



Deccan Education Society's
Fergusson College (Autonomous)
Pune

for 2 years M.Sc. Programme

as per guidelines of

NEP-2020

for

F. Y. M. Sc. (Biochemistry)

With effect from Academic Year

2023-2024

M. Sc. Biochemistry
Programme Structure

Semester	Paper Code	Paper Title	Credits
I	CHB-501	Biomolecules	4
	CHB-502	Microbiology and Cell Biology	4
	CHB-503	Enzymology and Biophysical Techniques	4
	OR		
	CHB-504	Clinical Nutrition and Food Technology	
	CHB-510	Research Methodology	4
	CHB-520	Biochemistry Practical – I	2
	CHB-521	Biochemistry Practical – II	2
	Total Semester Credits		
II	CHB-551	Metabolism	4
	CHB-552	Genetics and Membrane Biochemistry	4
	CHB-553	Techniques in Characterization of Biomolecules	4
	OR		
	CHB-554	Molecular Oncology & Animal Cell Culture	
	CHB-560	On Job Training /Field Project	4
	CHB-570	Biochemistry Practical III	2
	CHB-571	Biochemistry Practical IV	2
	Total Semester Credits		
Total PG-I Credits			40

OJT: On Job Training; Internship/ Apprenticeship; FP: Field project

Program Outcomes (POs) for M. Sc. Programme	
PO1	Disciplinary Knowledge: Demonstrate comprehensive knowledge of the discipline that forms a part of a postgraduate programme. Execute strong theoretical and practical understanding generated from the specific programme in the area of work.
PO2	Critical Thinking and Problem solving: Exhibit the skill of critical thinking and understand scientific texts and place scientific statements and themes in contexts and also evaluate them in terms of generic conventions. Identify the problem by observing the situation closely, take actions and apply lateral thinking and analytical skills to design the solutions.
PO3	Social competence: Exhibit thoughts and ideas effectively in writing and orally; communicate with others using appropriate media, build effective interactive and presenting skills to meet global competencies. Elicit views of others, present complex information in a clear and concise and help reach conclusion in group settings.
PO4	Research-related skills and Scientific temper: Infer scientific literature, build a sense of enquiry and be able to formulate, test, analyse, interpret and establish hypothesis and research questions; and to identify and consult relevant sources to find answers. Plan and write a research paper/project while emphasizing on academics and research ethics, scientific conduct and creating awareness about intellectual property rights and issues of plagiarism.
PO5	Trans-disciplinary knowledge: Create new conceptual, theoretical and methodological understanding that integrates and transcends beyond discipline-specific approaches to address a common problem.
PO6	Personal and professional competence: Perform independently and also collaboratively as a part of a team to meet defined objectives and carry out work across interdisciplinary fields. Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PO7	Effective Citizenship and Ethics: Demonstrate empathetic social concern and equity centred national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PO8	Environment and Sustainability: Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO9	Self-directed and Life-long learning: Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Program Specific Outcomes (PSOs) for M. Sc. Biochemistry	
PSO No.	Program Specific Outcomes(PSOs) Upon completion of this programme the student will be able to
PSO1	Academic competence (i) Articulate fundamental concepts, principles and processes underlying the field of biochemistry and its different branches (ranging from biomolecules, metabolism, nutrition, cell biology, genetics, enzymology, immunology, physiology, endocrinology, plant biochemistry, molecular biology to genetic engineering, neurochemistry) and its linkage with related disciplinary areas/subjects. (ii) Demonstrate an understanding and be able to explain a wide range of biochemical techniques (e.g. basic molecular biology, genetic engineering, microbiology methods, spectrophotometry, enzyme kinetics, chromatography, electrophoresis, immunological assays)
PSO2	Personal and Professional Competence (i) Execute critical thinking and be capable in experimental data interpretation and carry out laboratory-oriented numerical calculations. (ii) Identify biochemistry related problems and use appropriate concepts and methods to solve them. (iii) Formulate scientific protocols, write authentic reports and develop effective presentation and conversational competence.
PSO3	Research Competence (i) Review scientific literature, develop a hypothesis and formulate scientific protocols and conduct appropriate experiments. (ii) Plan and execute research projects professionally while emphasizing on academic and research ethics, scientific misconduct and creating awareness about intellectual property rights and issues of plagiarism (iii) Integrate informatics and statistical skills to explore and authenticate biological data for experimental and research purpose
PSO4	Entrepreneurial and Social competence (i) Develop solutions and apply appropriate techniques towards specific areas related to biochemistry including industrial production, clinical, health, agriculture. (ii) Execute social competence including listening, speaking, observational, effective interactive skills and presenting skills to meet global competencies.

F.Y. M.Sc. Semester I		
CHB-501	Biomolecules	Number of Credits : 04
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Define biomolecules and their properties. Recall structure, sources and examples of macromolecules	6
CO2	Differentiate between structural aspects of molecules.	5
CO3	Classify biomolecules based on various criteria. Outline the steps involved in synthesis and structural studies of molecules	4
CO4	Compare the biochemical significances and deficiency of molecules	3
CO5	Evaluate in-vitro and in-vivo reactions with their biochemical correlation	2
CO6	Construct macromolecules using their monomeric building blocks. Compile their features.	1

Unit No.	Title of Unit and Contents
I	Introduction, 1.1 Biological Significance, Classification with examples. Basic structures of Monosaccharides- Cyclisation of sugars according to the Fischer and Haworth formula. Anomers and Epimers. 1.2. Structures of complex carbohydrates- Disaccharides (Homo and Hetero), Oligosaccharides and Polysaccharides (Homo and Hetero). 1.3. Concept of reducing and nonreducing sugars, Mutarotation and inversion. General reactions of sugars with Phenylhydrazine, Acids, Bases, Oxidising agents and Reducing agents and its significance. 1.4. Derivatives of Sugars- Deoxy sugars, Phosphorylated sugars, Sulfated sugars, Amino sugars, Acetylated sugars, and Sugar acids, Sugar alcohols and its significance.

II	Lipids: 2.1 Introduction, Biological Significance, Classification with examples. Basic structures of major lipid subclasses- Types of fatty acids, Waxes, Glycerophospholipids (Ester linked and Ether linked), Shingophospholipids, Nonphospholipids, Steroids. Essential and non-essential fatty acids. 2.2. Blood group substance. Lipoproteins- Chylomicrons, VLDL, LDL and HDL. 2.3. General chemical reactions of lipids- Hydrolysis, Saponification, Emulsification, Oxidation. Saponification Number, Acid number, Iodine number, Reichert Meissel number, Polensky number. Hydrolytic and Oxidative rancidity of lipids. 2.4. Amphipathic Lipids-Formation of micelles, monolayers, bilayer, liposomes.
III	Nucleic Acids: 3.1. Structure of Nitrogenous bases- Purines and Pyrimidines, Nucleosides, Nucleotides and Polynucleotides. 3.2. The central Dogma, DNA as genetic material 3.3. Structure of DNA. Features of denaturation and renaturation of DNA 3.4. Structure and types of RNA.
IV	Amino acids: 4.1. Introduction, Biological Significance, Classification with examples based on R group, Polarity, optical activity. Essential and Non- essential amino acids, Standard and Nonstandard amino acids. 4.2. Zwitterions and Isoelectric pH, Titration curve of amino acids. 4.3. General reactions of Amino acids with Ninhydrin, Sanger's, Dansyl chloride, Dabsyl chloride reagents. Deamination, Transamination and decarboxylation of amino acids. UV spectra of amino acids. 4.4. Peptide bond formation. Solid phase synthesis of peptides.
V	Proteins: 5.1. Classification on the basis of composition, biological role and shape. 5.2. Structural levels of protein: Primary structure – End group analysis of N and C terminus, breaking of polypeptides to small peptides using enzymes and chemical reagents, Amino acid sequencing by Edmann degradation. 5.3. Secondary structure-alpha-helix, beta pleated structure, super secondary structure. 5.4. Tertiary Structure- Forces stabilizing the structure. 5.5. Quaternary structure – Hemoglobin. Denaturation and Renaturation of proteins. 5.6. Ramachandran plot and prediction of protein structure.

VI	Vitamins and Co-enzymes: 6.1. Classification- Water-soluble and Fat-soluble vitamins. 6.2. Structure, Coenzyme forms of B-complex vitamins, Source, dietary requirements. 6.3 Biochemical functions, deficiency conditions.
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References:

1. Principles of Biochemistry, Lehninger CRS publication
2. Biochemistry, L. Stryer
3. Biochemistry Voet&Voet
4. Problem Approaches in Biochemistry. Wood and Hood
5. Physiological chemistry- Haw

F.Y. M.Sc. Semester I		
CHB-502	Microbiology and Cell Biology	Number of Credits : 04
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Define microbiology and cell biology. Describe different types of microscopes and its role in evolution of cell theory.	6
CO2	Compare prokaryotic and eukaryotic cells and explain about subcellular organelles and their functions. Evaluate the host and microbes interaction.	5
CO3	Predict the types of bacterial, plant and animal viruses along with their characteristics. Interpret the role of germ cells and stem cells.	4
CO4	Explain different processes and events occurring in the cells, their significance and describe cellular aging and cell death. Apply the role of mitosis and meiosis in cells.	3
CO5	Review the mechanisms of membrane transport and compare different types of transport mechanisms across cell membranes	2
CO6	Rearrange the processes of microbial, animal and plant cells. Integrate the subject knowledge to write and present the scientific topics and research articles	1

Unit No.	Title of Unit and Contents
	Microbiology
I	Microscopy: 1.1. Introduction: Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells 1.2. Phase contrast microscopy: principle, working and applications 1.3. Fluorescence microscopy: principle, working and applications
I	2.1 Classification of microorganisms: system of classification, identifying characters for classification, classification based on different requirements (eg. Nutrition, temperature, oxygen etc.) 2.2 Characterization methods 2.3 Cell structure and components
III	Cultivation of bacteria: 3.1. Types of growth media (natural, synthetic, complex, enriched, selective- definition with example) 3.2. Pure culture methods (streak plate, spread plate, pour plate, stab culture, slant culture), pure culture characteristics 3.3. Nutrition, physiology and growth of microbial cells, reproduction and growth, synchronous growth, continuous culture of microorganisms

IV	Agents for growth control 4.1. Control of growth by physicals and chemicals agents 4.2. Mutations by growth control agents and mutant characterization
V	Host microbe interactions 5.1. Terminology, events of infection, effect of enzyme and other factors 5.2. Endotoxins, exotoxins, capsular material. 5.3. Tissue affinity, resistance and immunity
VI	Microbial membrane transport: 6.1. Phosphotransferase system, Group translocation 6.2. Specialized mechanism for transport of macromolecules (Virus membrane assembly and ribosome).
VII	Viruses: 7.1. Viruses of bacteria, plant and animal cells: Structure, classification and lifecycle 7.2. Mycoplasma and virioids, diseases
VIII	Role of Microbes 8.1. Food spoilage and microbial food toxin.
	Cell Biology
IX	Brief Introduction about cell: 9.1 Cell theory, Cell classification, cell variability, size, shape and complexity, function
X	Animal cell and Plant cell: 10.1. Animal cell: Morphology and functions of subcellular components: Nucleus, chromatin and chromosomes, plasma membrane, ribosomes, endoplasmic reticulum, lysosomes, peroxisomes, Golgi apparatus, mitochondria, cytoskeleton 10.2. Plant cell: cell wall, chloroplast, glyoxysomes, dictyosomes, vacuoles, xylem, phloem, plant cell epidermis 10.3. Sub-cellular fractionation: Differential and density gradient centrifugation, marker enzymes
XI	Cell division and cell cycle: 11.1. Mitosis: events of different phases and its significance 11.2. Meiosis -Types, process and its significance, comparison of mitosis and meiosis, cell cycle checkpoints.

XII	Cell junction 12.1 Anchoring junctions, communicating junctions, tight junctions, gap junctions 12.2 Extracellular matrix and role of collagen, elastin and fibronectin. Plasmodesmata. 12.3 Principles and mechanism of osmo-regulation, diffusion, passive, active and facilitated transport, features of uniport, symport and antiport transport system, role of proteins in the process like exocytosis, endocytosis-phagocytosis and pinocytosis, receptor mediated endocytosis (cholesterol transport), and ATP, ADP- exchanger.
XIII	Germ cells and Stem cells: 13.1. Gametogenesis, fertilization and organogenesis: zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals. 13.2. Stem cells: Types

References:

1. Microbiology, M.S. Pelczar, R.D. Reid, E.C.S. Chan, McGraw Hill, New York (1986).
2. General Microbiology (Vth Edition), R.Y. Stanier, Prentice Hall (1986)
3. Biology of Microorganisms by Brocks
4. Introductory Microbiology, F.C. Ross, Charles Merrill Publication (1983).
5. Molecular biology and biotechnology- edited by JM Walker and FB Gingold, Royal society of chemistry (1988)
6. Industrial Microbiology – Casida
7. General Microbiology Stainer R.Y. et al (1987) 5th Ed., Macmillan Press Ltd. London
8. Biotechnology by B.D. Singh
9. Molecular Biology of the Cell, fifth addition– Bruce Alberts, Garland Science
10. Cell and Molecular Biology – DeRobertis and Saunders (1980).
11. The Cell- A molecular approach by Geoffrey M. Cooper
12. Cell Biology – C.J. Avers, Addison Wesley Co. (1986).
13. Molecular biology by Lodish and Baltimore

F.Y. M.Sc. Semester I		
CHB-503	Enzymology and Biophysical Techniques	Number of Credits : 04
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Recall basic concepts of catalyst, biocatalyst its properties and separation and purification techniques of biomolecules along with their applications	6
CO2	Articulate concepts, classification, various parameters for enzyme studies and mechanisms and applications of various types of chromatography.	5
CO3	Illustrate the types of enzymes, their structure determination, mode of reaction types of electrophoresis, applications and principles underlying the techniques. Apply the knowledge for biomolecules and enzyme separation	4
CO4	Identify the types of techniques used for separation and identification of various enzymes and other biomolecules. Compare and choose proper technique for enzyme and other biomolecule studies	3
CO5	Evaluate the type, application of enzyme, type of reaction they catalyse and separation techniques for enzyme and biomolecules	2
CO6	Specify the working mechanisms and applications of biophysical techniques for enzymes and other biomolecules. Compile methods to separate biomolecules and present the subject relevant topics/ research articles.	1

Unit No.	Title of Unit and Contents
	Enzymology
I	Classification and features of enzymes 1.1. History, Nomenclature and classification, 1.2. Remarkable properties- High catalytic power, features of active site, enzyme substrate complex formation: lock and key hypothesis, induced fit and substrate strain theory, enzyme specificity, regulation. 1.3. Concept of Isoenzymes, conjugated enzymes- holoenzyme, apoenzyme, prosthetic groups: Cofactors coenzymes, multi-enzymes.
II	Mechanism of enzymes action 2.1. Theoretical background of enzymatic reactions 2.2. Factors leading to rate enhancement of enzyme catalyzed reactions, acid-base catalysis, proximity and orientation effects, covalent catalysis, strain or distortion and change in environment, site directed mutagenesis.

III	Isolation and Purification of Enzymes 3.1. Industrially useful enzymes (Amylase, Invertase, pepsin) their isolation and purification techniques. 3.2. Immobilization of enzymes and its applications
IV	Experimental approach to Enzyme mechanics 4.1. Kinetics studies 4.2. Detection of intermediates 4.3 X-ray crystallographic studies 4.4 Chemical modification of amino acid side chain and Affinity labelling 4.5. Examples of enzymes chymotrypsin, Pyruvate dehydrogenase complex, ATP synthase, Ribonuclease.
V	Enzymes kinetics 5.1 Factors affecting enzyme activity- 5.1.1 pH 5.1.2 Temperature 5.1.3 Substrate, product and enzyme concentrations 5.1.4 Activators and enzyme inhibition –reversible and irreversible 5.2 One-substrate reactions, two substrate reactions, pre-steady state kinetics-MM equation, LB equation, significance of K_m stopped flow technique, relaxation methods.
VI	Regulation of Enzyme activity and Enzyme turnover 6.1 Allosteric regulation, Zymogen activation, phosphorylation and dephosphorylation of enzymes involved in biochemical pathways. 6.2 Ligand binding and induced changes, theoretical models, MWC –KNF models and their usefulness. 6.3. Control of activities of single enzyme: Inhibitor molecules, substrate availability or cofactor and changes in covalent structure of enzyme, 6.4. Mechanism of enzyme degradation: lysosomal degradation, ubiquitination and other cellular processes of enzyme degradation. 6.5. Enzyme turnover, K_s and K_d , correlation between the rates of enzyme turnover and structure and function of enzymes, significance of enzyme turnover.
VII	Applications 7.1 Clinical aspects and applications of enzymes, Enzymes in food analysis and processing

	Biophysical Techniques
I	U.V. and Visible Spectrophotometry
II	Membrane filtration and dialysis: 2.1.Nitrocellulose, fiberglass, Polycarbonate filters 2.2.Dialysis, reverse dialysis, glass fibre dialysis. 2.3.Freeze drying and lyophilization
III	Chromatography theory and practice: 3.1. Introduction, Partition and Adsorption principle 3.2. Brief introduction of Paper chromatography and Thin layer chromatography 3.3.Column chromatography : parameters employed in column chromatography, retention, resolution, physical basis of peak broadening plate height equation, capacity factors, peak symmetry, standard systems of chromatography and its components, stationary phase, elution. 3.4. Ion exchange chromatography-principle, method, major matrices, examples of cation and anion exchangers, applications. 3.5. Gel chromatography- principle, method, and application. 3.6. HPLC -Instrumentation, method, Separate modes: normal and reverse, detectors. Introduction: Fast protein liquid chromatography (FPLC), 3.7. GC –instrumentation, principle, procedure, applications. 3.8. Affinity chromatography-principle, method, affinity ligands, immobilization of ligands, activation of matrices, coupling affinity ligands, metal affinity chromatography, covalent chromatography, hydrophobic interaction chromatography, Special chromatographic techniques for nucleic acids: DNA cellulose chromatography, MAK hydroxyl-apatite chromatography
IV	Electrophoretic techniques: 4.1. General principles, Types of electrophoresis : moving boundary electrophoresis and zone electrophoresis (paper, cellulose-acetate electrophoresis, gel Electrophoresis) 4.2. Electrophoresis of proteins – SDS-PAGE, native PAGE, disc PAGE, gradient PAGE, Capillary electrophoresis, Isoelectric focussing, 2-D gel electrophoresis, Western blotting 4.3. Staining techniques – Coomassie and Silver staining, 4.4. Nucleic acids- Agarose gel electrophoresis, DNA sequencing gels

References:

1. Fundamentals of Enzymology by Price and Stevens
2. Enzymology by Dixon and Webb
3. Enzymes by Palmer
4. Enzymes and food processing- GG Birch, N Blackbrough (1981)
5. Physical biochemistry by D. Freifelder II edition.
6. Biochemical techniques by Wilson and Walker.
7. Biophysical techniques by Upadhyay, Upadhyay and Nath.

F.Y. M.Sc. Semester I		
CHB-504	Clinical Nutrition and Food Technology	Number of Credits : 04
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Recall daily nutrition habits and pattern in population	6
CO2	Identify basic food composition and special food in normal and disease condition	5
CO3	Interpret deficiency and malnutrition and solutions to overcome that with food and nutritional supplements	4
CO4	Explain the management of different diseases through food and nutrition	3
CO5	Criticize food toxins, additives and side effects of food toxins	2
CO6	Design the food pattern for prevention of disease and for healthy life	1

Unit No.	Title of Unit and Contents
I	1.1 Food habits and nutritional status of India: Food pattern in India with respect to location and production, effect of lifestyle, impact of modernization and technology
II	2.1 Diet in disease condition
III	3.1 Malnutrition and mental development, Behavior, Infant and Geriatric Nutrition and Tranquilizers : Types of malnutrition: Kwashiorkor- Marasmus, symptoms, diagnosis, treatment and preventive measures. Effect of malnutrition on development of the brain and behaviour. Food requirement in various stages of age
IV	4.1 Nutritional Management of Inborn Errors of Metabolism, Amino acid Therapy Inborn errors of metabolism, its causes, presumptive measures through diet
V	5.1 Food Toxins, Adverse Effects of Alcohol, Tobacco, Tea 5.1.1. Various food toxins 5.2.2. Adverse effects of alcohol, tobacco and tea
VI	6.1 Food of Animal and Plant Origin : few examples
VII	7.1 Monitoring food quality: analytical methods to check the quality
VIII	8.1 Enzymes in food analysis and processing, toxins in food. Use of alcohols, amino acids and glucose in food
IX	Biochemistry of food spoilage, principles of food preservatives: reasons, causative agents, and health effects

References:

1. Essentials of food and nutrition M Swaminathan Vol. II, Applied aspects (1974), Ganesh Pub, Madras
2. Human biochemistry – James Orten and Otto Neuhaus, 10th ed , CV Mosby co London
3. Human nutrition and dietetics-Davidson and Passmore
4. Amino acids in therapy – Leon Chaitwo, Thorsons publishers Inc. NY
5. Physiological chemistry- Hawk
6. Enzymes and food processing- GG Birch, N Blackbrough (1981)
7. Nutrition and food processing- MG Miller , G Tobin, AVI publishing Co, Creem Holm (1980)
8. Introduction to food sciences and technology –GF Stewart and MA Amerine (1973) Academic Press

F.Y. M.Sc. Semester I		
CHB-510	Research Methodology	Number of Credits : 04
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Learn the various aspects of the research process, framing useful research questions, research design, data collection, analysis, writing and presentation	6
CO2	Understand the research problem, methods/techniques to be adopted	5
CO3	Apply statistical tools for analysing the data while performing their research	4
CO4	Develop skills in qualitative and quantitative data analysis and presentation	3
CO5	Analyse for fitting, errors in the measurements and able to withdraw conclusions from the analysed data	2
CO6	Execute a quality research paper and patents in science and technology	1

Unit No.	Title of Unit and Unit Content
I	An Introduction to Research Methodology: Objectives, motivation, different types of research, significance, approaches, perception of research , criteria of good research, characteristics of good hypothesis, History of research, Ancient and modern Indian research methodologies
II	Research Process: Literature search and review, defining research topic, plan of work (case study based), maintaining laboratory records (case study based). Safety in Laboratories, Ethical considerations, field data collection, safety in the field
III	Research Data Analysis: Data collection methods, Statistical analyses and its significance, various software tools for statistical analysis, errors in the measurements, Recommended for Arts, languages: creating questionnaires, data analysis from answers.
IV	Research Publications: Writing research paper, abstract, project report, making a presentation, writing a research proposal, and intellectual property rights, academic integrity and antiplagiarism.

References:

1. 'History of the Scientific Methods' by Martin Shuttleworth, History of the Scientific Method - How Science Became Important (explorable.com)
2. 'The Statistical Analysis of Experimental Data' by John Mandel, Dover Publications (2012).
3. 'Research Methodology Methods and Techniques' by C.R. Kothari, New Age International (P) Ltd. Publishers, 2nd revised edition (2004).
4. 'Handbook of Research Methodology: A Compendium for Scholars & Researchers' by Shanti Mishra & Alok S. Educreation Publishing, (2011).
5. 'Fundamentals of Research Methodology and Statistics' by Singh Yogesh kumar, New Age International Publishers (2006).
6. 'Research Methods: The Basics' by Walliman N., Routledge Taylor and Francis Group (2010).

F.Y. M.Sc. Semester I		
CHB-520	Biochemistry Practical – I Analytical Biochemistry and Microbiology	Number of Credits : 04
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Recall and tabulate the reactions of biomolecules and different types of sterilization techniques.	6
CO2	Infer tests performed for biomolecules and important techniques for cultivation of microorganisms.	5
CO3	Apply the knowledge to identify and estimate concentration of unknown compounds and preservation of microorganisms. Demonstrate methods to study and compare different techniques for qualitative and quantitative analysis.	4
CO4	Organize, tabulate and represent information and studies with proper understanding. Execute methods to study and compare the adulteration and pasteurization in milk samples.	3
CO5	Select the exact techniques for estimation of unknown compounds. Judge the outcomes of color tests and readings. Predict the effect of U.V. radiations on growth of microorganisms and growth curves.	2
CO6	Design an experiment to study, isolate and purify a particular biomolecule, microorganisms and interpret its results. Write the experiments and prepare the journal appropriately	1

Expt. No.	Title of Experiment
1	Isolation techniques (Starch from potato, Casein from milk, egg albumin and globulin)
2	Specific reactions for Carbohydrate and its identification with suitable test
3	Detection of amino acids from mixture (qualitatively and quantitatively)
4	Estimation of carbohydrate (PSA, DNSA)
5	Estimation of Proteins (Biuret, Lowry and Bradford)
6	Estimation of DNA/RNA by DPA/Orcinol method
7	Sterilization: Steam, Dry heat and filter and Preservation of bacterial culture

8	Microscopic examination (motility, monochrome staining and gram staining).
9	Media preparation, and isolations of microorganism by pour plate, spread plate and streak plate techniques and Total viable count determination
10	Detection of common enzyme (amylase, caseinase, catalase activity)
11	Phosphatase test and Methylene blue reduction test (MBRT) for the quality of milk
12	Growth curve analysis of <i>E. coli</i>
13	Ultraviolet irradiation and survival curve
14	Antibiotic Sensitivity Test

References:

1. An introduction to practical Biochemistry – David T. Plummer, Tata Mc Graw Hill Co. Ltd., Bombay. (2015) 3rd Edition
2. Introductory Practical Biochemistry (2001). Ed. S.K. Sawhney and Randhir Singh.
3. Practical Biochemistry by Sadasivam and Manickam.
4. Practicals in Biochemistry Sadashivam Manikham

F.Y. M.Sc. Semester I		
CHB-521	Biochemistry Practical-II Enzymology & Biophysical Techniques	Number of Credits : 04
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Describe the principle, mechanism role and concentrations of reagents used in enzymology and biophysical techniques experiments	6
CO2	Estimate enzyme activity and predict the effect of various factors, activators and inhibitors on it. Explain the role of pH and describe methods for preparation of buffers.	5
CO3	Carry out isolation, purification and detection of enzymes from different sources. Calculate the concentration of solutions.	4
CO4	Demonstrate basic techniques like electrophoresis, chromatography, dialysis enzyme activities at different parameters. Infer experimental results and draw graphs.	3
CO5	Decide the absorption maxima and measure the absorbance of the reactions using UV spectrophotometers. Defend problems / questions related to theory and experiments.	2
CO6	Compile methods to separate biomolecules and present the subject relevant topics/ research articles.	1

Exp. No.	Experiment Title
	Enzymology
1.	Extraction, Isolation and detection of common enzymes (invertase/amylase/peroxidase/catalase) from natural source
2.	Assay of Enzyme activity and Specific activity
3.	To assess the effect of substrate concentration (V_{max} and K_m) on enzyme activity.
4.	Effect of temperature on enzyme activity
5.	Effect of pH, on enzyme activity
6.	To assess the effect of activator and inhibitor on enzyme activity
7.	Immobilization of enzyme and its activity
8.	Enzyme isolation and purification (Any natural source).

	Biophysical Techniques
1.	Introduction to techniques: Use of pipettes (standardization), Concept of pH, preparation of buffer of desired pH and measurement of pH
2.	Calculation, preparation of normal, molar and percentage solutions.
3.	pH metry: Acid base titration curves. Measurement of pKa of amino acids.
4.	Gel filtration chromatography/Ion exchange chromatography
5.	Paper Chromatography/Thin layer chromatography
6.	Electrophoresis: Agarose/ 1D- PAGE
7.	UV and Visible Spectrophotometry: Absorption spectra, Verification of Lamberts-Beer's Law, absorption spectrum of proteins /amino acids/molecules
8.	Dialysis, reverse dialysis and membrane filtration
9.	Density gradient Centrifugation

Reference:

1. An introduction to practical Biochemistry – David T. Plummer, Tata Mc Graw Hill Co. Ltd., Bombay. (2015) 3rd Edition
2. Introductory Practical Biochemistry (2001). Ed. S.K. Sawhney and Randhir Singh.
3. Practical Biochemistry by Sadasivam and Manickam.
4. Practicals in Biochemistry Sadashivam Manikham
5. Biochemical techniques by Wilson and Walker.
6. Biophysical techniques by Upadhyay, Upadhyay and Nath.

F.Y. M.Sc. Semester II		
CHB-551	Metabolism	Number of Credits : 04
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Recall the structure of metabolic intermediates and names of enzymes	6
CO2	Explain and illustrate the steps in biochemical pathways along with their regulations.	5
CO3	Apply knowledge of genetics and enzymology to understand the formation of specific intermediates in biochemical pathways and inborn errors of metabolism	4
CO4	Classify the types of metabolic reactions and outline the concepts of bioenergetics.	3
CO5	Justify varied conditions required for the occurrence of desired metabolic reactions..	2
CO6	Rearrange and write the correct sequence of fates of metabolic products based on the specified physiological conditions	1

Unit No.	Title of Unit and Contents
I.	Introduction of Metabolism and Bioenergetics: 1.1. Anabolism, catabolism, precursors of metabolism and its significance. 1.2. Basic laws of thermodynamics, standard free energy, enthalpy, entropy 1.3. high energy compounds, structure and significance of ATP
II.	Carbohydrate metabolism: 2.1. Carbohydrate Catabolism: Glycolysis, Gluconeogenesis, Pentose Phosphate Pathway, feeder pathways of glycolysis, fates of pyruvate under aerobic and anaerobic conditions. TCA/Kreb's cycle, Glyoxylate cycle, Uronic acid pathway, Cori's cycle. Pasteur effect. 2.2. Carbohydrate biosynthesis: Biosynthesis of starch, sucrose, cellulose, Glycogen. Reaction intermediates, enzymes, energetics & regulation of all the pathways. 2.3 Inborn errors of carbohydrate metabolism.
III.	Lipid Metabolism: 3.1 Fatty acid catabolism: Beta oxidation of saturated and unsaturated fatty acids, odd and even number fatty acids. Reaction intermediates, enzymes, energy & regulation of all the pathways. 3.2 Lipid biosynthesis: Biosynthesis of fatty acids, fatty acid synthase complex, Triacylglycerol, Phospholipids, Ketogenesis, cholesterol biosynthesis. Reaction intermediates, enzymes, energetic & regulation of all the pathways. 3.3. Inborn errors of lipid metabolism

IV.	Biological oxidation: 4.1. Structure of mitochondria, features of electron carriers, Electron transport chain in mitochondria and oxidative phosphorylation- chemiosmosis hypothesis. 4.2 ATP synthase complex and its mechanism. 4.3. Inhibitors and uncouples of ETC and OP
V.	Amino acid Metabolism: 5.1. Amino acid degradation: Amino acid oxidation and production of Urea. Reaction intermediates, enzymes & regulation of all the pathways. Significance of Transamination, oxidative deamination, Decarboxylation reactions of amino acids. 5.2 Degradation of amino acids leading to formation of Pyruvate, Acetyl CoA, α Keto glutarate, Succinyl CoA, Oxaloacetate. Reaction intermediates, enzymes & regulation of all the pathways. 5.3 Amino acid biosynthesis: Synthesis of Glutamate, Glutamine, Proline, Arginine, from α ketoglutarate. Reaction intermediates, enzymes & regulation of all the pathways. 5.4. Synthesis of Serine, Glycine, Cystine, from 3 Phospho glutarate 5.5. Synthesis of amino acid using oxaloacetate and pyruvate as precursors 5.6. Synthesis of Aromatic Amino acids. 5.7. Inborn errors of amino acid metabolism.
VI.	Specialized Molecule derived from Amino acids: 6.1 Creatine, Glutathione, Porphyrins, Biological Amines, Nitric oxide. 6.2 Gamma glutamyl cycle.
VII.	Nucleotide metabolism: 7.1 Degradation of Purines and Pyrimidines. Reaction intermediates, enzymes & regulation of pathway 7.2 Denovo and salvage pathways of Purine and Pyrimidine biosynthesis. 7.3 Reaction intermediates, enzymes & regulation of pathway 7.4 Inborn errors of Nucleotide metabolism

References

1. Biochemistry – Lehninger.
2. Metabolic Pathways - Greenberg.
3. Biochemistry – G. Zubay, Addison Wesley Publ. (1983).
4. Biochemistry – Stryer (1988) 3rd Edition W.H. Freeman and Co.
5. Harper's Biochemistry

F.Y. M.Sc. Semester II		
CHB-552	Genetics and Membrane Biochemistry	Number of Credits : 04
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Recall the basic concepts and theories related to genetics and membrane biochemistry.	6
CO2	Explain the principles related to Genetics and discuss types of inheritance. Articulate the structure and composition of various cell membranes.	5
CO3	Apply the principles of genetics to solve the problems. Illustrate different methods of horizontal gene transfer in bacteria and different transport systems in cells.	4
CO4	Compare different types of mutations and their causes. Examine mechanism of ions/drug transport in cells and the role of different cells in transport.	3
CO5	Review the process of methods of gene transfer in microbes. Compare different types of transport mechanisms across cell membranes.	2
CO6	Rearrange the genetic processes and processes involved in transport mechanisms. across membranes. Integrate the subject knowledge to write and present the scientific topics and research articles.	1

Unit No.	Title of Unit and Contents
	Genetics
I	Concept of gene: 1.1. Evolution of gene: Beadle and Tatum's one gene one enzyme concept, one gene one polypeptide concept, 1.2. Allele, multiple alleles, pseudoalleles, multiple gene, 1.3. Fine structure of gene: Cistron, Recon and Muton, Eg. rII locus in T4 phage 1.4. Complementation test.
II	Mendelian genetics: 2.1. Mendel's History, Genetic terminology, Genotype, Phenotypes 2.2. Mendel's Laws—Dominance, Segregation and Independent assortment with examples
III	Extension of Mendelian principles: 3.1. Co-dominance, incomplete dominance 3.2. Gene interactions : epistasis, pleiotropy, penetrance and expressivity
IV	4.1. Chromosomal Sex determination, 4.2. Sex limited and sex influenced characters

V	Extra chromosomal inheritance: 5.1. Inheritance of mitochondrial and chloroplast genes with examples 5.2. Maternal inheritance, nucleocytoplasmic inheritance
VI	Human Genetics: Pedigree Analysis in human - symbols, construction of pedigree, molecular genetic analysis
VII	Mutation: 7.1. Types of mutations, causes and detection 7.2. Germinal vs. somatic mutation, chromosomal and genetic mutations 7.3. Human teratogenesis
VIII	Mutant types: 8.1. Auxotrophs, prototrophs, lethal, conditional mutants 8.2. Mutant isolation and selection method
IX	Microbial genetics: 9.3. Types of plasmids, Fertility factor, Hfr 9.4. Methods of genetic transfers –transformation, and conjugation in bacteria. Life cycle of bacteriophages, lytic and lysogeny, transduction types: specialized, generalized. 9.5. Mapping genes by interrupted mating technique 9.6. Tetrad analysis.
X	Genetic Code: Biochemical and genetic analysis of the genetic code.
	Membrane Biochemistry
XI	Biological membrane: 10.1. Significance of biological membranes. Membrane models: biological and physical model. 10.2. Molecular Constituents, percentage composition of plant, animal and microbial membranes, membrane permeability asymmetry and fluidity of membrane, rotation, flip flop movement, lateral diffusion of phospholipids. Cell to cell interactions. Protein lipid interaction and factors affecting properties of membranes.
XII	Membrane transport: 11.1. Principles and mechanism of osmo-regulation, diffusion, passive, active and facilitated transport, features of uniport, symport and antiport transport systems, 11.2. Role of proteins in the process like exocytosis, endocytosis- phagocytosis and pinocytosis, receptor mediated endocytosis (cholesterol transport), and ATP, ADP- exchanger.

XIII	Special molecules of Transport: 12.1. ATPases and its types (Sodium- Potassium pump, ABC, P type, V type ATPases). 12.2. Sodium, proton Potassium and chloride dependent processes. Phosphotransferase system, Group translocation, specialized mechanism for transport of macromolecules (Virus membrane assembly and ribosome).
XIV	Ion transport: Types, proteins involved in ion transport, ionophores (antibiotics: Gramicidin and Vancomycin)
XV	Role of liposome in drug transport, cellular permeability, some examples of drugs, role in cell signaling
XIV	Techniques: Freeze fracture, pinch-off

References:

1. Genetics by Monroe W. Strickberger, 1990 (3rd Ed.) Macmillan Pub
2. Genetics: A Molecular Approach by Peter J. Russell
3. Biochemistry, L Stryer, 3rd/4th/5th ed, 1989, Freeman and Co. NY
4. Principles of Biochemistry – Lehninger
5. Molecular Biology of the Gene- Watson Benjamin / Cummings Publ. Company (1987).
6. Introduction to Genetics: A Molecular Approach; T A Brown, Garland Science (2011).
7. Human Molecular Genetics; Peter Sudbery, (2002) Printice Hall
8. Molecular Biology of the Cell, fifth addition– Bruce Alberts, Garland Science.
9. Cell and Molecular Biology – DeRobertis and Saunders (1980).
10. The Cell - A molecular approach by Geoffrey M. Cooper
11. Molecular Cell Biology by Lodish and Baltimore

F.Y. M.Sc. Semester II		
CHB-553	Techniques in Characterizations of Biomolecules	Number of Credits : 04
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Recall basic concepts behind all the biophysical techniques	6
CO2	Explain the theory, principle, applications of different biophysical techniques along with instrumentation.	5
CO3	Illustrate the mechanisms of biophysical techniques and choose appropriate technique for characterisation of biomolecules	4
CO4	Select appropriate method for analysis and characterization of biomolecules.	3
CO5	Compare the types of methods used for structural determination of biomolecules and explain working principle and applications.	2
CO6	Specify the operation, instrumentation, uses of scanning and transmission electron microscopy and apply the knowledge to characterize the molecule.	1

Unit. No.	Title of Unit and Contents
Biophysical Methods	
I	Sedimentation: 1.1. Theory, Preparatory and analytical ultracentrifuges, Density gradient centrifugation. 1.2. Factors affecting sedimentation velocity, sedimentation coefficient, measurement of S, Zonal centrifugation, DNA analysis 1.3. Determination of molecular weight by sedimentation, diffusion and sedimentation equilibrium methods. 1.4. Applications of sedimentation techniques with examples
II	Viscosity: 2.1. Theory, effect of macromolecules on viscosity of a solution 2.2. Flow time measurement, relative viscosity, molecular weight determination

III	Isotope Tracer Techniques: 3.1 Types of radiations, types of decay, rate of radioactive decay, half-life, units of radioactivity 3.2 Detection and measurement of radioactivity, GM counter –design and application, Scintillation counters, types, advantages and limitations, background noise quenching, Radiation dosimetry, Cerenkov counting
IV	Autoradiography: Principle, method and applications
V	Spectroscopy: 5.1 Atomic Absorption Spectroscopy (AAS), 5.2 Inductively coupled Plasma, 5.3 Atomic Emission Spectrometry (ICP-AES or IES)
VI	X-Ray Diffraction: Principle and applications
	Structural determination of Biomolecules
VII	Spectroscopic methods : (a)NMR, (b) ESR, (c) IR, (d) Fluorescence, (e) ORD and CD
VIII	Biosensors: Introduction, types, Microchips, Cell Biosensors and application.
IX	Mass Spectrometry: LCMS, GCMS, MALDI-MS, MALDI-TOF-MS
X	SEM and TEM: Introduction, importance of electron microscopy, theory, sample preparation, working, principle, instrumentation and application.

References:

1. Physical Biochemistry by D. Freifelder IInd Edition Freeman publication (1982).
2. Biochemical techniques by Wilson and Walker, Seventh edition, Cambridge University press (2010)
3. Biophysical techniques by Upadhye and Upadhye, Himalaya Pub. House, (2009).
4. Biochemistry by L. Stryer 4th edition (1995)

F.Y. M.Sc. Semester II		
CHB-554	Oncology and Animal Cell culture	Number of Credits : 04
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Recall the basic concepts and terms in cancer biology and animal cell culture	6
CO2	Learn new terms in development of cancer, its genetic aspect and types of all animal cell culture	5
CO3	Understand the cellular defense towards tumor formation and the types of media and basic cell growth conditions and media preparation.	4
CO4	Demonstrate the mechanism in development of cancer and growth and development of animal cell.	3
CO5	Evaluate the parameters and conditions for cell growth.	2
CO6	Develop the method to grow the animal cell and study cancer metabolism	1

Unit No.	Title of Unit and Contents
Oncology and Animal Cell culture	
I	Introduction to Cancer Biology: What is carcinogenesis? Theories behind the cause of cancer, Initiation, Promotion and Progression of Cancer. Cancer and carcinogens: Role of DNA damage, repair and mutations, viruses and carcinogens. Benign and Malignant tumours, Tissue specificity, Hyperplasia and Precancerous lesions.
II	Genetic, molecular and cellular mechanisms of cancer : Genome stability, Transcriptional controls in cancer, Suppression and activation of oncogenes during transformation of cell, Viral oncogenes, examples ERB, HER-2, rel, large T-antigen etc. Cell cycle regulation and its alteration in cancer, Apoptosis, Necrosis, Signalling pathways in cancer involving p53, Ras and Rb, Growth factors.
III	Tumour environment and cell interactions : Tumour cell dormancy in microenvironment, Cell-Cell interactions, Cell matrix interactions, Invasive characters, activity of Morphogens, Angiogenesis, Tumour Stem Cells.
IV	Types of Cancers : Leukaemia: types of chromosomal translocations. Hodgkin's lymphoma, Burkitt's Lymphoma, HPV+ uterus cancer, Prostate cancer,
V.	Immunology and Tumours : Immune responses in tumour growth, Immune suppression by tumours, Tumour specific antigens and Immune response, immunotherapy by immune modulations. Cancer Vaccines- Whole cell vaccines, Peptide vaccines, Dendritic vaccines, Prophylaxis.

VI	Cancer research : Tumour specific Biomarkers for efficient diagnosis and prognosis Imaging-Use of different Imaging Modalities for assessing molecular and functional aspects of Tumour cells. DNA Microarrays- for individual specific analysis of target tumour, example-lymphochip. Metastasis detection- Techniques and Challenges. Nanotechnology in tumour therapy- Nano vectors for targeted drug delivery. Bioinformatics- Early diagnosis, Personalized therapy by comparing patient's tumour genetic profile to data of genetic profiles, respective treatments and responses globally. Treatment of cancer symptoms at molecular level targeting specific molecules, drug discovery. Introduction about clinical research of proposed treatment strategies for ensuring safety, efficacy and early implementation. miRNAs- role in tumours and use in therapy
VII.	Cell culture methods and ACC Techniques: Types of tissue culture systems: cell culture, tissue culture, organ culture, embryo culture; Types of cell culture: Primary culture, diploid culture, cell line normal tissue ,cancer tissue; ,adult) plasma, milk, coconut water, amniotic fluid, Synthetic MEM M199, L 15, DMEM. RPMI 1640, d) incubators, desiccators with candle; Sterility and disinfection, Storage of cells, media, sera, tissue reagents, Factors affecting success of cell culture, Cytotoxicity.
VIII.	Techniques in Animal cell culture: Techniques of making primary cell culture: a) Non enzymatic: Hanging drop, Tissue explant culture b) Enzymatic : trypsin, dispase, collagenase etc.
IX.	Organ culture : definition, techniques, Grid method, Raft method Tracheal organ culture; Cell environment : a) Substratum (glass/plastic) different tissue culture flasks, Petri plates, tubes, 24well plates, b) Balanced salt solutions, Hanks, Earle, Dulbecc, c) Media : Natural serum, (fetal, c) Media : Natural serum, (fetal, adult) plasma, milk, coconut water, amniotic fluid, Synthetic MEM M199, L 15, DMEM. RPMI 1640, d) incubators, desiccators with candle; Sterility and disinfection, Storage of cells, media, sera, tissue reagents, Factors affecting success of cell culture, Cytotoxicity
X.	Applications of Cell culture in research and industries

References:

1. Molecular Biology of Cancer-Mechanisms, Targets and Therapeutics, Lauren Pecorino
2. Advances in Cancer Research, D. Avedo
3. The Cell: A Molecular Approach by Geoffery M. Cooper
4. Molecular Oncology: Principles and Recent Advances by Javier Camacho
5. Principles of Molecular Oncology, Edited by MH Bronchud, MA Foote, G Giaccone, OOlopade and P Workman
6. Culture of Animal Cells: A Manual of Basic Technique and Specialize Applications, 6thEdition by Ian Freshney.
7. Principle and practice of Animal Tissue Culture by Sudha Gangal
8. Cell and Tissue Culture –Alan Doyle and J. Bryan Griffiths

F.Y. M.Sc. Semester II		
CHB-570	Biochemistry Practical-III Biostatistics and Bioinformatics	Number of Credits : 04
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Recall the basic concepts in Biostatistics and Bioinformatics and represent data in an appropriate way.	6
CO2	Explain the steps and procedures to represent experimental data and search biological databases	5
CO3	Use information and apply respective methods or tools to solve biostatistics and bioinformatics.	4
CO4	Compare sequence, select proper database and choose statistical tool, execute programs to generate results, compare output and demonstrate data.	3
CO5	Select the correct piece of information and summarise the results of the experiments in suitable format.	2
CO6	Hypothesise the results, write the experiments, interpretation and prepare the report and journal appropriately. Develop basic statistical technique	1

Expr No.	Title of Experiment
Biostatistics	
1.	Use of various software for making structures of molecules, Use of Microsoft word, Excel, poster making & Power- point to present experimental data
2.	Statistical analysis: Selection of data use of mean, mode, median, SD average and R-square,
3.	Construction of Standard curve and calculation of unknown concentration
4.	Use of Pie chart, bar diagram, flowsheets to represent experimental data
5.	Application of ANOVA, Z test, t -Test and chi square test to the data
6.	Construction of Network pharmacology diagram (Data mining, data linking and diagram construction)
7.	Box and Whisker Plot
8.	Referencing tool: Use of Mendeley, Zotero, End note etc
Bioinformatics	
1.	Study of Bioinformatics resources. E.g. NCBI, CGEB, EMBL, EBI, DDJB, ExPASy, Chemo informatics etc.
2.	Open access bibliographic resources and literature databases. E.g. PubMed, BioMed Central, Public Library of Sciences (PloS), CiteXplore, CD ROM bibliographic databases. Concept of boolean operators in searching

3 & 4	Introduction to biological data bases and its types and importance. Sequence Databases: (a) Nucleic acid sequence databases: GenBank, EMBL, DDB (b) Protein sequence databases: Uniprot-KB: SWISS-PROT, ChEMBL TrEMBL, UniParc (c) Repositories for high throughput genomic sequences: GSS. (d) Genome Databases at NCBI, EBI, TIGR, SANGER
5	BLAST, FASTA programs for sequence database search, Sequence alignment using BLAST/Database Similarity searching using BLAST Pairwise alignment- Needleman-Wunsch and Smith-Waterman algorithms Multiple alignment- CLUSTALW & PRINTS
6.	Homology modelling of given protein structure ; Prediction and analysis of protein structure using any method (Swiss PDB viewer, MODELLER and by other molecular visualization tools.
7.	Phylogenetic analysis using Phylip or Mega
8.	Genome data bank – study the features of human genome
9.	Molecular Docking using AutoDock and Molecular visualization of 2 docked complexes (using Pymol or Chimera)
10.	Basic Structure visualization using Deep View (Performing basic tasks 2 like Selecting and Displaying structures, Colouring, Measuring distances and labeling) Calculation of phi – psi angles - Ramachandran plot

References:

1. Bioinformatics Sequence and Genome Analysis: David Mount, Cold Spring Harbor Laboratory Press, New York. 2004
2. Bioinformatics- a Practical Guide to the Analysis of Genes and Proteins by Baxevanis, A.D. and Francis Ouellette, B.F., Wiley India Pvt Ltd. 2009
3. Bioinformatics: Sequence, structure and databanks – 2000 – Des Higgins & Willie Taylor – Oxford University Press.
4. Introduction to bioinformatics by Teresa K. Attwood, David J. Parry-Smith, Pearson Education. 1999.
5. Fundamentals of Biostatistics by Khan and Khanum
6. Biostatistics-A foundation for Health Science, Daniel WW, John Wiley (1983)

F.Y. M.Sc. Semester II		
CHB-571	Biochemistry Practical – IV Photochemistry and Animal Cell Culture	Number of Credits : 04
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Describe and tell basic phytochemicals and genetics theories/principles	6
CO2	Predict different techniques for extraction of phytochemicals and explain methods to study phytochemicals. Articulate concepts and processes of animal cell culture.	5
CO3	Use different techniques to extract and study the presence of different phytochemicals. Know various methods in animal cell culture	4
CO4	Analyse the basic phytochemicals present in plants with their role and identify them by performing qualitative tests. Learn media components and its preparation and handling of cell culture with precautions.	3
CO5	Evaluate activities from standard and other plant sources. Determine the quantity of hair protein by performing a suitable method. Demonstrate the cell growth and morphological features of cell growth.	2
CO6	Design new experiments for extraction of phytochemicals from different sources and. Select the proper method of phytochemical isolation, write the experiments, interpretation and prepare the report and journal appropriately. Grow cells independently and study various activities.	1

Expt. No.	Phytochemical Practical
1.	Extraction methods of Phytochemicals (Cold and Hot -Reflux, Stirring at RT, Soxhlet etc)
2.	Study of Phytochemicals (Qualitative) a. (Chemical and Fluorescent Method) b. Liposoluble pigment c. Anthocyanin by pH differential method
3.	Quantitative estimation of phytochemicals: a. Polyphenols by FC method. b. Flavonoids by AlCl₃ method c. Tannins by Vanillin -HCl method
4.	Estimation of Total antioxidant activity by reducing power method /Antioxidant activity by Radical scavenging method
5.	Isolation of marker enzyme /antioxidant enzyme from plant and check its activity
6.	Isolation and characterization of amino acid cysteine from human hair hydrolysate.

7.	Isolation of alkaloid Caffeine from tea powder /Isolation of lycopene from plants.
8.	Isolation, characterization and identification of fatty acids from oil by soxhlet method.
Cell culture	
I	Basics of cell culture: Acquaintance with cell culture laboratory, Culture place: culture cubical P1 to P4; Laminar flow system. Preparatory techniques: Washing of glassware, dry and steam sterilisation. Maintenance of aseptic conditions, Sterilization techniques, Media preparation: Filter sterilization, and media storage. Serum inactivation.
II	Culturing and sub-culturing of animal cell lines and its maintenance
III	Cell counting, viable cell count, trypsinization, cryopreservation and revival.
IV	Culturing and sub-culturing of callus in different media its characterization
V.	Chick embryo fibroblast culture

References:

1. Biochemical Methods by S. Sadashivam , A. Manickam
2. Phytochemical Methods A Guide to Modern Techniques of Plant Analysis by A.J. Harborne
3. Culture of Animal Cells: A Manual of Basic Technique and Specialize Applications, 6th Edition by Ian Freshney.
4. Principle and practice of Animal Tissue Culture by Sudha Gangal
5. Cell and Tissue Culture –Alan Doyle and J. Bryan Griffiths