Deccan Education Society's

Fergusson College (Autonomous), Pune

Learning Outcomes-Based Curriculum

As per guidelines of

NEP 2020

for
M. Sc. I - Biochemistry

With effect from Academic Year

2023-2024

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

Fergusson College (Autonomous), Pune
Proposed First Year Curriculum as per NEP 2020
Department of Chemistry
M. Sc. Biochemistry

Programme Structure: M. Sc.-I Biochemistry

Semester	Paper Code	Paper Title	Type	Credits
I	CHB-501(Major I)	Biomolecules	Theory I	4
	CHB-502 (Major II)	Microbiology and Cell Biology	Theory II	4
	CHB-503(Elective) OR	Enzymology and Biophysical Techniques	Elective	4
	CHB-504 (Elective)	Clinical Nutrition and Food Technology		
	CHB-510 (RM)	Research Methodology	RM	4
	CHB-520 (Practical I)	Practical - I	Practical I	2
	CHB-521 (Practical II)	Practical - II	Practical II	2
		Total Semester Credits	20	20
II	CHB-551 (Major I)	Metabolism	Theory I	4
	CHB-552 (Major II)	Genetics and Membrane Biochemistry	Theory II	4
	CHB-553 (Elective) OR	Techniques in Characterization of Biomolecules	Elective	4
	CHB-554 (Elective)	Molecular Oncology & Animal Cell Culture		
	CHB-560 (OJT/FP)	On Job Training/ Field Project	OJT / FP	4
	CHB-570 (Practical I)	Practical III	Practical I	2
	CHB-571 (Practical II)	Practical IV	Practical II	2
		Total Semester Credits	**20**	
		Total PG-I Credits	**40**	

Teaching and Evaluation (Only for FORMAL education courses)

Course Credits	No. of Hours per Semester Theory/Practical	No. of Hours per Week Theory/Practical	Maximum Marks	CE 40 %	ESE 60%
1	**15 / 30**	**1 / 2**	**25**	**10**	**15**
2	**30 / 60**	**2 / 4**	**50**	**20**	**30**
3	**45 / 90**	**3 / 6**	**75**	**30**	**45**
4	**60 / 120**	**4 / 8**	**100**	**40**	**60**

Eligibility: **Graduates in Chemistry , Botany, Microbiology, Zoology, Life Science, Nanoscience, Nanotechnology, B-Pharm and Biotechnology**

F.Y. M.Sc. Semester I		
Title of the Course and Course Code	**Biomolecules (CHB-501)**	**Number of Credits: 04**
		Numbers of lectures: 60
Course Outcome (COs) **On completion of the course, the students will be able to:**		
CO1	Recall sources, structures and list the significance of biomolecules.	
CO2	Classify biomolecules with suitable examples and differentiate between their features.	
CO3	Apply the knowledge of membrane composition to correlate with its properties and different types of transport mechanisms.	
CO4	Analyze the interrelationship between biomolecules and their derivatives. Identify the sequence of steps required to determine hierarchy in the structural organization of macromolecules.	
CO5	Evaluate in-vitro and in-vivo reactions of biomolecules along with their significance.	
CO6	Assemble and tabulate the coenzymes of vitamins and correlate its significance in biochemical reactions. Plan the use of suitable methodologies for characterization of biomolecules.	

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, Oxidisng 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. 2.5 Membrane structure and composition: Fluid Mosaic model, Significance of biological membranes. 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. Protein lipid interaction and factors affecting properties of membranes.
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 andC 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.

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 – Hawk.

Title of the Course and Course Code	Microbiology and Cell Biology (CHB-502)	Number of Credits: 04
		Number of Lectures: 60
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Recall the basic concepts and theories related to microbiology and cell biology. Describe different types of microscopes, characteristics of different microorganisms, their structures and different sterilization techniques	
CO2	Compare prokaryotic and eukaryotic cells and explain about subcellular organelles and their functions. Identify host and microbes interaction.	
CO3	Predict the types of bacterial, plant and animal viruses along with their characteristics. Interpret the different processes of developmental biology and role of germ cells and stem cells.	
CO4	Explain different processes and events occuring in the cells, their significance and describe cellular aging and cell death. Infer role of microbes in nitrogen metabolism, food spoilage and as toxins.	
CO5	Review the mechanisms of membrane transport and compare different types of transport mechanisms across cell membranes.	
CO6	Rearrange the processes of microbial, animal and plant cells. Integrate the subject knowledge to write and present the scientific topics and research articles.	

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 1.4 Techniques: specimen preparation Freeze Itching, Freeze fracture, pinch-off

II	2.1 Classification of microorganisms: system of classification, identifying characters for classification, classification based on different requirements (e. g. 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 life cycle 7.2 Mycoplasma and viriods, diseases due to viruses
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 andcomplexity, 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 and mechanism of transport across cell:** 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 formationof germ layers in animals. 13.2 Stem cells: Types and Uses.

References:

1. Microbiology, M. S. Pelczar, R. D. Reid, E. C. S. Chan, McGraw Hill, New York (1986).
2. General Microbiology (V^{th} Edition), R. Y. Stanier, Prentice Hall (1986).
3. Biology of Microorganisms by Brocks.
4. Introductory Microbiology, F. C. Ross, Charles Merril Publication (1983).
5. Molecular Biology and Biotechnology - edited by J. M. Walker and FB Gingold, Royal Society of Chemistry (1988).
6. Industrial Microbiology - Casida.
7. General Microbiology Stainer R. Y. et al (1987) 5^{th} 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, Addision Wesley Co. (1986).
13. Molecular Biology by Lodish and Baltimore.

Title of the Course and Course Code	Enzymology and Biophysical Techniques (CHB-503)	Number of Credits: 04
		Number of Lectures: 60
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Recall basic concepts of separation and purification techniques along with their applications.	
CO2	Articulate concepts, parameters, mechanisms and applications of different types of chromatography.	
CO3	Illustrate the types of electrophoresis, applications and principles underlying the techniques. Apply the knowledge for biomolecules separation.	
CO4	Identify the types of techniques used for separation and identification of biomolecules	
CO5	Evaluate the separation techniques for biomolecules.	
CO6	Specify the working mechanisms and applications of biophysical techniques. Compile methods to separate biomolecules and present the subject relevant topics/ research articles.	

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 - pH 5.1.1 Temperature 5.1.2 Substrate, product and enzyme concentrations 5.1.3 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 Km 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, substrateavailability or cofactor and changes in covalent structure of enzyme, 6.4 Mechanism of enzyme degradation: lysozomal degradation, ubiquitation and other cellular processes of enzyme degradation. 6.5 Enzyme turnover, Ks and Kd, correlation between the rates of enzymeturnover and structure and function of enzymes, significance of enzymeturnover.
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.

Title of the Course and Course Code	Clinical Nutrition and Food Technology	Number of Credits: 04
		Number of Lectures: 60

Course Outcome (COs) On completion of the course, the students will be able to:	
CO1	Recall daily nutrition habits and pattern in population
CO2	Identify basic food composition and special food in normal and disease condition
CO3	Interpret deficiency and malnutrition and solutions to overcome that with food and nutritional supplements
CO4	Explain the management of different diseases through food and nutrition
CO5	Criticize food toxins, additives and side effects of food toxins
CO6	Design the food pattern for prevention of disease and for healthy life

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 malnutritionon 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 5.1.2 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.

Title of the Course and Course Code	Research Methodology (CHB-510)	Number of Credits: 04
		Number of Lectures: 60
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Recall the concept of research and basics of biostatistics and informatics.	
CO2	Articulate different types of research in the context of biology, importance of ethics, IPR and identify tools to search and represent biological data.	
CO3	Apply the knowledge to identify appropriate research methods, tools and technique and softwares.	
CO4	Explain the research process, frame research problem and prioritize data collection method and compare specific biological databases.	
CO5	Summarize the research article and choose appropriate method to write and present scientific data.	
CO6	Design an experiment and prepare a scientific document, abstract and integrate concepts of bioinformatics and statistics. Present the subject relevant topics or journal articles.	

Unit No.	Title of Unit and Content
I	**Introduction:** 1. Definitions and objectives of research. 2. Types of research (qualitative, quantitative, survey, case studies, applied, meta-analysis, descriptive etc.). 3. Research approaches, significance of research, main components of research process. 4. Ethics and scientific conduct, ethics in life science studies. 5. Introduction to Intellectual Property Rights.
II	**Research process and methods**: 2.1 Identifying the gap or problem. Review of public research in relevant field. 2.2 Literature survey: Print: Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, Digital: Web resources, E-journals, Journal access, TOC alerts, Hot articles, Citation index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, Preprint servers, Search engines, Google Scholar, Science Direct, SciFinder, Scopus, WoS etc. Information Technology and Library Resources: The Internet and World Wide Web. Internet resources for life sciences, Finding and citing published information. 2.3 Research methods: Framing the research problem, hypothesis design: qualities of a good hypothesis, null hypothesis & alternative hypothesis, designing of experiments, Quantitative and Qualitative methods: Data collection, data types, methods of data collection, repeatability, reproducibilityand reliability, sampling methods, data analysis and interpretation. Importance of controls in designing the experiment.

III	**Scientific writing and Presentations**: 3.1 Report writing, significance of report writing, different types of scientific reports. 3.2 Format for writing thesis, project report, journal articles: research paper, review paper; reports for popular magazines, seminars / symposia / conferences / workshops, poster sessions, effective illustration, tables and figures, reference styles. 3.3 Presentations: Power point presentation, poster presentation, Oral presentations in classrooms, scientific meets & public audience, defence of thesis / research presentations, communication skills (writing and oral) for public speaking, workplace communications. 3.4 Use of tools and techniques: methods to search required information effectively, reference management software like Mendeley, End Note, Zotero etc., Software for paper formatting and detection of Plagiarism.
IV	**Biostatistics:** 1. Introduction to Biostatics, Principles and practice of statistical methods in biological research, samples and populations, identification of data for statistical analysis. 2. Basic statistics: average, statistics of dispersion, coefficient of variation, confidence limits, Probability distributions (binomial, normal and poisson). Mean variants, standard deviations and standard error, correlation and regression, Tests ofstatistical significance (t-Test, chi-square test); Analysis of variance - one way and two wayANOVA, latest software, introduction of software, exercise on biochemical problems.
V	**Bioinformatics** 1. Introduction to bioinformatics: Application of bioinformatics, Bioinformatics resources. Biological databases: overview of biological databases, nucleotide databases (Gen Bank, DDBJ, ENA) Protein structure databases (PDB, SCOP, CATH), Organism specific databases, Bibliographic databases. 2. Sequence analysis: pair wise alignment, multiple sequences alignment, Scoring matrices, Phylogenetic trees. Sequence similarity search, Blast, FASTA, CLUSTAL.

References:

1. Fisher R A, The Design of Scientific Experiment (1971) 9th edition, Collier Macmillan Publishers, London.
2. Guide to Scientific and Technical Writing: Cooray P. G.
3. Dawson, C. (2002). Practical Research Methods. UBS Publishers, New Delhi.
4. Anthony M. Graziano, Michael L. Raulin, Research Methods: A Process of Inquiry (2012) 8th Edition, Pearson Publication, Delhi.
5. Barass Robert, Scientists Must Write: A Guide to Better Writing for Scientists, Engineers and Students (2002), Routledge Publication, UK.
6. David B. Resnik, The Ethics of Science: An Introduction (1998), Routledge Publication, UK.
7. Ganguli Prabuddh, Intellectual Property Rights (2001), Tata McGraw-Hill Publishing Company Ltd., Delhi.
8. Jacob Bronowski and Bruce Mazlish, The Western Intellectual Tradition (1960), Harper & Row, New York.
9. John D'Angelo, Ethics in Science: Ethical Misconduct in Scientific Research (2012), CRC Press, USA.

10. Martha Davis, Scientific Papers and Presentations 2nd edition (2004), Academic Press
11. Robert A. Day, Barbara Gastel, How to Write and Publish a Scientific Paper, 7th edition (2011), ABC-CLIO, USA.
12. Bioinformatics: Sequence and Genome Analysis by Mount D., Cold Spring Harbor Laboratory Press, New York. 2004.
13. Introduction to Bioinformatics by Teresa K. Attwood, David J. Parry-Smith, Pearson Education. 1999.
14. Introduction to Bioinformatics, 2001. AH Wood, T. K. Parry Smith DJ, Pearson Education Asia.
15. Bioinformatics: A practical guide to the analysis of genes and proteins - 2001 - AD Baxevanis & BFF Ouellette - Wiley Interscience - New York.
16. Fundamentals of Biostatistics by Khan and Khanum.
17. Biostatistics - A foundation for Health Science, Daniel WW, John Wiley (1983).
18. Bioinformatics Databases, Tools and Algorithms: Orpita Bosu, Simminder Kaur Thukral.
19. Bioinformatics Sequence and Genome Analysis: David Mount, Cold Spring Harbor Laboratory Press, New York. 2004.
20. Bioinformatics: Methods and Protocols - 2000 - Stephen Misener & Stephen A. Krawetz, Humana Press, New Jersey.
21. Bioinformatics: Sequence, Structure and Databanks – 2000 - Des Higgins & Willie Taylor - Oxford University Press.

Title of the Course and Course Code	Biochemistry Practical - I (CHB-520) Analytical Biochemistry and Microbiology	Number of Credits: 04
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Recall and tabulate the reactions of biomolecules and different types of sterilization techniques.	
CO2	Infer tests performed for biomolecules and important techniques for cultivation of microorganisms.	
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.	
CO4	Organize, tabulate and represent information and studies with proper understanding. Execute methods to study and compare the adulteration andpasteurization in milk samples.	
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.	
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	

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

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. Practicals in Biochemistry by Sadashivam and Manickham.

Title of the Course and Course Code	Biochemistry Practical - II (CHB-521) Enzymology & Biophysical Techniques	Number of Credits: 04
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Describe the principle, mechanism role and concentrations of reagents used in enzymology and biophysical techniques experiments.	
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.	
CO3	Carry out isolation, purification and detection of enzymes from different sources. Calculate the concentration of solutions.	
CO4	Demonstrate basic techniques like electrophoresis, chromatography, dialysis enzyme activities at different parameters. Infer experimental results and draw graphs.	
CO5	Decide the absorption maxima and measure the absorbance of the reactions using UV spectrophotometers. Defend problems / questions related to theory and experiments.	
CO6	Plan an experiment, interpret and conclude its results. Write the experiments and prepare the journal appropriately.	

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 (Vmax and Km) 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

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. Practicals in Biochemistry by Sadashivam and Manickam.
4. Biochemical techniques by Wilson and Walker.
5. Biophysical techniques by Upadhyay, Upadhyay and Nath.

F. Y. M. Sc. Semester II		
Title of the Course and Course Code	**Metabolism (CHB-551)**	**Number of Credits: 04**
		Number of Lectures: 60
Course Outcome (COs) **On completion of the course, the students will be able to:**		
CO1	Recall the structure of metabolic intermediates and names of enzymes..	
CO2	Explain and illustrate the steps in biochemical pathways along with their regulations.	
CO3	Apply knowledge of genetics and enzymology to understand the formation of specific intermediates in biochemical pathways and inborn errors of metabolism	
CO4	Classify the types of metabolic reactions and outline the concepts of bioenergetics.	
CO5	Justify varied conditions required for the occurrence of desired metabolic reactions.	
CO6	Rearrange and write the correct sequence of fates of metabolic products based on the specified physiological conditions.	

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 aminoacids. 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, Addision Wesley Publ. (1983).
4. Biochemistry - Stryer (1988) 3rd Edition W. H. Freeman and Co.
5. Harper's Biochemistry.

Title of the Course and Course Code	Genetics and Membrane Biochemistry (CHB-552)	Number of Credits: 04 Number of Lectures: 60
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Recall the basic concepts and theories related to genetics and membrane biochemistry.	
CO2	Explain the principles related to Genetics and discuss types of inheritance. Articulate the structure and composition of various cell membranes.	
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.	
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.	
CO5	Review the process of methods of gene transfer in microbes. Compare different types of transport mechanisms across cell membranes.	
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.	

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. rIIlocus 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:** 9.1 Types of plasmids, Fertility factor, Hfr. 9.2 Methods of genetic transfers - transformation, and conjugation in bacteria. Life cycle of bacteriophages, lytic and lysogeny, transduction types: specialized, generalized. 9.3 Mapping genes by interrupted mating technique. 9.4 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 Valinomycin)
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 Monoroe W. Strickberger,1990 (3rd Ed.) Macmillan Pub.
2. iGenetics: 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.

Title of the Course andCourse Code	Techniques in Characterisation of Biomolecules - (CHB553)	Number of Credits: 04
		Number of Lectures: 60
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Recall basic concepts behind all the biophysical techniques	
CO2	Explain the theory, principle, applications of different biophysical techniques along with instrumentation.	
CO3	Illustrate the mechanisms of biophysical techniques and choose appropriate technique for characterisation of biomolecules	
CO4	Select appropriate method for analysis and characterization of biomolecules.	
CO5	Compare the types of methods used for structural determination of biomolecules and explain working principle and applications.	
CO6	Specify the operation, instrumentation, uses of scanning and transmission electron microscopy and apply the knowledge to characterize the molecule.	

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 weightdetermination
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 - designand 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).

Title of the Course and Course Code	Oncology and Animal Cell culture	Number of Credits: 04
		Number of Lectures: 60
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Recall the basic concepts and terms in cancer biology and animal cell culture	
CO2	Learn new terms in development of cancer, its genetic aspect and types of ll animalcell culture	
CO3	Understand the cellular defense towards tumor formation and the types of media and basic cell growth conditions and media preparation.	
CO4	Demonstrate the mechanism in development of cancer and growth and development of animal cell.	
CO5	Evaluate the parameters and conditions for cell growth.	
CO6	Develop the method to grow the animal cell and study cancel metabolism	

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. Hodgekin's lymphoma, Burkitt's Lymphoma, HPV+ uterus cancer, Prostate cancer etc.
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 specificmolecules, drug discovery. Introduction about clinical research of proposed treatment strategies for ensuring safety, efficacy and earlyimplementation. miRNAs - role in tumours and use in therapy.
VII	**Introduction to Animal Cell Culture Laboratory:** Definition, applications and limitations of tissue culture. Requirement of the tissue culture laboratory: different areas requirement, equipments. Aseptic Techniques, Sterilization of materials to be used for cell culture: Liquid reagents, media, serum.
VIII	**Media Requirements:** Properties and special requirements of tissue culture media - types of media, requirement of serum, antibiotics, growth factors, conditioned medium, serum free media, commonly used cell lines and media used.
IX	**Types of Tissue Culture:** Organ culture, Primary Explant Culture, Cell Cultures: primary culture (adherent cell and suspension cells) and secondary cell culture, contact inhibition. Transformation, differentiation and dedifferentiation. Cell lines: concept, properties and maintenance. Types of microbial contaminants. Cryopreservation and thawing of cells, Factors affecting success of cell culture, Cytotoxicity
X	**Applications of Cell Culture:** In vitro testing of drugs, production of pharmaceutical proteins and vaccines.

References:

1. Molecular Biology of Cancer - Mechanisms, Targets and Therapeutics, Lauren Pecorino
2. Advances in Cancer Research, D. Avecedo.
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, Olo and P Workman.
6. Culture of Animal Cells: A Manual of Basic Technique and Specialize Applications, 6th Edition 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.

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

Expt. No.	**Title of Experiment**
	Biostatistics
1.	Use of Microsoft word, Excel & 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 etc

Bioinformatics	
1.	Study of Bioinformatics resources. E.g. NCBI, CGEB, EMBL, EBI, DDJB, ExPASy 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, TrEMBL, UniParc (c) Repositories for high throughput genomic sequences: EST, STS, 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
6.	Pairwise alignment- Needleman-Wunsch and Smith-Waterman algorithms
7.	Multiple alignment- CLUSTALW & PRINTS
8.	Prediction and analysis of protein structure using any method (Swiss PDB viewer, MODELLER and by other molecular visualization tools
9.	Phylogenetic analysis using Phylip or Mega
10.	Genome data bank – study the features of human genome
11.	Molecular Docking using AutoDock and Molecular visualization of 2 docked complexes (using Pymol or Chimera)
12.	Basic Structure visualization using Deep View (Performing basic tasks 2 like Selecting and Displaying structures, Colouring, Measuring distances and labeling)
13.	Calculation of phi – psi angles - Ramachandran plot
14.	Homology modelling of a given protein sequence

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 Ouellellette, 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)

Title of the Course and Course Code	Biochemistry Practical – IV (CHB-571) Phytochemistry and Animal Cell Culture	Number of Credits : 04
Course Outcome (COs) **On completion of the course, the students will be able to:**		
CO1	Describe and tell basic phytochemicals and genetics theories/principles	
CO2	Predict different techniques for extraction of phytochemicals and explain methods to study phytochemicals. Articulate concepts and processes of animal cell culture.	
CO3	Use different techniques to extract and study the presence of different phytochemicals. Know various methods in animal cell culture	
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.	
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.	
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.	

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