	1	-	-				-
		Second Semester							-
I	**17MBCC07**	Bioinformatics	3	-	3	40	60	100	3
I	**17MBCC08**	Genetics and Molecular Biology	3	-	3	40	60	100	3
I	**17MBCC09**	Diagnostic Biochemistry	3	-	3	40	60	100	3
I	**17MBCC10**	Nutritional Biochemistry	3		3	40	60	100	3
I	**17MBCC11**	Practicals III - Bioinformatics and Clinical Biochemistry	-	5	6	40	60	100	3
I	**17MBCC12**	Practicals IV - Molecular Biology	-	6	6	40	60	100	3
I	**17MBCC13**	Mini Project	1	-	-	100	-	100	2
I		Interdisciplinary Course	4	-	3	40	60	100	4
II		CSS	2	-	3				1
II		Professional Certification			-				2
		Internship during summer vacation for one month							

Part	Subject code	Title of the paper	Hours of instruction /week		Scheme of Examination				
			T	P	Duration of exam	CIA	CE	Total	Credit
		Third Semester							-
I	**17MBCC14**	Immunology and Immuno technology	4	-	3	40	60	100	3
I	**17MBCC15**	Physiology, Biochemistry and Biotechnology of Plants	4	-	3	40	60	100	3
I	**17MBCC16**	Genetic Engineering	4	-	3	40	60	100	3
I	**17MBCC17**	Advanced Enzymology	4			40	60	100	3
I	**17MBCC18**	Practicals V- Enzymology and Immunology	-	6	6	40	60	100	4
I	**17MBCC19**	Practicals VI - Tissue Culture	-	5	6	40	60	100	3
I	**17MBCC20**	Environmental Biochemistry (Self study)	1	-	3	40	60	100	4
I		Multidisciplinary Course	2	-	3	100	-	100	2
II	**17MBCC21**	Internship			-	100	-	100	2
		Fourth Semester							
I	**17MBCC22**	Neurochemistry	3	-	3	40	60	100	3
I	**17MBCC23**	Biostatistics and Research Methodology – (Open Book Test)	4	-	3	100	-	100	3
I	**17MBCC24**	Thesis	23	-	-	100	100	200	6
		Total						2700	**85**

Other course to be undergone by the student

MOOC Course - 2 credits

Note: Minimum 85 credits to earn the degree

Other courses offered by the Department

IDC: 17MBCI01 - Natural Antioxidants in Human Health and Diseases

MDC: 17MBCM01- Home Remedies for Common Ailments

Biophysical Methodology

Semester I **Hours of instruction/week: 4**
17MBCC01 **No. of credits: 3**

Objectives:

1. To understand the latest advances in biophysical techniques
2. To gain knowledge about the developments in nanotechnology

Unit I *Basic biochemical techniques* **12 hrs**

Chromatography - Paper, TLC, Adsorption, Ion-exchange, Affinity, Gel filtration, HPLC and Gas chromatography, FPLC

Electrophoresis - Paper, Agarose gel electrophoresis, PAGE 2D-PAGE, Capillary electrophoresis, Immunoelectrophoresis

Centrifugation techniques - principles, types and applications. Ultracentrifugation- types, optical methods used and applications of preparative and analytical ultra centrifuges

Self Study: Isoelectric focusing and PFGE

Unit II *Microscopy and Radioistopes* **12 hrs**

Microscopy – Principle, light, bright field, phase contrast, fluorescent microscopy, confocal microscopy.

Electron microscopy - principle, instrumentation and applications of SEM and TEM and super resolution microscopy.

X-rays - Introduction, production and properties of X-ray. X-ray diffraction, X-ray fluorescence, detection and applications

Radioisotope techniques - nature of radioactivity, measurement of radioactivity, Applications of radioactive and stable isotopes in biological research. Autoradiography

Self Study: Radiation health hazards, FISH, ELISA

Unit III *Spectroscopy Techniques I* **12 hrs**

Fundamental principles of spectroscopy-introduction, regions of electromagnetic spectrum and properties of electromagnetic radiation. Molecular and atomic spectra, types of molecular spectra.

Absorption spectroscopy - principle, instrumentation and applications of atomic absorption spectroscopy, UV-visible spectroscopy, infrared spectroscopy, nuclear magnetic resonance spectroscopy, COSY, NOSY and ROSY techniques. Electron spin resonance spectroscopy.

Self Study: Fourier transform infrared spectroscopy

Unit IV *Spectroscopy Techniques II* **12 hrs**

Emission Spectroscopy - Introduction, principle, method and applications of Flame Photometry.

Fluorimetry – principle, instrumentation and applications.

Mass Spectroscopy – principle, Instrumentation and applications

Light scattering and Raman Spectroscopy: Principles, method, applications with reference to biological macromolecules such as proteins and nucleic acids

Self Study: ORD and CD

Unit V ***Nanotechnology*** **12 hrs**

Introduction, elementary concepts of nanomaterials and bionanomaterials. Nanotechnology applications-medicinal applications:-nanomedicine-drug delivery system, cancer detection, *in vivo* therapy, nanorobots, neuroelectronic interfaces, cell repair machines.

Nanotechnology in biomedicinal sciences - biodetection of pathogens, nanobiosensors probing DNA structure, Tissue engineering

Self Study: Biosensors

Total 60 hrs

References

1. ***Wilson. K and Walker. J.*** (2010), ***Practical Biochemistry – Principles and techniques of Biochemistry and Molecular Biology***, 7th Edition, Cambridge University Press, New York, USA.
2. ***Upadhyay, A., Upadhyay, K., and Nath, N.,*** (2014), ***Biophysical chemistry – principle & techniques***, Himalaya publishing House, Mumbai.
3. ***Gurdeep, R. Chatwal and Aanand. S.K.*** (2009). ***Instrumental Methods of Chemical Analysis***,Himalaya publishing House, New Delhi.
4. ***Foster, L.E.*** (2007), ***Nanotechnology Science, Innovation and opportunity*** (First edition),Pearson Education, Inc, New York.
5. ***Pattabhi, V and Gautham,*** (2015), ***Biophysics***, Narosa Publishing House PVT Ltd, New Delhi.
6. ***Rathi, R.*** (2007), ***Core Concept of Nanotechnology with application spectrum*** (First Edition),SBS Publishers and Distribution Pvt Ltd, New Delhi.
7. ***Sharma. P.K***. (2008), ***Origin and Development of Nanotechnology*** (first edition), Vista International publishing House Mumbai, New Delhi.

Cell Biology and Microbial Biochemistry

Semester I **Hours of instruction/week: 4**
17MBCC02 **No. of credits: 3**

Objectives

- To obtain through knowledge about cell structure, organization and transport of nutrients
- To understand the basic concepts involved in Microbial Taxonomy, Growth, Nutrition, Physiology and Metabolism

Unit I Cell structure and organization **12 hrs**

Cell and subcellular organization- Ultra structure of prokaryotic and eukaryotic cells. Subcellular organells-mitochondria, ribosomes, ER, lysosomes, Golgi, peroxisomes, nucleus, chloroplast. Cytskeleton- actin and myosin - interfilament, microtubules.
Self study: variation in cell differentiation and progression

Unit II Membrane structure and transport **12 hrs**

Membrane structure-Models- membrane rafts. Membrane transport- types. Diffusion(passive, facilitated) Active. Ion pumps, channels, ionophores, aquapores. Transport of water, glucose, aminoacids, exocytosis, endocytosis.
Cell cycle- phases, regulation, cell death- apoptosis, necrosis, autophagy.
Self study: cell division- mitosis and meiosis

Unit III Microbial taxonomy **12 hrs**

Morphological, physiological, metabolic, genetic and molecular concepts, classification, structure and composition of bacteria, archaebacteria, fungi and algae.
Self Study: Life cycle of *Saccharomyces*, *Neurospora*, blue green algae, dinoflagellates and protozoa.

Unit IV *Bacterial nutrition, growth and metabolism* **12 hrs**

Synchronous, batch and continuous culture. Physical and chemical factors affecting microbial growth. Microbial respiration, microbial metabolism-TCA cycle, Embden-Mayer-Hoff's pathway, Glyoxalate pathway, Oxidative and substrate level phosphorylation. Biogeochemical cycles- carbon, nitrogen, sulphur and phosphorus cycles.
Self Study: Fermentation of carbohydrates - homo and hetero lactic fermentation.

Unit V Genetic recombination **12 hrs**

Conjugation, Transformation and transduction- mechanism and significance,
Generalized site specific recombination, tetrad analysis and gene conversion
Structure of bacteriophages- DNA phages, Lambda phages and T_4 phages, RNA phages and lipid containing phages**.** Virus multiplication cycles – absorption, penetration, protein synthesis, breakage of host cell DNA , maturation and release
Phage genetics – Organization of genetic material of bacteriophage lambda and T_4.
Genetic recombination in phages, regulation of gene expression in vegetative (in bacteriophage lambda andT4) and prophage cycle (in bacteriophage lambda).
Self study: Lysogenic conversion

Total 60 hrs

References:

1. ***Ananthanarayan and Panikers***, (2009), ***Text book of microbiology***, 8th edition, Orient. Longman (p) Ltd, Hyderabad
2. ***Verma. P.S and Agarwal. V.K***. (2008), ***Cell Biology***, ***Genetics, Molecular Biology, Evolution and Ecology***, 5th Edition, S. Chand and Co. Ltd, New Delhi.
3. ***Casida., J.R.,*** (2003), ***Industrial Microbiology***, 5th edition, New Age International Publisher, New Delhi.
4. ***Chakraborty, P,*** (2005), ***A textbook of microbiology***, New Central Book Agency (p) Ltd Publications.
5. ***Gupta, P.K*** (2008). ***Cell and molecular biology***, 6th Edition, Rastogi Publication, Merut, India.
6. ***Ingraham, J.L and Ingraham, C.A***. (2006) ***Introduction to microbiology***, 5th edition, Brookscole, California.
7. ***Karp. G*** (2009), ***Cell and Molecular Biology- Concepts and Experiments***, 6th Edition, John Wiley and Sons, Inc, Newyork.
8. ***Lodish. H., Berk. A., Matsudaira. P., Kaiser. C.A., Krieger. M., Scott. P.M., Zijursky. S.L. and Darnell, (***2012), ***Molecular Cell Biology***,7th Edition, W.H Freeman and Company, New York
9. ***Nelson, D and Cox, M.M***. (2009), ***Principles of Biochemistry***, 5th Edition, W.H.Freeman Company, New York.
10. ***Pollard. T.D. and Earnshaw, W.C.*** (2002), ***Cell Biology***, Saunders Publishing and Co, New York.
11. ***Talaro, K.P and Talaro.A,*** (2008) ***Foundations in Microbiology***, 6th edition, Mc Graw Hill Publishers, NewYork.
12. ***Tortora, J. G, FunKe, K. B and Case, L.C*** (2006), ***Microbiology: An Introduction***, 8th edition, Pearson Education, Inc, New Delhi

Intermediary Metabolism and Regulation

Semester I **Hours of instruction/week: 4**
17MBCC03 **No. of credits: 3**

Objectives:

- To help the students to understand the fate of dietary constituents after digestion and absorption
- To help the students to understand the basic metabolic pathways
- To help the students to understand the inter relationship between major foodstuffs.

Unit I ***Carbohydrate Metabolism*** **12 hrs**

Regulation of Glycogen metabolism, Reciprocal regulation of Glycolysis and Gluconeogenesis. Biosynthesis of Oligosaccharides-N-linked and O-linked Oligosaccharides, Glycosaminoglycans, Microbial cell wall polysaccharides. Regulation of Pyruvate dehydrogenase and TCA cycle

Self Study:. Structure and functions of storage polysaccharides (starch and glycogen) structural polysaccharides (cellulose, pectin and chitin).

Unit II ***Lipid Metabolism*** **12 hrs**

Regulation of fatty acid and cholesterol metabolism. Metabolism of plasma lipoproteins, ethanol, isoprenoids, eicosanoids-prostanoids, thromboxanes and leckotrienes. Biochemical role of eicosanoids

Self Study: Structure, classification and functions of lipids and fattyacids

Unit III ***Metabolism of Proteins*** **12 hrs**

General breakdown of proteins, deamination, transamination and urea cycle. Decarboxylation reactions and biogenicamines – Histamine, GABA and polyamines

Self Study: Integration of Metabolism, metabolic profile of liver, Adipose tissue and brain. Altered metabolism in starvation.

Unit IV M*etabolism of amino acids* **12 hrs**

Metabolism of Glycine, Phenylalanine, Tyrosine and Tryptophan.

Biosynthesis of catecholamines. Specialized products of amino acids (Glycine, Tyrosine and Tryptophan), Metabolism of one carbon compounds

Self Study: Structure and properties of amino acids

Unit V ***Metabolism of Nucleic acids*** **12 hrs**

Biosynthesis and degradation of purine and pyrimidine nucleotides – conversion of mononucleotides to di and tri nucleotides- *De novo* and salvage pathways. Role of nucleotide reductase.

Degradation of purine and pyrimidine nucleotides Disorders of nucleic acid metabolism

Self Study: Structure and properties of nucleic acids

Total 60hrs

References:

1. ***Murray, K.R., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, W.V. and Weil, P.A.*** (2012), ***Harper's Illustrated Biochemistry***, 29th Ed, The McGraw-Hill Companies
2. ***Nelson, D.L. and Cox, M.M*** (2013), ***Lehninger Principles of Biochemistry***, 7th Ed, W.H.Freeman and Company, New York
3. ***Voet, D and Voet, G***. (2012), **Fundamentals of *Biochemistry***, John Wiley and Sons, New York.
4. ***Zubay, G. L.*** (1999), ***Principles of Biochemistry***, 4th edition, William C. Brown Publications.
5. ***Bery, J.M., Tymoezko, J.L. and Stryer, L.*** (2008) ***Biochemistry***, 6th Ed, W.H. Freeman and Company, New York
6. ***Mathews, C.K., Van Holde, K.T*** (2000), ***Biochemistry***, 3rd Ed, Addison-Wesleyings Publishing Co., Inc., Sanfrancisco.
7. ***Devlin, T.M.*** (2002), ***Textbook of Biochemistry with Clinical correlations***, 5th edition, John Wiley & Sons Inc, Publications.

Pharmaceutical and Hormonal Biochemistry

Semester I **Hours of instruction/week: 4**
17MBCC04 **No. of credits: 3**

Objective:

- To understand the nature of drugs used in the treatment of various diseases.
- To gain knowledge about the mechanism of action and metabolism of drugs.
- To enlighten the students about the specific modes of action of hormones.
- To help the students to understand the role of hormones in metabolism and the disorders associated with it.

Unit I *Introduction to Pharmaceuticals* **12 hrs**

Classification of drug, sources, nature and nomenclature of drug, dosage forms and routes of drug administration.

Absorption, distribution, Metabolism and elimination of drugs - Absorption – Drug absorption across biological membranes-active transport of drugs bio pharmaceutical factors influencing drug absorption – effects of surface active agents on drug absorption. Distribution of drugs and biological action - Pathways of metabolism - drug biotransformation pathways - Detoxification of xenobiotics – pesticides and cyanides.

Self Study: Adverse drug reactions and drug interactions.

Unit II *Mechanism of action of drugs* **12 hrs**

Receptor theory of drug action, non-receptor theory of drug action, Mechanism of action of antibiotics- Penicillin, sulfonamides and antimalarial drugs- Chloroquine. Biochemical basis of toxicity – mechanism of toxicity, genotoxicity – dose – response relationship – determination of ED50 and LD50. Acute and chronic toxicity.

Self Study: Detoxification of carcinogens/mutagens**,** Factors influencing toxicity,

Unit III *Introduction to Hormones* **12 hrs.**

Definition of hormone, Classification based on secreting glands, solubility and chemical nature.
General mechanism of action of GroupI and GroupII hormones; Role of second messengers- cAMP, cGMP, inositol phospholipids, receptor tyrosine kinase, calcium and others. Regulation of hormone action.

Self Study: Basic characteristics of cell signalling- autocrine, paracrine, endocrine and uxtacrine

Unit IV *Biochemical action of Group I hormones* **12 hrs.**

Chemistry, biosynthesis, secretion, biochemical actions and disorders of the hormones of thyroid glands, adrenal cortex, ovary and testes.

Self Study: Diseases associated with gonodal hormones

Unit V *Biochemical action of Group II hormones* **12 hrs.**

Chemistry, biosynthesis, secretion, biochemical actions of the hormones of hypothalamus, anterior, posterior pituitary, parathyroid, pancreas, adrenal medulla.

Self Study: Gastrointestinal tract hormones

Total 60 hrs

References:

1. ***De, A.K*** (2017) *'**Environmental Chemistry'** 8th* edition, New age international (p) Ltd. Publishers, New Delhi.
2. ***Nirmala, N., Rege, R.S., Santoskar, S.D. and Bhandarkar*** (2011), Pharmacology and Pharmacotherapeutics, 23rd edition, CBS Publishers and Distributors Pvt. Ltd.
3. ***Omkar*** (2003) ***'Concepts of Toxicology'*** 2nd edition, Vishal Publishers.
4. ***Sharma, P.D*** (2012) '***Toxicology',*** 3rd edition, Rastogi publications, Meerut.
5. ***Subramanian.M.A*** (2004) ***Toxicology-Principles and methods***, M.J.P Publishers. Chennai
6. ***Tripathi, K.D***. (2013) ***'Essentials of Medical Pharmacology'*** 7th edition, Jaypee brothers, Medical publishers, New Delhi.
7. ***Yadav, P.R***. (2004), ***Endocrinology***, Discovery Publishing Home
8. ***Prakash and Lohar.*** (2005), ***Endocrinology: Hormones and Human health***, MJP Publishers.
9. ***Hardley, E.Mc.*** (2010), ***Endocrinology***, 4th Edition, Prentice Hall.

Practicals I – Analytical Biochemistry

Semester I **Hours of instruction/week: 6**
17MBCC05 **No. of credits: 4**

Objectives:

1. To develop skills in handling sophisticated instruments.
2. To help the students to learn the latest techniques in analytical Biochemistry

Experiment

1.	Spectrophotometry – Preparation of standard curves – linear regression – assessment of ranges and reliability	**5 hrs**
2.	Estimation of ascorbic acid	**5 hrs**
3.	Separation and estimation of total carotenoids and β-carotene	**10 hrs**
4.	Extraction and estimation of vitamin A, vitamin E, niacin and free amino acids	**20 hrs**
5.	Estimation of phosphorus by Fiske and Subbarow method	**5 hrs**
6.	Fluorimetric estimation of thiamine and riboflavin	**10 hrs**
7.	Characterization of fats – estimation of saponification number, iodine number, acid number and R.M.Number	**10 hrs**
8.	Extraction of Phytoconstitutents by Soxhlet and quantification	**15 hrs**
9.	Ultracentrifugation – separation of cell organelles – confirmation of fractions using marker enzymes	**10 hrs**
		Total 90 hrs

Practicals II – Microbial Techniques

Semester I **Hours of instruction/week: 5**
17MBCC06 **No. of credits: 3**

Objectives:

1. To provide hands – on - training on various techniques involved in Microbiology

Experiment

1. Principles and methods of sterilization	**5 hrs**
2. Staining Techniques	**5 hrs**
3. Preparation of media –Nutrient agar, Nutrient broth, plates, slants.	**5 hrs**
4. Pure culture techniques – Streak plate, spread plate, pour plate.	**5 hrs**
5. Enumeration of bacteria from soil, water and air.	**5 hrs**
6 .Isolation and purification of bacteria, fungi- Serial Dilution Technique	**5 hrs**
7. Determination of viable count of yeasts – Haemocytometery	**5 hrs**
8. Identification of bacteria –IMVic Tests	**5 hrs**
9. Determination of microbial growth –Turbidity method	**5 hrs**
10. Determination of antibiotic sensitivity	**5 hrs**
11. Production of amylase, protease and indole acetic acid	**5 hrs**
12. Estimation of urease from soil microbes	**5 hrs**
13. Estimation of phosphatase from soil microbes	**5 hrs**
14. Estimation of oxidase, catalase and deaminase	**5 hrs**
15. Molecular confirmation of bacteria –PCR-16 S r RNA	**5 hrs**
	Total 75 hrs

References:

- Vasanthakumari.R, (2009) ***Practical Microbiology***, BI Publishers Pvt Ltd, India
- Dubey.R.C and Maheshwari D.K., (2002), ***Practical Microbiology***, S.Chand & comp Ltd, New Delhi

Bioinformatics

Semester II **Hours of instruction/week: 3**
17MBCC07 **No. of credits: 3**

Objectives:
1. To build a strong background in bioinformatics
2. To introduce the students to the biological databases
3. To became familiar with various bioinformatics tools
4. To master the computational techniques used biological sequence and structure analysis
5. To understand the potential application of bioinformatics

Unit I *Introduction to bioinformatics* **9 hrs**
Biological databases – features and layout – Sequence databases, structure databases, specialized databases – primary and secondary databases – genome databases, microbial and cellular databanks, model organism databases – database search and retrieval tools – Entrez, SRS and other tools.
Self Study: Structural classification of proteins (SCOP, CATH and other classifications)

Unit II *Sequence analysis* **9 hrs**
Need and importance – pairwise alignment – dot plot, dynamic programming – global (Needleman-Wunsch) and local (Smith - Waterman) alignment algorithms – scoring matrices – gap penaltie – substitution matrices – need, types – PAM and BLOSUM – pairwise alignment tools – BLAST, FASTA Multiple alignment – Clustal – NJ plot – phylogenetic trees – parts, types – Construction and analysis of phylogenetic trees PHYLIP
Self Study: Variations of BLAST – PSI-BLAST, PHI-BLAST, bl2seq.

Unit III *Bioinformatics tools to analyze nucleotide sequences* **9 hrs**
Detecting ORFs, finding genes, constructing restriction maps, designing primers and probes, calculating T_M, theoretical translation of coding region – prediction of secondary structure of RNA
Bioinformatic tools to analyze protein sequences – finding protein parameters – tools for peptide cleavage and mapping – prediction of secondary structure of proteins.
Self Study: Programs used to analyze nucleotide and protein sequences

Unit IV Genomics and Proteomics **9 hrs**
Genomics – structural, functional and comparative genomics – DNA microarrays – Present status and future prospects.
Proteomics – traditional proteomics vs modern proteomics – 2-D gel electrophoresis, mass spectroscopy, MALDI-TOF and other methods of analysis Protein microarrays – present status and future prospects.
Self Study: Modifications of DNA microarrays – transcriptomics.

Unit V *3-D structural analysis of biomolecules* **9 hrs**
Molecular visualization tools – RasMol, Deep View – Homology modelling of proteins.

Molecular modelling (elementary concepts of force field, stereodynamics and energy minimization) – prediction of ligand binding – design of best-fitting ligands – Computer -aided drug design – steps involved – lead compound identification, optimization energy minimization, ADME studies, combinatorial chemistry and other approaches – QSAR – high throughput screening

Self Study: Other visualization tools – Chime, WebLab Viewer, MolMol

Total 45 hrs

References:

1. ***Dubitzky, W.*** (2007) ***Fundamentals of Data mining in Genomics and Proteomics***, Springer Publication, New Jersey.
2. ***Gromiha, M.M.*** (2010) ***Protein Bioinformatics: From Sequence to Function***, Academic press, New Delhi.
3. ***Krane, D.L.*** (2006) ***Fundamental Concept of Bioinformatics***, Pearson Publication, Asia.
4. ***Lacroix, Z. and Critchlow, T.*** (2009) ***Bioinformatics: Managing Scientific Data*** – Mayan Kaufmann publishers, San Francisco.
5. ***Lesk, A.*** (2007) ***Introduction to Bioinformatics***, Oxford University Press, UK
6. ***Mount, D.*** (2006) ***Bioinformatics – Sequence and Genome Analysis***, CBS.
7. ***Polanski, A. and Kimmel, M.*** (2010) ***Bioinformatics***, Springer Pvt. Ltd.
8. ***Roy, D.*** (2009) ***Bioinformatics***, Narosa publishing house, India.
9. ***Ramsden, J.J***. (2009) ***Bioinformatics: An introduction***, Kluwer academic publishers.

Genetics and Molecular Biology

Semester II **Hours of instruction/week: 3**
17MBCC08 **No. of credits: 3**

Objectives:
1. To understand the nature of the genetic material
2. To learn about the central dogma of molecular genetics and the details of the events – replication, transcription and translation.
3. To know about the expression of genes in prokaryotes and eukaryotes and the regulation of gene expression.

Unit I ***Laws of inheritance*** **9 hrs**

Mendelian and non-Mendelian inheritance, Sex linked inheritance, interaction of gene and probability. Linkage and crossing over and Chromosome mapping in *Drosphila melanogaster*
Self Study: Life cycles of animals (Gametogenesis, Oogenesis and Spermatogenesis), plants (Diploid and Haploid life stages and Sexual reproduction in flowering plants) and fungi (Budding and Sexual Cycle).

Unit II ***Population genetics*** **9 hrs**

Gene pool, Gene frequency, Hardy Weinberg law, non random mating, factors influencing allele frequency, Herbitability, Genetic variation at the molecular level- Polymorphism, Multiple alleles. Chromosome structure – polytene and Lampbrush chromosomes. Types of chromosomes based on centromere position . Karyotyping.
Self Study: Legal and ethical issues in genetics

Unit III ***DNA Replication*** **9 hrs**

Structure, properties and functions of DNA (different forms of DNA) and RNA – types of RNA - The central dogma of molecular biology, E.coli chromosomes and plasmids. Eukaryotic chromatin organization, DNA sequence elements – unique sequence and repetitive DNA.
DNA replication in bacteria and eukaryotes, enzymes and proteins involved, mechanism. End replication problem, DNA damage, DNA repair – photoreaction, excision, mismatch.
Self Study: Transposable elements

Unit IV ***Transcription*** **9 hrs**

Transcription in E.coli – RNA polymerase, promoter, mechanism. Transcription in eukaryotes – DNA Pol I,II,III, structure. Transcription factors, Promoter. Mechanism of Transcription – pre initiation complex formation, initiation, elongation, termination. Post transcriptional processingof prokaryotic and eukaryotic m RNA. RNA editing.
Self study: Reverse transcription

Unit V ***Genetic code and translation*** **9 hrs**

Genetic code – Universal and mitochondrial. Mutations- point and frame shift .Translation- AA activation, Initiation, elongation and termination in prokaryotes and eukayotes. Post translational modifications. Protein targeting, folding and degradation.Regulation of gene expression in prokaryotes. Lac and Trp operons. Regulation of gene expressions in eukaryotes by steroid hormones, alternative splicing, RNA interference.

Self study: Brief outline of epigenetic regulation- DNA methylation and histone modifications.

Total 45 hrs

References:

1. ***Benjamin, A.P***. (2002), ***Genetics A conceptual approach***, W.H.Freeman and Company, New York.
2. ***Bery, J.M., Tymoezko, J.L. and Stryer, L.*** (2008), ***Biochemistry***, 6th Edition, W.H.Freeman and Company, New York.
3. ***Brown, T.A.*** (2006), ***Gene cloning and DNA analysis***, John Wiley and Sons Publications, New York.
4. ***Gardner, E.J., Simmons, M.J. and Snusted, D.P***. (2002), ***Principles of Genetics***, Eighth Ed, John Wiley and Sons, New York.
5. ***Jeyanthi, G.P.*** (2009), ***Molecular Biology***, MJP Publishers, Chennai
6. ***Karp. G***, (2009), ***Cell and Molecular Biology- Concepts and Experiments***, 6th Edition, John Wiley and Sons, Inc, Newyork.
7. ***Lewin, B.*** (2004), ***Genes VII***, Pearson Education Limited, New York.
8. ***Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Scott, P.M., Bretscher, A., Ploegh, H. and Matsudaira, P.*** (2012), ***Molecular Cell Biology***, 7th Edition, W.H.Freeman and Company, New York.
9. ***Tamarin, R.H.*** (2007), ***Principles of Genetics***, 7th Education, TMH Publishing Company, New Delhi, New York.
10. ***Verma, P.S. and Agarwal, V.K.*** (2008), ***Cell Biology***, Genetics, Molecular Biology, Evolution and Ecology, 5th edition, S. Chand and Co. Ltd.
11. ***Cooper, G.M. and Hausman, R.E.*** (2013), ***The Cell – A molecular approach,*** 6th Edition, Sinauer Associates Inc.

Diagnostic Biochemistry

Semester II **Hours of instruction/week: 3**
17MBCC09 **No. of credits: 3**

Objectives:
1. To understand the basic concepts of laboratory techniques.
2. To gain knowledge about various investigations and their interpretations.

Unit I *The clinical biochemistry laboratory* **9 hrs**
The use of biochemical tests , Investigation of Inborn errors of Metabolism: Patterns of inheritance - alkaptonuria, phenyl ketonuria, albinism, glycogen storage diseases and inherited disorders associated with urea cycle.
Self Study: Specimen collection and types**,** Automation and Computerization

Units II *Investigation of Homeostasis* **9 hrs**
Water and electrolyte homeostasis - renin angiotensin – aldosterone system
Pathological variations of water and electrolytes- diagnosis and Interpretations.
Abnormal hemoglobin and hemoglobinopathies- Sickle cell anemia and thalassemias, porphyrias and porphyrinurias.
Protein: Plasma proteins in health and diseases
Self study: Acid base balance and imbalance - Mechanism of regulations, Anion gap, Acidosis and Alkalosis**.**

Units III *Investigation of Organ functions* **9 hrs**
***Renal functions tests*:** Preliminary investigations, tests based on GFR, RPF and tubular function. Diseases related to kidney - nephritis, nephrosis, uremia, renal failure, renal calculi, renal hypertension, renal tubular acidosis, diabetes insipidus.. Dialysis - hemodialyis and peritoneal dialysis.
Gastric function tests: Examination of resting content, Fractional gastric analysis, stimulation tests, Tubeless gastric analysis. Malabsorption syndrome, acidity, ulcers - gastric, duodenal and peptic, colon cancer, pancreatitis, gastric and pancreatic function tests.
Self study: Gout, Lesch nyhan syndrome and orotic aciduria**.**

Units IV *Liver function tests and Lipid disorder* **9 hrs**
Liver function tests: Tests based on abnormalities of bile pigment metabolism, detoxification and excretory functions. Diagnosis of different types of jaundice. pancreatic function tests.
Diseases relating to liver - jaundice, cirrhosis, hepatitis, cholestasis, cholelithiasis, hepatic coma, hepatic carcinoma, inherited diseases of bilirubin metabolism
***Lipid*:** Lipoprotinemias and atherosclerosis coronary heart diseases and hypertension.
Self study: Biochemical changes in cancer - detection of tumor markers

Units V *Investigation of metabolic disorders* **9 hrs**
Carbohydrates: Blood glucose level - regulation and its clinical significance, Diabetes mellitus, Glycosuria and GTT.

Enzymes and Isoenzymes of clinical importance - general principles of assay - Clinical significance of enzymes and isoenzymes (LDH, CK, phosphatase, 5' nucleotidase, amylase, lipase, acetyl cholinesterase, transaminase and gamma glutamyl transferase)
Self study: meningitis, encephalities, epilepsy, Parkinsons, Alzheimers, cerebral palsy.

Total 45 hrs

References:

1. ***Chatterjee and Shindae*** (2007). ***Text book of medical biochemistry***, 7th edition.
2. ***Devlin, T.M*** (2002). ***Text Book of Biochemistry with clinical correlations***, 5th edition. NewYork.
3. ***Gans, G and Murphy, J.M.*** (2008). ***Clinical Biochemistry***, fourth edition, Churchill Livingstone, Elsevier.
4. ***Gowenlock, A.H. and Donald, J*** (2002). ***Varley's practical clinical Biochemistry***, sixth edition, CBS publications and Distributors, New Delhi.
5. ***Sembulingam, K and Sembulingam, P*** (2010). ***Essentials of Medical Physiology***, fifth edition. Jaypae Brothers (p) ltd, New Delhi.
6. ***Burtis and Ashwood*** (2007) ***Tietz Fundamentals of Clinical chemistry***, 6th edition, WB Saunders Company, Oxford Science Publications USA.

Nutritional Biochemistry

Semester II **Hours of instruction/week: 3**
17MBCC10 **No. of credits: 3**

Objectives:

1. To understand the concepts and applications of nutrition and their linkage with Biochemistry
2. To understand the role of antinutrients
3. To gain knowledge in planning diets in health and disease conditions

Unit I ***Assessment of Nutritional Status*** **9 hrs**

Methods of assessing the nutritional status- Anthropometric measurements for children, adolescents and adults. Biochemical methods for assessment of nutritional status, PEM – Marasmus and Kwashiokar. Anorexia, bulimia and obesity – causes and consequences.

Self Study: Clinical methods and diet surveys.

Unit II Importance of Nutrition **9 hrs**

Nutritional Significance of carbohydrates, proteins and lipids. Effects of excess and deficiency of proteins and energy. Balanced diet, recommended dietary allowances of nutrients for all age groups. Sources, Daily requirements and nutritional significance of water soluble and fat soluble vitamins.

Self Study:. Antioxidants- enzymic and non-enzymic**.**

Unit III ***Minerals and Water*** **9 hrs**

Macrominerals: Calcium, Phosphorus, Magnesium, Sulphur, Sodium, Potassium and Chloride their sources, functions, deficiency and toxicity.

Trace Minerals: Iron, Zinc, Copper, Manganese, Fluorine, Iodine, Chromium, Selenium, Molybdenum and Cobalt- their sources, functions, deficiency and toxicity.

Self Study: Water, fluid and electrolyte balances.

Unit IV ***Balanced Diet and Nutrition*** **9 hrs**

Balanced diet and nutriton in special conditions (pregnancy and lactation, and sports nutrition), Disease condition (Diabetes mellitus, cancer, cardiovascular diseases, disease of Kidney and Liver and Peptic ulcer).

Self Study: Neurological Disorders**.**

Unit V ***Naturally occurring food toxicants*** **9 hrs**

Protease inhibitors, hemagglutinins, glucosinolates, cyanogens, saponins, gossypol, lathyrogens, favism, allergens, carcinigens, miscellaneous toxic factors their physiological role and prevention of toxicity.

Self Study: Interaction of Nutrition and Infection

Total 45 hrs

References:

1. ***Srilakshmi. E .***(2016) ***Nutrition Science***, New Age International Publishers.
2. **Gopalani, S**. (2008) ***Diet and Nutrition***, Cyber Tech. Publication.
3. ***Mahan, Kathleen L.*** (2004) Krause's ***Food, Nutrition and Diet Therapy***, W.B.Saunder's 11th Edition
4. ***Recommended dietary intakes for Indian***- Indian Council of Medical Research, New Delhi, 2000.
5. ***Srilakshmi. E***. (2016) ***Dietetics***, New Age International Publishers.
6. ***Swaminathan, M*. (2009)** ***Advanced Textbook on Food Science and Nutrition***, Vol: 2, 2nd Edition, Reprinted, Bangalore Printed and Publishing Co Inc, Banglore
7. ***Swaminathan, M***. (2010) ***Essentials of Food and Nutrition***, Volume I and II Ganesh and Co., Madras.
8. ***Gopalan, C., Ramasastry, B.V and Balasubramanian, S***. (2007) ***Nutritive Value of Indian Foods***, National Institute of Nutrition, Hyderabad.

Practicals III - Bioinformatics and Clinical Biochemistry

Semester II **Hours of instruction/week: 5**

17MBCC11 **No. of credits: 3**

Objectives:

1. To work with basic Bioinformatics tools for biological sequence analysis
2. To familiarize with the use of Bioinformatics tools for biological structure analysis
3. To gives hand on training clinical biochemistry techniques

Experiment

1. Introduction to biological databases, Use of searching tools – Entrez, BLAST and FASTA	**5 hrs**
1. Pairwise alignment of sequences – near and far relative sequence in dentification	**5 hrs**
3. Multiple alignment – Clustal – NJ plot – PHYLIP – construction of phylogenetic trees	**5 hrs**
4. Molecular visualization – Downloading atom co-ordinates from pdb – using the co-ordinate file to view the molecules using molecular visualization tools – RasMol, WebLab Viewer, ChemDraw, ISIS Draw, Deep View	**10 hrs**
5. Biology Workbench – retrieval of sequences, alignment of sequences, phylogenetic tree building – rooted and unrooted trees – alignment presentation method – secondary structure prediction of proteins	**10 hrs**
6. Gene finding programs	**5 hrs**
7. Protein Analysis Tools	**5 hrs**
8. EMBOSS tools for sequence analysis	**5 hrs**
9. Computer-aided drug design and analysis – demonstration of the modules of Schrodinger Drug Design Suite	**5 hrs**
10. GTT	**5 hrs**
11. Estimation of serum lipid profile	**5 hrs**
12. Liver Function Test	**5 hrs**
13. Kidney Function Test	**5 hrs**
	Total 75 hrs

Practicals – IV Molecular Biology

Semester II **Hours of instruction/week: 6**
17MBCC12 **No. of credits: 3**

Objectives:

1. To train the students for isolation and estimation procedures used to quantify
2. Nucleic acids and Proteins
3. To give hands – on - training to students on methods and techniques involved in Molecular Biology

Experiment

1.	Isolation and estimation of DNA from Mammalian cells DNA – Diphenylamine method and UV absorption	**5 hrs**
2.	Isolation and estimation of RNA from mammalian cells RNA – Orcinol method and UV absorption	**5 hrs**
3.	Isolation and estimation of Protein mammalian cells Protein – Lowry's method	**5 hrs**
4.	Agarose gel electrophoresis of DNA	**5 hrs**
5.	Isolation of genomic DNA from plant cells Estimation by UV and agarose gel electorphoresis	**5 hrs**
6.	Isolation of RNA from yeast	**5 hrs**
7.	Isolation and purification of plasmids a. Alkaline lysis method b. Acid-phenol extraction for genomic DNA c. Agarose gel electrophoresis of Plasmid DNA	**5 hrs**
8.	Preparation of competent cells – $DH5\alpha$ 4	**6 hrs**
9.	Transformation of *E.coli* cells and characterization of transformants a. Transfection of plasmid b. Plating and selection of transformants c. Slot lysis for confirmation of transformants	**6 hrs**
10.	Restriction digestion of DNA (lambda DNA)	6 **hrs**
11.	Purification of DNA on LMP agarose	**6 hrs**
12.	Polyacrylamide gel electrophoresis (SDS and 2D PAGE)	
13.	Southern blot (demonstration)	**6 hrs**
14.	DNA sequencing and silver staining of sequenced gels (demonstration)	**5 hrs**
15.	Polymerase Chain Reaction for amplification of DNA (demonstration)	**5 hrs**

Total 90 hrs

References:

1. ***Michel, R. and Sambrook, J.*** (2014), Molecular Cloning: A laboratory manual, 4th Ed, Vol 1, 978- 1-621821-04-5, Cold Spring Harbor Laboratory Press.
2. ***Maniatis, T., Fritsch, E.F. and Sambrook, J***. (2012) ***Molecular Cloning,*** Vol, 1- Cold Spring Harbor, New York

Immunology and Immunotechnology

Semester III **Hours of instruction/week: 4**
17MBCC14 **No. of credits: 3**

Objectives

1. To have a key understanding of the components of the immune system, their functions and interactions.
2. To understand the immune mechanisms involved in disease conditions.
3. To impart knowledge on the latest techniques in immunology.

Unit I ***The Immune System*** **12 hrs**

History of immunology - Cells and Organs of the immune system-structure and functions of the cells of the lymphoid and myeloid lineages and primary and secondary lymphoid organs.
Differentiation and Generation of T-cells and B-cells from bone marrow. B-cell receptors and T-cell receptors.
Stem cells - sources, types, properties & applications.
Antigens – types and characteristic features, antigenicity & immunogenicity, epitopes, cross reactions. Haptens and mitogens
Antibodies – basic structure, types of immunoglobulins- structure, properties and functions, immunoglobulin super family.
Complement cascades - components, mechanism of Classical, Alternative and other pathways, biological consequences of complement cascades and their fragments.
Self study: History of immunology.

Unit II ***Immunity and Immune Response*** **12 hrs**

Types of immunities -Innate and Acquired.
Immune response-Humoral and Cellular immune responses-their characteristics & effector mechanisms. Regulation of immune response.Immune response to infections-bacterial, viral, fungal and others.
Immunodeficiency diseases-primary and secondary.
Self study: Immunodeficiency diseases.

Unit III ***Hypersensitivity and Autoimmunity*** **12 hrs**

Hypersensitivity – classification, causes, mechanism, clinical manifestations, diagnosis and treatment of Types I – IV hypersensitivities.
Autoimmunity- classification, spectrum of autoimmune diseases, overlap, pathogenesis, diagnosis and treatment of autoimmune diseases.
Self study: Classification and spectrum of autoimmune diseases.

Unit IV ***Immunogenetics and Transplantation Immunology*** **12 hrs**

Immunogenetics- antibody diversity- theories of antibody formation, organization of immunoglobulin genes and their expression, class switching.
Major Histocompatibility Complex- organization, structure and functions of MHC and HLA genes and non - MHC molecules. Gene products. Role in antigen processing and presentation. Role of MHC in transplantation, disease susceptibility and resistance and genetic control of primary histocompatibility.

Transplantation- types of grafts, principles involved and mechanism of transplantation of various organs, immunosuppressive therapy, graft rejection.
Self study: Organization of immunoglobulin genes and their expression, class switching.

Unit V *Immunotechniques* **12 hrs**

Principles of antigen-antibody interactions- characteristics features.
Precipitation techniques-immunodiffusion and immuno electrophoresis.
Agglutination techniques- haemagglutination, ABO blood grouping & Rh typing.
Tagged assays- RIA, ELISA, immunofluorescence, immunoblotting, immunoelectron microscopy.
Isolation of pure antibodies, Assays for complement, FACS, Flow cytometry.
Antibody engineering - Hybridoma technology- polyclonal and monoclonal antibody production and their applications. Recombinant antibody production.
Vaccine production- types of vaccines, principles of vaccine production, production of conventional and modern vaccines, new vaccine strategies and vaccines under development. Adjuvants- types and properties.Vaccination strategies, immunization schedules.
Self study: New vaccine strategies and vaccines under development.

Total 60 hrs

References

1. ***Peter J. Delves, Ivan Maurice Roitt, Seamus J.Martin and Deninis Burton*** (2016). ***Essential Immunology,*** 13th edition, Wiley Blackwell Scientific Publications, London.
2. ***Fathimunisa Begum*** (2014). Immunology, PHI Learning.
3. ***Judy Owen, Jenni Punt and Sharon Stanford***, (2012), ***Kuby Immunology***,7th edition, W.H.Freeman and Company, New York, USA.
4. ***Ian R.Tizard*** (2012), ***Veterinary Immunology***, 9th edition, W.B.Saunders Co., Philadelphia.
5. ***Madhavee Latha P.*** (2012). Textbook of Immunology, 1st edition, S. Chand Publishers.
6. ***Basir Seemi Farhat*** (2012). Textbook of Immunology, 2nd edition, PHI Learning.
7. ***Talaro, K.P, Barry Chess and Talaro,A.*** (2011). ***Foundations in Microbiology***, 8th edition, McGraw Hill Publishers , New York.
8. ***Hannigan, B.M.*** (2010). Immunology, 2nd edition, Viva Books
9. ***Kuby, J. Goldsby,R.A., Kindt,T.J. and Osborne, B.A***. (2007). ***Immunology***, 6th edition, W.H.Freeman and Company, NewYork, USA.
10. ***Rao, C.V***. (2006). ***An Introduction to Immunology***, 2th edition, Narosa Publishing House, Delhi, Chennai, Mumbai, Kolkata.

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Physiology, Biochemistry and Biotechnology of Plants

Semester III **Hours of instruction/week: 4**
17MBCC15 **No. of credits: 3**

Objectives

1. To understand the functions and regulation of major biosynthetic pathways in plants.
2. To become familiar with the exciting topics in plant biology research from agricultural genomics to IPR and patenting
3. To appreciate the relevance of plant physiology to industry and the survival of humanity**.**

Unit I *Photosynthesis and Electron transport system in plant* **12 hrs**

Photosynthetic apparatus, pigments of photosynthesis, role of carotenoids, photosystems I and II, their location; Hill reaction, photosynthetic electron transport and generation of NADPH & ATP, cyclic and non-cyclic photophosphorylations, complexes associated with thylakoid membranes; light harvesting complexes, path of carbon in photosynthesis – $C_{3,}$ C_4 and CAM pathway of carbon reduction and its regulation, Photorespiration

ETC - oxidative phosphorylation, mitochondrial respiratory complexes, order and organization of electron carriers, electrochemical gradient, chemiosmotic theory and ATP synthesis

Self study: CO2 and green house gases and their effect on biodiversity, artificial leaves

Unit II *Proximate principles in plants* **12 hrs**

Storage proteins - Classification and function; polysaccharides – sucrose, raffinose, starch and cellulose; lipids – classification and function, defense signals

Phytochromes, cryptochromes and phototrophins.

Self study: Secondary metabolites and their functions

Unit III *Biochemical changes and regulation of gene expression* **12 hrs**

With specific reference to floral development, seed development and germination, biotic and abiotic stresses.

Nitrogen fixation - Basic concepts, nif genes and their regulation, potential scope in crop improvement nitrate and ammonia assimilation: amino acid biosynthesis.

Self study: The Nitrogen cascade and its effect on environment

Unit IV *Gene mapping* **12 hrs**

Concept of linkage maps, physical maps and genetic maps. Molecular markers (RFLP, RAPD, AFLP, SSR, SNP, STS).

Rice genome sequencing, strategies used for sequencing. Applications of genome projects. New generation sequencing strategies.

Self study: DNA fingerprinting and Basmathi rice patent

Unit V *Principles of Gene Manipulation in Plants* **12 hrs**

In vitro culture of plants. Concept of totipotency, types of in vitro culture – meristem culture, organ culture, protoplast culture and protoplast fusion, embryo culture and embryo rescue. Initiation and maintenance of in vitro cultures (callus and organ cultures). Embryogenesis and organogenesis.

Micropropagation and commercial tissue culture. Application of organ culture for secondary

metabolite production (case of withanolide production).
Genetic engineering in plants, plant transformation vectors, Ti plasmids, Direct transformation by physical methods. Transformation in *Oryza sativa* and *Arabidopsis thaliana*.
Self study: Steps involved in the development of golden rice
Case study: Status of BT cotton in India

Total 60 hrs

References:

1. ***Buchanan, B.B., Gruissem,W. and Jones, R.L.,*** (2002); ***Biochemistry and Molecular Biology of Plants;*** ISBN: 978-0-943088-39-6; American Society of Plant Physiologists, 2nd Indian Reprint (2007), I.K. International Pvt. Ltd. N. Delhi.
2. ***Russell Jones, Helen Ougham, Howard Thomas, Susan Waaland***, (2012), ***The Molecular life of Plants,*** ISBN 978-0-470-87011-2; Wiley-Blackwell Publishers
3. ***Heldt Hans-Walter and Birgit Piechulla***, (2011); ***Plant Biochemistry***, 4th Edition, Elsevier Academic Press Publication, USA.
4. ***Lincoln Taiz, Eduardo Zeiger***, (2010); ***Plant Physiology: International Edition*** (5th Edition); ISBN-13: 978-0123849861, Elsevier Academic Press Publication, USA.
5. ***Jeyanthi, G.P*** (2009), ***Molecular Biology***, MJP Publishers, Chennai.
6. ***Sathyanarayana, B.N*** (2007); ***Plant Tissue Culture : Practices and New Experimental Protocols***; I.K.International Pvt. Ltd.

Genetic Engineering

Semester III **Hours of instruction/week: 4**
17MBCC16 **No. of credits: 3**
Objectives:

1. To understand the principle of recombinant DNA technology
2. To study the techniques and application of gene transfer methods

Unit 1 ***Introduction to gene cloning*** **12 hrs**

Gene cloning – Manipulation of purified DNA, DNA manipulative enzymes – nucleases, ligases, polymerases, topoisomerases, restriction enzymes – performing restriction digests, restriction mapping, ligation – joining DNA molecules together – random labelling, nick translation and end filling – importance of gene cloning.

Self study: Isolation and Purification of DNA – Total cell DNA, Plasmid DNA and Plant cell DNA.

Unit II ***Cloning and expression vectors*** **12 hrs**

Plasmids – pBR322, pUC vectors, bacteriophages (M_{13} and λ), phagemids, cosmids, yeast vectors, YAC, BAC, Ti Plasmid, Ri Plasmid

Self study: Viral vectors

Unit III ***Gene transfer methods*** **12 hrs**

Biolistics, electroporation, microinjection, liposome – mediated method, calcium phosphate method, Agrobacterium mediated gene transfer, Viral mediated gene Transfer - Transgenic animals and birds (any two)

Self study: Intellectual Property Rights and types and Patenting.

Unit IV ***Identification and expression of cloned genes*** **12 hrs**

Studying gene and genome structure, construction of libraries, blotting techniques, *in situ* hybridization, DNA sequencing, chromosome walking and jumping, DNA foot printing, DNA finger printing, RFLP, RAPD, HRT and HART

Self study: PCR and its applications

Unit V ***Applications of genetic engineering*** **12 hrs**

Applications of genetic engineering - in medicine: pharmaceutical compounds, insulin production, recombinant vaccine, gene therapy; in agriculture: gene addition, Antisense RNA technology, insect and virus resistant plants - herbicide tolerant plants. in environmental management and industry

Self study: Gene therapy

Total hours **60 hrs**

References:

1. ***Brown, T.A.,*** (2007), ***Gene cloning and DNA analysis***, 6 th edition John Wiley & Sons, New York
2. ***Tamarin, R.H.,*** (2007), ***Principles of Genetics***, 7th Ed., TMH Publishing Company, New Delhi.
3. ***Russell Jones, Helen Ougham, Howard Thomas, Susan Waaland,*** (2012), ***The Molecular Life of Plants***, Wiley Blackwell publishers.
4. ***Peter J. Russell.,*** (2013) ***Genetics***, 5 th Edition, Pearson Benjamin Cummings, New York.

5. ***Gardner, E.J., Simmons, M.J and Snusted, D.P*** (2006), ***Principles of Genetics***, Eighth Ed, John Wiley & Sons, New York.
6. ***Nicholl D S T (2010),Introduction to genetic engineering 3rd edition,*** Cambridge India

Advanced Enzymology

Semester III **Hours of instruction/week: 4**
17MBCC17 **No. of credits: 3**
Objectives:

- To enlighten the students about enzyme kinetics
- To help the students to understand the mechanism of action of enzymes
- To help the students to learn the applications of enzymes

Unit I *Structure and organization of protein* **12 hrs**

Protein: peptide bond, peptides, Forces that determine the structure of proteins- short range repulsions, electrostatic force, van der waals interaction, hydrogen bond and hydrophobic interaction. Primary structure and its determination. The Ramachandran plot, secondary structure: α-helix, 3_{10} and π helix, β- sheets, reverse turns and super secondary structures. Tertiary structure and quaternary structure: myoglobin and hemoglobin, collagen.
Protein sequencing- chemical and enzymatic protein fragmentation, amino acid sequence analysis
Self study: Mass spectrometry in protein sequencing

Unit II *Classification and Enzyme kinetics* **12 hrs.**
Nomenclature and classification of enzymes, co-enzymes and cofactors: water soluble vitamins and their coenzymes, metallo enzymes, methods for measuring kinetics and rate constants of enzymatic reaction and their magnitudes. Purification of enzymes: Methods to isolate and purify enzymes, assays, activity units, specific activity.
Active site - determination of active site amino acids - chemical probe, affinity label, and site-directed mutagenesis, intrinsic and extrinsic regulations
Classification of multisubstrate reaction, kinetics of multisubtrate reaction, derivation of rate of expression for Ping Pong and ordered Bi-Bi reaction mechanism, random order and compulsory order mechanism, use of initial velocity, inhibition and exchange studies to differentiate between multisubstrate reaction mechanisms.
Self study : Kinetics of single substrate - Michaelis-Menten equation, Lineweaver Burk plot, Eadie- Hofstee plot, Eisenthal and Cornish - Bowden plot and Hanes plot

Unit III *Mechanism of action of enzyme and inhibition* **12 hrs.**
Methods of examining enzyme-substrate complexes, Enzyme turnover and methods employed to measure turnover of enzymes, significance of turnover. Enzyme specificity.
Mechanism of Enzyme Action – Acid-base catalysis, covalent catalysis, proximity, orientation effect. Strain & distortion theory. Mechanism of action of ribonucleaseand triose phosphate isomerase.
Enzyme inhibitions: reversible inhibition - kinetics of competitive - non-competitive and uncompetitive inhibition, Dixon Plot. Irreversible inhibition.
Allosteric enzymes, sigmoidal kinetics and their physiological significance, symmetric and sequential modes for action allosteric enzymes and their significances, Half site reactivity, Flip-flop mechanism. Protein-ligand binding, measurement and analysis of binding isotherms, cooperative phenomenon, Hill and Scatchard plots.

Self study: positive and negative co-operativity with special reference to aspartate transcarbamoylase & Phosphofructokinase, DNA and RNA enzymes, Abzymes, Isoenzymes

Unit IV: ***Enzyme regulation and multienzyme complex*** **12 hrs.**

General mechanisms of enzyme regulation: Feedback inhibition and Feed forward stimulation, Enzyme repression, induction and degradation, control of enzymic activity by products and substrates. Reversible (glycogen phosphorylase) and irreversible (protease) covalent modification of enzymes, monocyclic and multicyclic cascade.

Multienzyme system: occurrence, isolation and their protperties, polygenic nature of multienzyme systems.

Self study: mechanism of action and regulation of Pyruvate dehyrogenase and fatty acid synthetase complex

Unit V ***Applications of enzymes*** **12 hrs.**

Immobilized enzymes and their industrial applications. Effect of partition on kinetics and performance with particular emphasis on changes in pH and hydrophobicity. **Clinical enzymology**: enzymes as thrombolytic agents, anti inflammatory agents, debriding agents, digestive aids. Therapeutic enzymes. Enzymes in diagnosis. **Industrial applications**: Food, leather, detergent, textiles and paper industry. **Rationale of enzyme engineering**: basic assumptions of protein engineering ,Rational and irrational design approach - site directed and random mutagenesis - fusion proteins containing enzymes and their application.

Self study: Methods of enzyme immobilization, biosensors

Total 60 hrs

References:

1. ***Cornish-Bowden, A.*** (2012) ***Fundamentals of Enzyme Kinetics,*** Wiley-VCH Verlag GmbH, Germany.
2. ***Price, N.C. and Steven, L.*** (2000) ***Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins,*** 3rd Edition, Oxford University Press
3. ***Khan, M.Y. and Khan, F***. (2015) ***Principles of Enzyme Technology***, PHI Learning
4. **Leskovac, V.** (2003) ***Comprehensive Enzyme Kinetics***, Springer Sciences
5. ***Buchholz, K., Kasche, V. and Bornscheur, L.T***. (2012) ***Biocatalyst and Enzyme Technology***, Wiley-VCH Verlag GmbH, Germany.
6. ***Palmer, T.*** (1995) ***Understanding of Enzymes***, 4th Edition, Prentice Hall
7. ***Nelson, D.L. and Cox, M.M*** (2013), ***Lehninger Principles of Biochemistry***, 7th Ed, W.H. Freeman and Company, New York
8. ***Voet, D and Voet, G***. (2012), **Fundamentals of *Biochemistry***, John Wiley and Sons, New York.

Practicals V- Enzymology and Immunology

Semester III **Hours of instruction/week: 6**
17MBCC18 **No. of credits: 4**

Objectives

1. To isolate, purify and study a selected enzyme like amylase.
2. To apply the principles of immunology in studying antigen-antibody interactions.

Enzymology

1.	Isolation of amylase from saliva and partial purification by ammonium sulphate precipitation.	**15 hrs**
2.	Assay of isolated & purified amylase.	**8 hrs**
3.	Characterization of amylase - effect of pH, temperature, substrate concentration and metal ions on the activity of amylase .	**15 hrs**

Immunology

1.	Preparation of any one antigen	**8 hrs**
2.	Isolation of lymphocytes	**8 hrs**
3.	Precipitation techniques - Single radial immunodiffusion, Double immunodiffusion, Rocket electrophoresis, Counter current immunoelectrophoresis, Immunoprecipitation and Precipitin ring test	**15 hrs**
4.	Agglutination techniques- Blood grouping and Haemagglutination	**7 hrs**
5.	Tagged assays - Radio immunoassay, Enzyme Linked Immunosorbent Assay and Western blotting	**14 hrs**
	Total	**90 hrs**

References

1. ***Sadasivam, S. and Manickam, A.*** (2008). ***Biochemical Methods***, 3rd Edition, New Age International (P) Ltd. Publishers.
2. ***Nigam Arti and Ayyagari Archana*** (2007). ***Lab Manual in Biochemistry, Immunology and Biotechnology,*** Tata McGraw Hill Publishing**.**
3. ***Franck C.Hay and Olwyn M.R.Westwood*** (2002), ***Practical Immunology***, 4th Edition, Blackwell Scientific Publishers.

Practicals - VI Tissue Culture

Semester III **Hours of instruction/week: 5**
17MBCC19 **No. of credits: 3**

Objectives:

- To introduce the basic principles of *in vitro* culture techniques
- Understand the differences between growth and differentiation of animal and plant cell cultures

	Contents	Hours
	Plant Tissue culture	
1	Principles of tissue culture and media preparation	5
2	Influence of PGR on plant cell cultures	10
3	Influence of PGR on plant organ cultures	10
4	Large scale culture of plant organs in bioreactors	5
	Animal Tissue Culture	
5	Media preparation – filter sterilization – serum preparation - initiation and maintenance of primary cultures – maintenance of established cell lines	10
6	Staining of cells and observation under microscope	5
	Phytochemical analysis	
7	Qualitative analysis of phyto-chemicals	10
8	Quantitative analysis of secondary metabolites – saponins, flavanoids, phytosterols, alkaloids	10
	Separation of secondary metabolites by paper, thin layer and column chromatography	5
9	HPTLC analysis of secondary metabolites – Estimation of quercetin	5
	Total	**75**

References

1. ***Vargas, V.M. and Flota, F.V.*** (2006), ***Plant cell culture protocols*** 2nd Edition, Humana Press.
2. ***Freshney, I.F*** (2010), ***Culture of animal cells: A manual of basic techniques and specialized applications.*** Wiley Blackwell publishers.

Environmental Biochemistry
(Self study)

Semester III **Hours of instruction/week: 1**
17MBCC20 **No. of credits: 4**

Objectives

1. To understand the structure and importance of environment.
2. To learn about pollution aspects of environment
3. To understand the effect of environment on human activity

Unit I *The Environment* **3 hrs**

a) Structure and composition of atmosphere
b) Physico-chemical and biological factors in the environment.
c) Concept of habitat and niche.

Unit II *Ecosystem* **3 hrs**

a) Introduction –structure, components, types and functions.
b) Food chain, food web.
c) Ecological pyramids and energy flow.

Unit III *Biogeochemical cycles* **3 hrs**

a) Introduction.
b) Carbon, nitrogen, sulphur, phosphorus and oxygen cycles.
c) Structure and function of terrestrial ecosystem.

Unit IV *Pollution* **3 hrs**

a) Introduction –Types of wastes.
b) Air pollution-sources, effects, air quality indices.
c) Noise pollution-sources, effects, prevention. Noise quality indices.
d) Water pollution-solid waste management causes, effects and control measures of urban and industrial waters.
e) Treatment of waste water.

Unit V *Disaster management* **3 hrs**

a) Types of environmental hazards and disasters.
b) Flood, earthquake, cyclone and landslides.
c) Pre disaster stage, emergency stage and past disaster stage. Integrated approach.
d) Role of institutions and media.

Total 15 hrs

References:

1. ***Kumar, A.*** (2010*) **Disaster Management –Recent approaches***. Animolpublishers.
2. ***Gwendo, B., Ben, L., singh and Theodore, L.*** (2005) ***Hand book of Environment Management and Technology***. John Wiley and Sons, New York.
3. ***De, A.K.*** (2000) ***Environmental Chemistry*** 4th edition. New Age International publishers. New Delhi.
4. ***Arumugam, N.*** (2006) ***Concepts of Ecology Environmental Biology***. Sara Publication. Nagerkoil.
5. ***Thyagi.O.P.*** (2000) **A Textbook of Environmental Chemistry,** Animol Publications, New Delhi.

Neurochemistry

Semester IV **Hours of instruction/week: 3**
17MBCC22 **No. of credits: 3**

Objectives

- To learn the components and features of the nervous system .
- To understand axonal and synaptic neurotransmission, the role of neurotransmitters and neuropeptides and ion channels.
- To study the significance of the blood- brain barrier and blood-CSF barrier
- To understand various types of neurodegenerative disorders..

Unit I - Neuromorphology and Neurocellular Anatomy **9 hrs.**

Divisions of the nervous system - Central nervous system and Peripherel nervous system . Structure and Organization of neurons .. Axonal and Synaptic neurotransmission. Electrical excitability and Ion channels.

Self study: Neurotubules and Neurofilaments

Unit II – Neurotransmitters and Neuropeptides **9 hrs.**

Synthesis. Storage and Release of GABA, Glycine, Glutamate, Aspartate, Adrenaline, Nor-Adrenaline, Dopamine, Serotonin, Histamine, Acetylcholine, Nitric oxide, Substance P, Endorphins, Enkephalins, Vasopressin, Oxytocin, CCK and Neuropeptide Y. Role of neuropeptides in obesity and pain.

Self study: Effects of drugs on synapse.

Unit III - Chemical composition of Brain **9 hrs.**

Types, Characteristics, Biosynthesis, and Catabolism of Major brain lipids,

Self study: EPSP and IPSP

Unit IV - Blood-Brain Barrier and Blood-CSF barrier **9 hrs.**

Formation and Transport of Cerebrospinal fluid . Characteristics and Functions of blood - brain barrier . Transport of glucose, amino acids , ions , macromolecules and drugs across blood - brain barrier and blood - CSF barrier.

Self study: Similarities and Differences between Blood -Brain Barrier and Blood – CSF Barrier.

Unit V- Neurodegenerative disorders **9 hrs.**

Etiology, Symptoms, Pathogenesis, Diagnosis and Treatment of Alzheimer's disease, Parkinson's disease, Schizophrenia, Huntington's disease, Amyotrophic Lateral Sclerosis, Senile Dementia.

Self study: Epilepsy

Total 45 hrs.

References

1. ***Sherman, J*** and ***Luciano, D***. (2017). ***Human Physiology,*** 13th edition, McGraw Hill Publishing Company.
2. ***Eric J.Nestler*** and ***Steven E. Hyman*** (2015). ***Molecular Neuropharmacology,*** 3rd edition, McGraw Hill, New York.
3. ***Michael McKinley*** and ***Valerie Dean O' Houghlin*** (2014). ***Human Anatomy***, 5th edition, McGraw Hill Publishing Company.
4. ***Grabouski, T.*** (2013). ***Principles of Human Anatomy and Physiology,*** 14th edition, John Wiley and Sons.
5. ***George J.Siegel*** and ***Wayne Albers, R.*** (2011). ***Basic Neurochemistry,*** 8th edition, Academic Press.
6. ***Eric. P. Widmaier., Hershel Raff*** and ***Kevin-T. Strang.*** (2008). ***Vander's Human Physiology***, 11th edition, McGraw Hill Publishing Company.
7. ***Glen Baker*** (2007). ***Handbook of Neurochemistry and Molecular Neurobiology,*** Springer Publicatons.
8. ***David Fitzpatrick., Antony-Samuel Lamantia., Dale Pures, William C.Hall*** and ***George J. Augustine*** (2007). ***Neuroscience,*** 5th edition, Sinaller Associates.
9. ***George M.D.Siegel*** (2006). ***Basic Neurochemistry***, 8th edition, Elsevier Publications Amsterdam, Boston.
10. ***Afifi, A.K.*** and ***Bergrman, R.A***. (2005). ***Functional Neuroanatomy***, 2nd edition, McGraw Hill International.
11. ***Frederic H. Martini and Michael J. Timmons*** **(**2005). Human Anatomy, 5th edition.
12. ***Elaine K. Perry, Heather Ashton and Allan H. Young*** (2002). ***Neurochemistry of Consciousness,*** 1st edition**,** John Benjamins Publishing Co.

Biostatistics and Research Methodology
(Open Book Test)

Semester IV **Hours of instruction/week: 4**
17MBCC23 **No. of credits: 3**

Objectives:

1. To understand the statistical tools commonly used in biological research
2. To assimilate the concepts of hypothesis testing and its importance in research
3. To know the aspects fundamental to research and to understand the methods of research
4. To know the nuances of technical writing of scientific documents like thesis and journal articles

Unit I ***Statistical survey and data collection*** **12 hrs**

Statistical survey – Organization of a statistical survey, methods of data collection, data representation, diagrammatical and graphical representation of data

Sampling fundamentals – need for sampling, properties of an ideal sample, sampling procedures

Self study: Frequency distributions, sampling distributions, standard error

Unit II ***Measures of central tendency, deviation, correlation and regression*** **12 hrs**

Measures of central tendency – arithmetic mean, median, mode

Measures of deviation – range, quartile deviation, variance, standard deviation

Correlation and regression – correlation analysis and regression analysis

Self study: Relationship between mean, median and mode; pros and cons of the measures of central tendency and deviation; applications of correlation and regression

Unit III ***Probability and hypothesis testing*** **12 hrs**

Probability and theoretical distributions – probability definition, types, binomial, Poisson and normal distributions, large and small samples, degrees of freedon

Hypothesis testing – Formulation of null and alternate hypotheses, testing the hypothesis, Student's *t* test, Chi square test and goodness of fit, Analysis of Variance (one way and twoway only), acceptance and rejection of hypothesis

Self study: Simple problems on probability, theoretical distributions, hypothesis testing; importance of hypothesis testing

Unit IV ***Research methodology*** **12 hrs**

Research methodology – meaning of research, objectives of research, types of research, research methodology and research designs, single blind and double blind trials

Inclusion and exclusion criteria – importance of inclusion and exclusion criteria in animal and human research with special reference to clinical research (elementary concepts only), examples and case studies

Self study: Random block design; importance of single blind and double blind studies

Unit V ***Report Writing*** **12hrs**

Writing a thesis – layout of the thesis, preparing the components of the thesis – hypothesis, abstract, introduction, review of literature, methodology, results, discussion, summary and conclusion, references

Writing a journal article – format of an article – journal requirements – differences between the thesis components and article components; abstract preparation – concise presentation, outline of work presented; keywords – list of important technical terms; main article – introduction, materials and methods, results, discussion, presentation of tables, figures and graphs, conclusion, acknowledgement, references, conflicts of interest

Avoiding plagiarism – definition of plagiarism, ethical issues, copyright issues

Self study: Different formats of thesis; plagiarism-detection software; ShobhGanga and ShobhGangotri

Total 60 hrs

References:

1. ***Gupta, S.P.*** (2010) ***Statistical methods***, Sultan Chand and Sons, New Delhi.
2. ***Gurimani N*** (2008) ***An introduction to Biostatistics***, M.J.P. Publishers, Chennai.
3. ***Banerjee, P.K***. (2008) ***Introduction to Biostatistics***, S. Chand and Co., New Delhi.
4. ***Kothari, C.R.*** (2004) ***Research Methodology, Methods and Techniques***, II Edition, New Age International Publishers, New Delhi.
5. ***Day, R.A***. (2006) ***How to write and publish a scientific paper***, Cambridge University Press, UK.
6. ***Alred, G.J., Bursaw, C.T. and Oliu, W.E.*** (2003) ***The Handbook of Technical Writing***, McGraw Hill Publishers, New Jersey.