|| Jai Sri Gurudev ||

Adichunchanagiri University

Adichunchanagiri School of Natural Sciences

M.Sc BIOCHEMISTRY
SYLLABUS

Course Description

Biochemistry deals with the structures and functions of cellular components such as lipids, carbohydrates, proteins, nucleic acids etc. The main aim of pursuing

M. Sc in Biochemistry is to understand each and every aspect of living organism at the molecular level and to use the knowledge to benefit mankind. Empowered with learning of biochemistry from basics to advanced applications which inculcate in research and problem-solving mode of learning. The two-year programme concludes with a Master's thesis on a special research topic in Biochemistry. Upon successful completion of the programme, the academic title "Master of Science" will be awarded.

Adichunchanagiri School of Natural Sciences

2023-24

Adichunchanagiri University

Department of Studies in Biochemistry

B.G. Nagara - 571 448, Nagamangala Taluk, Mandya District, Karnataka, India.

Syllabus for
M. Sc. Biochemistry
Choice Based Credit System (CBCS)

From the Academic Year

2023 - 2024

Adichunchanagiri University

Department of Studies in Biochemistry

Choice Based Credit System (2022 - 2023)

M.Sc. in the subject Biochemistry

Programme Objectives

The main objectives of this M.Sc. Biochemistry programme are to provide strong foundation in the subject of Biochemistry to become

- Researchers in research institutions/industries.
- Entrepreneur to start their own company and for socio-economic development.
- Teaching faculties in academic institutions.
- Trained biochemist to cater the national and global needs.

Programme Outcomes

On successful completion of M.Sc. programme in Biochemistry each student will:

- Have a strong foundation in understanding the basic biochemical reactions that occurs in both prokaryotic and eukaryotic systems at molecular level.
- The student will be able to learn cutting edge technology in the field of biochemical techniques, molecular biology, immunology, cell biology and medicinal biology.
- Develop analytical and practical skills along with their theory components, which will help in their research carrier in national and International research laboratories, academic institutions and industries.
- Inculcate skills for teaching in academic institutions for undergraduate and postgraduate students.
- Develop confidence in taking competitive examination in the field of life science both in India and abroad so that they can pursue higher education.

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Name of the Course	**:**	M.Sc. Biochemistry
Duration of the course	**:**	Two years (Four Semesters)
Eligibility	**:**	Candidates must have secured 45% (40% for SC/ST) in aggregate with Biochemistry / Chemistry / Industrial Chemistry as one of the cognate subjects at B.Sc., level.
Intake	**:**	26 seats
Admission	**:**	As per the prevailing University regulations.

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The Choice Based Credit System (CBCS) comprises Hard Core, Soft Core subjects for Nanoscience Students and Open Elective for students other than Nanoscience. Following shall be the minimum and maximum subjects per semester.

The credit pattern is Lecture (L); Tutorial (T); Practical (P); (L:T:P) Pattern.

Lecture: One-hour session of theory class per week in a semester is 1 credit.

Tutorial and Practical: Two-hour session of tutorial or practical per week in a semester is 1 credit.

One semester period is **16 weeks** of teaching and learning.

Duration of semester is **20 weeks** that includes semester end examinations.

Credit Distribution:

Course Type	Credits
Hard Core	Minimum Credits - 48 and Maximum Credits - 56
Soft Core	Minimum Credits - 16
Open Elective	Minimum Credits - 8

A Candidate can enroll for a minimum of **18 Credits** course per semester and maximum of **24 Credits** course per semester inclusive of Open Elective earned from the other Departments /SWAYAM/MOOC as per UGC regulations.

A Candidate has to earn a minimum of **76 Credits** for successful completion of a Masters degree.

A minimum **76 Credits** and additional **18 Credits** (76 + 18 = 94 Credits) shall acquire add on Proficiency Diploma.

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SCHEME OF STUDY AND EXAMINATION
I to IV SEMESTER M. Sc. BIOCHEMISTRY COURSE

Sl. No.	Semester	HCT	SCT	HCP	OE	Credits
1	Semester I	3	2	2	—	24
2	Semester II	3	2	2	—	24
3	Semester III	3	2	2	—	24
4	Semester IV	Complete semester is dedicated for Major project (MAP)			2 + 1	16
					Total	**88**

HCT = Hard Core Theory = Credits 4
SCT = Soft Core Theory = Credits 4
HCP = Hard Core Practical = Credits 2
OE = Open Elective = Credits 4
MAP = Major Project = Credits 8

Sl. No.	Course	L	T	P	[(No. of theory × (L+T)] + (No. of practical × P) + project work	Credits
1	Hard Core	3	1	2	(9×4) + (6×2) + 8	56
2	Soft Core	3	1	—	6×4	24
3	Open Elective	3	1	—	2×4	08
					Total	**88**

Adichunchanagiri University

Department of Studies in Biochemistry

Choice Based Credit System (2022 - 2023)

Semester-wise distribution of the course structure

First Semester

Paper Code	HC/SC	T/P	Title of the Paper	Teaching hours /week	Exam hours	Marks			Credits
						IA	Exam	Total	
22BCHCT101	HC	T	Bio-organic and Bio-inorganic Chemistry	3+1	3	40	60	100	4
22BCHCT102	HC	T	Biophysical and Biochemical Techniques	3+1	3	40	60	100	4
22BCHCT103	HC	T	Biomolecules	3+1	3	40	60	100	4
Choose two among the three Soft Core subjects									
22BCSCT104	SC	T	Enzymology	3+1	3	40	60	100	4
22BCSCT105	SC	T	Cell Biology	3+1	3	40	60		
22BCSCT106	SC	T	General Microbiology	3+1	3	40	60	100	4
22BCP107	HC	P	Practical I	4	6	20	30	50	2
22BCP108	HC	P	Practical II	4	6	20	30	50	2
							Total	**600**	**24**

Second Semester

Paper Code	HC/SC	T/P	Title of the Paper	Teaching hours /week	Exam hours	Marks			Credits
						IA	Exam	Total	
22BCHCT201	HC	T	Metabolism I	3+1	3	40	60	100	4
22BCHCT202	HC	T	Membrane Biochemistry and Endocrinology	3+1	3	40	60	100	4
22BCHCT203	HC	T	Genetics	3+1	3	40	60	100	4
Choose two among the three Soft Core subjects									
22BCSCT204	SC	T	Clinical Biochemistry	3+1	3	40	60	100	4
22BCSCT205	SC	T	Human Physiology	3+1	3	40	60		
22BCSCT206	SC	T	Nutritional Biochemistry	3+1	3	40	60	100	4
22BCP207	HC	P	Practical III	4	6	20	30	50	2
22BCP208	HC	P	Practical IV	4	6	20	30	50	2
							Total	**600**	**24**

Adichunchanagiri University

Department of Studies in Biochemistry

Choice Based Credit System (2022 - 2023)

Semester - wise distribution of the course structure

Third Semester

Paper Code	HC/SC	T/P	Title of the Paper	Teaching hours /week	Exam hours	Marks			Credits
						IA	Exam	Total	
22BCHCT301	HC	T	Molecular Biology	3+1	3	40	60	100	4
22BCHCT302	HC	T	Immunology	3+1	3	40	60	100	4
22BCHCT303	HC	T	Metabolism II	3+1	3	40	60	100	4
Choose two among the three Soft Core subjects									
22BCSCT304	SC	T	Advanced Biochemical Techniques	3+1	3	40	60	100	4
22BCSCT305	SC	T	Plant Biochemistry	3+1	3	40	60	100	4
22BCSCT306	SC	T	Cell Culture and Genetic engineering	3+1	3	40	60		
22BCP307	HC	P	Practical V	4	6	20	30	50	2
22BCP308	HC	P	Practical VI	4	6	20	30	50	2
							Total	**600**	**24**

Fourth Semester

Paper Code	HC/SC	T/P	Title of the Paper	Teaching hours /week	Exam hours	Marks			Credits
						IA	Exam	Total	
22BCOET401	OE	T	Research Methodology	3+1	3	40	60	100	4
Choose one among the 22BCOET402 and 22BCOET403									
22BCOET402	OE	T	MOOC/ SWAYAM	3+1	3	40	60	100	4
22BCOET403	OE	T	Biochemistry in Health and Disease	3+1	3	40	60	100	
22BCMAP404	HC	PR	Major Project			50	150	200	8
							Total	**400**	**16**

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Choice Based Credit System (2022 - 2023)

Hard Core Subjects

Sl. No.	Paper Code	T/P	Title of the Paper	Credits
1	22BCHCT101	T	Bio-organic and Bio-inorganic Chemistry	4
2	22BCHCT102	T	Biophysical and Biochemical Techniques	4
3	22BCHCT103	T	Biomolecules	4
4	22BCHCP107	P	Practical I	2
5	22BCSCP108	P	Practical II	2
6	22BCHCT201	T	Metabolism I	4
7	22BCHCT202	T	Membrane Biochemistry and Endocrinology	4
8	22BCHCT203	T	Genetics	4
9	22BCHCP207	P	Practical III	2
10	22BCSCP208	P	Practical IV	2
11	22BCHCT301	T	Molecular Biology	4
12	22BCHCT302	T	Immunology	4
13	22BCHCT303	T	Metabolism II	4
14	22BCHCP307	P	Practical V	2
15	22BCSCP308	P	Practical VI	2
16	22BCMAP403	P	Major Project	8
			Total	**56**

Soft Core Subjects

Sl. No.	Paper Code	T/P	Title of the Paper **Select any two (22BCSCT104, 22BCSCT105 & 22BCSCT106)** **Select any two (22BCSCT204, 22BCSCT205 & 22BCSCT206)** **Select any two (22BCSCT304, 22BCSCT305 & 22BCSCT306)**	Credits
1	22BCSCT104	T	Enzymology	4
2	22BCSCT105	T	Cell Biology	
3	22BCSCT106	T	General Microbiology	4
4	22BCSCT204	T	Clinical Biochemistry	4
5	22BCSCT205	T	Human Physiology	
6	22BCSCT206	T	Nutritional Biochemistry	4
7	22BCSCT304	T	Advanced Biochemical Techniques	4
8	22BCSCT305	T	Plant Biochemistry	
9	22BCSCT306	T	Cell Culture and Genetic engineering	4
			Total	**24**

Open Electives Subjects

Sl. No.	Paper Code	T/P	Title of the Paper	Credits
1	22BCOET401	T	Research Methodology	4
2	22BCOET402	T	MOOC/SWAYAM	4
3	22BCOET403	T	Biochemistry in Health and Disease	4
			Total	**8**

SEMESTER - I
22BCHCT101 - Bio-organic and Bio-inorganic Chemistry
(Hard Core)

Course objectives

- To study organic reactions and chemistry of biomolecules and heterocyclic compounds.

Course outcome

- The student will understand the different types bonds involved in the biomolecules and organic reactions, stereochemistry of biomolecules, and role of heterocyclic compounds in biological systems.

Total number of lecture hours: 64 **Total number of credits: 04**

Unit I **16 hrs.**

Properties of water: Physical and chemical properties of water, ionization and ionic product of water, Hydrophilic, hydrophobic and amphipathic molecules in aqueous solution.

Buffers: Buffers, buffer action, Henderson–Hasselbalch equation, biological relevance of pH and pKa, determination of pKa of weak acid, and buffer capacity, preparation of buffers. Units for expressing strength of solutions: Normality, molarity, molality, mole, ppm, ppb. Calculations with examples.

Unit II **16 hrs.**

Chemical bonding: Types of bonding in biological molecules (Covalent, co-ordinate, hydrogen, ionic bonds, hydrophobic and Vander-Waals interactions and their importance in biological systems). Role of metal ions in biological systems, metalloporphyrins, metalloenzymes, cytochromes and iron-sulfur proteins. Bonding of iron in hemologibin and cytochromes, cobalt in vitamin B12, magnesium in chlorophyll. Chelators - types of ligands and complexes.

Unit III **16 hrs.**

Stereochemistry: Importance of stereochemistry. Geometric and optical isomerism. Absolute and relative configuration. Symmetry view of chirality, relation between chirality and optical activity. Structure and stereochemistry of sugars and amino acids, anomer, epimer, diastereomer, stereo-isomer, D and L, (+) and (-), R and S.

Mechanism of bio-organic reactions: Reaction energetic, Reaction rates, order and molecularity of reaction. Types of organic reactions: addition, elimination, substitution and rearrangement reactions. Esterification and hydrolysis.

Unit IV **16 hrs.**

Heterocyclic compounds: Chemistry of furan, indole, thiazole, pteridine, isoalloxazine, pyrrole. Chemistry and biological importance of porphyrins and heme.

Free radicals: Introduction, formation - photolysis, thermolysis, redox reactions and radical reactions with biomolecules.

Text Books:

1. Advanced organic chemistry. Bahl A (2010), S Chand & Company Limited, New Delhi.
2. Text book of Organic Chemistry. Arun Bhal and B.S. Bhal (1997), Chand Publishers.

22BCHCT102 - Biophysical and Biochemical Techniques (Hard Core)

Course objectives

- To study properties of biomolecules with the help of spectroscopic methods and to characterize biomolecules based on their size, shape and structure.

Course outcome

The student will understand the following:

- Principles involved in different spectroscopic methods to analyze biomolecules.
- Separation and characterization of biomolecules using different chromatographic methods, electrophoretic methods and blotting techniques.
- Cell fractionation techniques using different type of centrifugation methods.

Unit I **14 hrs**

Extractions: Extraction of biomolecules (protein and nucleic acids) from prokaryotic and eukaryotic cells/tissues. Salting in and out.

Principle of Spectroscopy: Beer-Lambert's law and its limitations, chromophore and auxochrome, Principles and instrumentation of colorimeter, spectrophotometer and fluorimeter. Fluorescent probes and their applications.

Unit II **18 hrs**

Chromatography: Partition coefficient, RF value, Principle and applications of paper chromatography, thin-layer chromatography, gel filtration chromatography, ion exchange chromatography and affinity chromatography.

HPLC: Instrumentation, RP-HPLC and NP-HPLC, columns for RP and NP HPLC, factors affecting resolution in HPLC.

HPLC detectors: UV-visible detector, fluorescence detector, evaporative light scattering detector and electrochemical detector.

Gas chromatography: Principle and design of instrument. Factors affecting GC, type of columns used in GC.

GC detector: Flame ionization.

Unit III **16 hrs**

Spectroscopy: Theory and construction of mass spectrometer. Electrospray ionization, ToF, MALDI, LC-MS and GC-MS.

Centrifugation: Principle of centrifugation, types of centrifuges and rotors. Density gradient centrifugation - cesium chloride and sucrose density gradients. Differential centrifugation. Design and working of analytical and preparative ultracentrifugation.

Microscopy: Resolution of microscope, principle and working of Light microscopy - Phase contrast microscopy and fluorescent microscopy.

Unit IV **16 hrs**

Electrophoresis: Principle of electrophoresis, polyacrylamide gel electrophoresis - native PAGE and SDS-PAGE. Zymogram. Agarose gel electrophoresis. Protein staining - CBB and silver and DNA staining - EtBr and SYBR G/R.

Immuno-electrophoresis: Dot blotting and immunodiffusion tests with antibodies, zone electrophoresis, rocket electrophoresis and counter immuno-electrophoresis.

Text Books:

1. Biophysical Chemistry: Principles and Techniques. A. Upadhyay, K. Upadhyay and N. Nath, 2nd ed., Himalaya Publishing House, Delhi.
2. Principles and Techniques of Biochemistry and Molecular Biology. Wilson K, Walker J (2010), Cambridge University Press.
3. Biochemical Methods. Sadasivan S and Manickam A, 2nd ed., (1996), New Age International Pvt. Ltd.

22BCHCT103 - Biomolecules
(Hard Core)

Course objectives

- To study various biomolecules of a cell and their structural characterization.

Course outcome

The student will understand the following:

- Structure and classification of carbohydrates, amino acids, lipids, proteins and nucleic acids.
- Protein folding, forces affecting protein folding and structural characterization of nucleic acids.

Total number of lecture hours: 64 **Total number of credits: 04**

Unit I **16 hrs.**

Carbohydrates: Structure, reactions, classification and functions of monosaccharides, disaccharides, oligosaccharides and polysaccharides.

Monosaccharides and disaccharides: Pentoses, hexoses, amino sugars, muramic acid, neuraminic acid. Linkages in sucrose, lactose and maltose.

Polysaccharides: Homopolysaccharides and heteropolysaccharides. Starch, cellulose, glycogen, hyaluronic acid, chondroitin sulphate, bacterial cell wall polysaccharides and blood group polysaccharides.

Glycoproteins: Glycosidic bond, N- and O-glycosylation.

Unit II **20 hrs.**

Amino acids: Nomenclature and classification of amino acids. Zwitter ionic structure, stereochemistry of amino acid D and L, R and S. Physical and chemical properties. Essential and non-essential amino acids. Non-standard and non-protein amino acids.

Peptide bond: Features of the peptide bond, naturally occurring peptides - glutathione, enkaphalins and endorphins. Chemical synthesis of peptides - solution phase synthesis, Merrifield's solid phase synthesis and peptide ligation.

Proteins: Primary structure of proteins, secondary structure of proteins - α, β sheet, β bend, β turn and super secondary structures. Ramachandran plot. Tertiary (myoglobin) and quaternary (hemoglobin) structures.

Factors responsible for protein folding: Anfinsen’s experiment. Weak forces of interaction- hydrogen bonding, Vander Waal’s forces, London forces, ionic interactions, hydrophobic interactions and S-S bridges.

Unit III **12 hrs.**

Lipids: Classification of lipids. Oils, fats, and waxes. Occurrence and properties of fatty acids, esters of fatty acids, cholesterol, phospholipids, glycolipids, sphingolipids, cerebrosides and gangliosides.

Unit IV **16 hrs.**

Nucleic acids: Nitrogenous bases, nucleosides, nucleotides, Physico-chemical properties of nucleic acids - melting of DNA, Tm and factors affecting Tm. Denaturation - hypochromic and hyperchromic effect. C_0t curve and classification of DNA based on C_0t curve.

Structure of nucleic acids: Primary, secondary and tertiary structure of DNA - Watson and Crick model. A, Z DNA other models of DNA structure. Chargaff's rule. Hoogsten base pairing. Cruciform - Supercoiled, bend, triplex and G4-DNA. Forces stabilizing the structure of DNA. Structures of different RNA's - mRNA, rRNA, tRNA, SnRNA, miRNA, siRNA and shRNA.

Text Books:

1. Fundamentals of Biochemistry. JL Jain (2018), 7th ed., S Chand & Company Limited, New Delhi.
2. Biochemistry. U Satyanarayana and U Chakrapani 5th ed., Elsevier
3. Lehninger Principles of Biochemistry. Nelson DL, Lehninger AL, Cox MM (2008), 6th ed., Macmillan.
4. Biochemistry. Voet D, Voet JG (1995) New York: J. Wiley & Sons.
5. Biochemistry. Zuby G (1988), New York. MacMillan.
6. Harper's Illustrated Biochemistry. Murray R, Granner D, Mayes P, Rodwell V (2003) (LANGE basic science): McGraw-Hill Medical.
7. Proteins: Structures and Molecular Properties. Creighton TE (1993), Macmillan.
8. Biochemistry. Jeremy M Berg, John L Toymoczko and Lubert Stryer, 6th ed., W H Freeman and Co. (2006).

22BCSCT104 - Enzymology
(Soft Core)

Course objectives

- To study general aspects of enzymes, their classification, mechanisms of enzyme reactions using inhibitors and activators.

Course outcome

The student will understand the following:

- Enzymes reactions using inhibitors and activators, kinetic reactions, nature of catalysis, mechanism of action, type of inhibition and their regulation in metabolic reactions.

Total number of lecture hours: 64 **Total number of credits: 04**

Unit I **16 hrs.**

Introduction to enzymes: Nomenclature and classification of enzymes, criteria of purity of enzymes, fold purity, specificity and active site. Units of enzyme activity, IU and Katal. Assay methods - coupled enzyme assays, continuous, end point and kinetic assay.

Enzyme kinetics: Rate of reaction, Michaelis-Menton equation, initial velocity approach and steady state approach. Vmax, Km and their significance. Line Weaver Burk plot. Turnover number. Factors affecting enzyme kinetics - Effect of enzyme concentration, substrate concentration, pH, temperature and activators and inhibitors.

Unit II **16 hrs.**

Kinetics of bi-substrate reactions: Sequential mechanism, compulsory order and random order mechanism, non-sequential mechanism and ping pong mechanism.

Mechanisms of enzyme catalysis: Active site structure, methods of determining active site structure, affinity labelling, chemical modification studies and active site structure investigation.

Unit III **16 hrs.**

Enzyme inhibition: Reversible and irreversible inhibition; competitive, non-competitive, uncompetitive product inhibition and suicide inhibition. Determination of K_i and K_d.

Mechanisms of action of specific enzyme: Chymotrypsin, acid-base catalysis, charge relay network. alcohol dehydrogenase, ribonuclease, carboxypeptidase A, RNA as an enzyme.

Coenzymes: Mechanistic role of nicotinamide nucleotides, flavin nucleotides, pyridoxal phosphate, coenzyme A, as coenzymes in enzyme catalyzed reactions.

Unit IV **16 hrs.**

Monomeric and oligomeric enzymes: Monomeric enzymes - serine proteases, zymogen activation. Oligomeric enzymes - isoenzymes (LDH), multifunctional enzymes (DNA polymerase) and multi-enzyme complexes (Pyruvate dehydrogenase complex).

Allosteric enzymes: ATCase - as typical allosteric enzyme.

Oxygen utilizing enzymes: Generation of reactive oxygen species (ROS), role of mixed function oxidase (monooxygenase), catalase, peroxidase and super oxide dismutase.

Text Books:

1. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry. Palmer T, Bonner PL (2007), Elsevier.
2. Fundamentals of Enzymology. Price NC, Frey PA (2001).
3. Enzyme inhibition and activation. Dixon M, Webb E (1979).
4. The Enzymes. Boyer (1982), Academic Press.

22BCSCT105 - Cell Biology
(Soft Core)

Course objective

- To study the basic components of a cell, cell cycle and cell death.

Course outcome

The student will understand the following:

- Detailed structure of a cell and various organelles.
- Process of cell cycle and cell death and their regulation.

Unit I **16 hrs**

Structural frame work of eukaryotic cell: cytoskeleton, microfilaments, microtubules, and intermediate filaments. Composition, assembly and function.

Plasma membrane: Membrane biogenesis - lipids and proteins, membrane flow hypothesis, membrane lipid and protein turnover. Osmosis, ion channels and active transport.

Micro bodies: peroxisomes, lysosomes and glyoxysomes - role and functions.

Unit II **16 hrs**

Nucleus: Structure, nuclear membrane, nuclear lamins, pore complexes, nuclear matrix composition and its role, cajal bodies, SFCs, nuclear speckles, PML bodies, nucleolus - its structure and functions.

Extracellular matrix and cell-cell interaction: Extracellular components - cell matrix adhesion, collagens - types of collagens, elastin, fibronectins, connective tissues, proteoglycans and laminin. Cell-cell adhesion, cadherins, selectins, integrins, desmosomes, hemidesmosomes, tight junction, gap junction, catenins, actins, tubulins, intermediate filaments and glycosaminoglycans.

Unit III **18 hrs**

Chromosomes: Types of chromosomes, basic structural features, chromosomal banding, molecular organization of eukaryotic chromosome. Nucleosome organization, arrangement of chromatin fibers in a chromosome. C-value paradox. Heterochromatin and euchromatin structures. Structural organization of centromeric region, components and structure of kinetochore. Difference between mitotic kinetochores and meiotic kinetochores. Structural organization of telomeres and proteins involved in heterochromatization of telomeric regions.

Unit IV **14 hrs**

Cell cycle: Cell division: mitosis and meiosis, role of centrioles, role of spindle fibres, comparison of cell division in prokaryotes and eukaryotes. An overview of cell cycle; phases of cell cycle, Cell cycle check points, cell cycle regulatory genes, regulation and control of cell cycle. Types of cyclins (D, E, A, and B), CDK's and their role. Phase transition regulation (G1-S, S-G2, G2-M).

Cell death: Apoptosis, necrosis and autophagy role and mechanism, caspases, calpains and cathepsins. APAF, pro- and anti-apoptotic molecules.

Protein degradation: Lysosomal targeting of protein and degradation and ubiquitin mediated protein degradation.

Text Books:

1. The Cell- A Molecular Approach; Cooper and Geoffrey, M. (2001), Oxford University Press.
2. Cell biology; David E. Sadava; Jones and Bartlett Publishers
3. Molecular Cell Biology. Lodish HF, Berk A, Zipursky SL, Matsudaira P, Baltimore D, et al. (2000), 5th ed., WH Freeman New York.

22BCSCT106 - General Microbiology
(Soft Core)

Total number of lecture hours: 64 **Total number of credits: 04**

Unit I **16 hrs.**

General microbiology: Historical aspects - Discovery of microorganisms. Theory of spontaneous generation. Era of Louis Pasteur. Contributions of Edward Jenner, Louis Pasteur, Joseph Lister, Robert Koch and Alexander Fleming. Microbes and fermentation. Microbes and diseases. Koch's Postulates. General characteristics: morphology, nomenclature and classification of bacteria, yeast, molds, fungi, actinomycetes and rickettesiae.

Staining techniques: Principal, procedure and application of Gram staining, acid-fast staining, endospore staining, flagella staining and fungal staining.

Unit II **16 hrs.**

Cultivation of microbes: Types of growth media (natural, synthetic, complex, enriched, selective- definition with example), pure culture methods (streak plate, spread plate, pour plate, stab culture, slant culture). Anaerobic (thioglycolate, anaerobic chamber, Robertson's media, microaerophilic), liquid shake culture of aerobic bacteria.

Control of microorganisms: Bacteriostatic and bactericidal agents. Physical and chemical methods - Sterilization, disinfection, antiseptic, tyndallisation and pasteurization. Mechanisms of disinfection and sterilization.

Unit III **18 hrs.**

Microbial nutrition: Growth curve of bacteria. Measurement of growth and factors influencing growth. Auxotrophs, autotrophs, heterotrophs, methods of cultivations and preservation of microorganisms.

Bacteria: Classification (based on morphology and flagella), Bergey's manual (in brief). Structure: pili, capsule, cell wall (structure and chemical composition of Gram positive and Gram-negative bacteria), plasma membrane (including mesosomes), cytoplasmic inclusions, nuclear material, and endospores. Reproduction - Vegetative, fission and budding. Genetic recombination - conjugation, transformation and transduction. Cyanobacteria: Morphology/structure and economic importance -Type Study: Spirulina and Anabaena.

Unit IV **14 hrs.**

Viruses: Classification based on morphology, nucleic acids and host. Role of ICTV, structure of TMV and T4 phage. Replication of T4. Economic importance.

Strain improvement methods: recombination using mutagens, protoplast fusion, r-DNA technology, selection of improved strains: Enrichment technique.

Text Books:

1. Pelczar MJ, Chan ECS, Krieg NR, Edwards DD, Pelczar MF (1993) Microbiology: concepts and applications: McGraw-Hill New York.
2. Industrial microbiology. Prescott SC, Dunn CG (1949).
3. Fundamental Principles of Bacteriology. Salle AJ (1984), Tata McGraw-Hill Education.

SEMESTER - II
22BCHCT201 - Metabolism I
(Hard Core)

Course objectives

- To study different aspects of catabolism, anabolism and amphibolic pathways of metabolism.
- To study basic aspects of carbohydrate, lipid, amino acid, protein and nucleic acid metabolism.

Course outcome

The student will understand the following:

- Degradation of carbohydrates via glycolysis, citric acid cycle and its regulations.
- Biosynthesis and degradation of glycogen, cholesterol, purine and pyrimidine nucleotides.
- Process of oxidative phosphorylation, general mechanism of amino acid metabolism.

Total number of lecture hours: 64 **Total number of credits: 04**

Unit I **18 hrs.**

Introduction to metabolism - Catabolism and anabolism. Catabolic, anabolic and amphibolic pathways.

Carbohydrate metabolism - Glycolysis - regulation and energetics. Alternative pathways of glucose oxidation - HMP-shunt pathway and glucuronate pathway. Pathways of utilization of pyruvate-lactate and ethanol. Gluconeogenesis and its regulation. Cori cycle. Glucose paradox. Citric acid cycle and its regulation. Anaplerosis. Glyoxylate cycle. Glycogen metabolism - synthesis, degradation and regulation.

Unit II **14 hrs.**

Lipid metabolism - Biosynthesis and degradation of triglycerols, phospholipids and sphingolipids. α-, β- and ω-oxidation and its regulatory aspects. Role of carnitine in lipid metabolism. Formation of ketone bodies and their oxidation. Cholesterol synthesis, degradation, and regulations.

Unit III **16 hrs.**

Biological oxidation - Biological redox couplers and mitochondrial electron transfer system.

Oxidative phosphorylation - Mechanism of proton pumping. Proton motive force and Mitchell hypothesis. F_0F1-ATPase - structure and mechanism. Coupling of electron transfer to ATP synthesis. Uncouplers, inhibitors and ionophores. P/O ratios, mechanism of oxidative phosphorylation. Substrate level phosphorylation, futile cycles and their application.

Unit IV **16 hrs.**

Amino acid metabolism: General metabolic reaction of amino acids - transamination, oxidative deamination, transdeamination, Urea cycle and its regulation.

Biosynthesis of creatine and creatine phosphate, polyamines - putrescine, spermidine and spermine, glutathione (γ-glutamyl cycle), physiologically active amines (serotonin. γ-amino butyric acid, histamine, and catecholamines - dopamine, epinephrine and nor-epinephrine).

Nucleotide metabolism: Biosynthesis of purine and pyrimidine nucleotides and their inter conversion, regulation of biosynthesis. Degradation of purine and pyrimidines.

Text Books:

1. Fundamentals of Biochemistry. JL Jain (2018), 7th ed., S Chand & Company Limited, New Delhi.
2. Biochemistry. U Satyanarayana and U Chakrapani 5th ed., Elsevier
3. Lehninger Principles of Biochemistry. Nelson DL, Lehninger AL, Cox MM (2008), 6th ed., Macmillan.
4. Biochemistry. Voet D, Voet JG (1995) New York: J. Wiley & Sons.
5. Biochemistry. Zuby G (1988), New York. MacMillan.
6. Harper's Illustrated Biochemistry. Murray R, Granner D, Mayes P, Rodwell V (2003) (LANGE basic science): McGraw-Hill Medical.
7. Biochemistry. Jeremy M Berg, John L Toymoczko and Lubert Stryer, 6th ed., W H Freeman and Co. (2006).

22BCHCT202 - Membrane Biochemistry and Endocrinology (Hard Core)

Course objectives

- To study structure, functions and physiological process of biological membranes.
- To study the mechanism of actions of hormones and their regulations.

Course outcome

The student will understand the following:

- Properties of biological membrane, and different models of membranes explaining the biological functions, membrane asymmetry and other properties using various methods.
- The mechanism involved in transportation of biomolecules across membranes.
- The various endocrine organs in relation to the regulation of various metabolic processes.
- Hypo and hyperactivities of all the endocrine organs and their manifestation in various disorders.

Total number of lecture hours: 64 **Total number of credits: 04**

Unit I **16 hrs.**

Biomembranes: Physicochemical properties of biological membranes and their compositions. Membrane lipids, proteins and carbohydrates and their lateral diffusion.

Models of membrane: Gorter and Grendel's experiment, bilayer structure, Danielle - Davson model of membrane. Singer and Nicholson's model.

Membrane lipid phases, bilayer phase, non-bilayer phase, phase transition, membrane potential and bilayer nature.

Unit II **16 hrs.**

Membrane transport: Laws of diffusion across membranes; simple diffusion, facilitated diffusion and active transport. Glucose transporters, Ca^{2+} ATPase, Na^{+}-K^{+} ATPase (structure and mechanism of action). Endocytosis, receptor mediated endocytosis, exocytosis, ion channels - gated and non-gated, aquaporin channel.

Methods of study of membrane structure: Lipid transfer proteins, phospholipases, freeze fracture and freeze etching. Lipid vesicles - liposome preparations and application.

Unit III **16 hrs.**

Endocrine System: Hormones, classification and chemistry of hormones, hormones of hypothalamus, pituitary, thyroid, parathyroid, pancreas, liver, adrenals, gonads and intestine.

Functions and abnormalities: Hypo and hyper production of hormones secreted by pituitary, thyroid, pancreas, adrenals and gonads.

Chemistry and action of prostaglandins, prostacyclins and thromoxanes.

Unit IV **16 hrs.**

Mechanism of hormone action: Peptide hormones: General mechanisms of cell signaling by hydrophilic factors, transmembrane receptors, G-protein coupled receptors, receptor tyrosine kinase, eicosanoid receptors.

Second messengers: IP3, DAG, cAMP and protein kinases.

Growth factors: Structure, mechanism of action and receptors of EGF, PDGF, NGF and IGF. Insulin receptor.

Text Books:

1. Lehninger Principles of Biochemistry. Nelson DL, Lehninger AL, Cox MM (2008), 6th ed., Macmillan.
2. Biochemistry. Voet D, Voet JG (1995) New York: J. Wiley & Sons.
3. Biochemistry. Zuby G (1988), New York. MacMillan.
4. Harper's Illustrated Biochemistry. Murray R, Granner D, Mayes P, Rodwell V (2003) (LANGE basic science): McGraw-Hill Medical.
5. Biochemistry. Jeremy M Berg, John L Toymoczko and Lubert Stryer, 6th ed., W H Freeman and Co. (2006).
6. Text of book of Biochemistry for Medical Students, DM Vasudevan, S Sreekumari and K Vaidyanathan, 6th ed., Jaypee Brothers Medical Publishers (P) Ltd. New Delhi.
7. Principles of Anatomy and Physiology. GJ. Tortora, B Derrickson,13th ed., John Wiley and Sons, Inc.

22BCHCT203 - Genetics
(Hard Core)

Course objective

- To study basics genetics, chromosomal aberrations, repair mechanisms and regulations of genetic materials.

Course outcome

- The student will understand the following:
- Early genetic work from Mendelian laws up to recent molecular study of genetic principles.
- Basic principles of Mendelian, population genetics and heritable diseases and syndromes.
- The various aberration processes and the repair mechanism.

Unit I **14 hrs**

Basic Principles of Mendelism: Laws of inheritance, dominance, codominance, incomplete dominance, epistasis, independent assortment.

Concept of gene: Allele, multiple alleles, pseudo allele and complementation tests.

Gene linkage and chromosome: Linkage and crossing over, recombination of genes in a chromosome. X-linked inheritance. Polygenic inheritance, Y-chromosome inheritance.

Chromosome number: Ploidy, Karyotyping, sex chromosome and dosage compensation.

Mobile genetic elements, transposons, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy. Pedigree analysis.

Unit II **18 hrs**

Study of model systems: Drosophila, Arabidopsis and human beings.

Chromosome analysis: Karyotyping, Cytogenetic mapping, Fluorescent In-situ Hybridization (FISH) Technique.

Mendelian and chromosome based heritable diseases and syndromes (color blindness, hemophilia, cystic fibrosis, sickle cell anemia and Down's syndrome).

Prenatal diagnosis: Amniocentesis and chorionic villus sampling.

Sex Determination and Dosage Compensation: Sex determination in Drosophila and mammals. Secondary sex determination in mammals. Dosage compensation in Drosophila and mammals.

Unit III **16 hrs**

Mutation: Mutations; Types, causes and detection, mutant types - lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis. Spontaneous and induced mutation, conditional, lethal (temperature sensitive) mutation. Point mutation, base substitution mutation, missense, nonsense and silent mutation. Chemical mutagens, radiation induced mutation, reverse mutations and suppressor mutations - intergenic and intragenic suppression. Ames test.

Unit IV **16 hrs**

Regulation of gene expression in prokaryotes: Operon model, structure and regulation of lac operon and tryptophan operon. Galactose operon; role of two promoters. Arabinose operon; positive control. Tryptophan operon; T attenuation control.

Eukaryotic gene regulation: Regulation of gene expression at the level of DNA structure - super coiling, DNA methylation. Role of nucleosome structure in eukaryotic gene expression.

Text Books:

1. Genetics. B.D. Singh, Kalyani Publishers.
2. Principles of genetics / D. Peter Snustad and Michael J. Simmons, 6th ed., John Wiley & Sons, Inc.
3. Molecular Biology of the Cell. Alberts B, Bray D, Lewis J, Raff M, Roberts K, Peter Walter (1995) 5th ed., Garland Science. Taylor & Francis Group, LLC.
4. Essentials of Cell and Molecular Biology. De Robertis ED, De Robertis EM 1981, Saunders College.
5. Molecular Cell Biology. Lodish HF, Berk A, Zipursky SL, Matsudaira P, Baltimore D, et al. (2000), 5th ed., WH Freeman New York.

22BCSCT204 - Clinical Biochemistry
(Soft Core)

Course objective

- To study health and diseases associated with blood, liver, kidney, gastrointestinal system, endocrine system and metabolic disorders

Course outcome

The student will understand the following:

- Disorders of blood, liver, kidney, gastrointestinal system and endocrine system.
- Metabolic disorders with respect to diabetes and coronary heart diseases.
- Hypo and hyperactivities of all the endocrine organs and their manifestation in various disorders.

Total number of lecture hours: 64 **Total number of credits: 04**

Unit I **16 hrs.**

Basic Concepts: Normal and pathological changes affecting cells in the body.

Blood: Disorders of hemoglobin - Thalassemia and sickle cell anemia. Anemias - microcytic, normocytic and macrocytic.

Cardiovascular disorders: Atherosclerosis and myocardial infraction - risk factors, pathogenesis, diagnosis and prognosis. In myocardial infraction - CK and LDH.

Unit II **16 hrs.**

Liver: Biochemical indices of hepatobiliary diseases. Bile pigments - formation of bilirubin, urobilinogen and bile acids. Jaundice - pre-hepatic, hepatic and post-hepatic.

Diagnosis: Liver function tests. Liver diseases - Hepatitis, cholestasis, cirrhosis and gall stones.

Kidney profile: Assessment of renal function; creatine clearance, renal calculi, uremia. Laboratory investigations of kidney disorders - UTI, kidney stones, nephritis, urolithiasis, and hypouricemia.

Unit III **14 hrs.**

Gastrointestinal disorders: Fractional gastric analysis, hypo and hyper acidity, gastric ulcers, malabsorption syndrome, steatorrhea and diarrhea.

Endocrine disorders: Laboratory diagnosis - function of pituitary, thyroid, adrenals and gonads. Disorders - Grave's disease, Addison's disease, hypo and hyper secretion of hormones. Infertility tests. Thyroid function tests, measurement of TSH, T3 and T4,

Unit IV **18 hrs.**

Metabolic disorders: Disorders of carbohydrate metabolism - Diabetes mellitus, classification, etiology, laboratory investigations - GTT, HbA1c and diabetic complications. Inborn errors of carbohydrate metabolism, glycogen storage diseases, galactosemia, and lactose intolerance.

Disorders of amino acid and protein metabolism: Inborn errors of amino acid metabolism - Phenyl ketonuria (PKU) and Alkaptonuria.

Disorders of Purine and Pyrimidine Metabolism: Gout and Lesch-Nyhan syndrome.

Text Books:

1. Textbook of Biochemistry: with Clinical Correlations. Devlin TM (2011),
2. Basic Medical Biochemistry: A Clinical Approach. Smith CM, Marks AD, Lieberman M (2005), Lippincott Williams & Wilkins.
3. Clinical Biochemistry. Kaplon
4. Handbook of Clinical Biochemistry. Swaminathan (2011), R. 2nd ed., Oxford University Press.
5. Applied Biochemistry of Clinical disorders. Gomal A.G.

22BCSCT205 - Human Physiology
(Soft Core)

Course objective

- To study different physiological systems operating in living organisms.

Course outcome

The student will understand the following:

- Understand various systems and their physiological functions.
- Understand blood and its composition, nervous, respiratory, excretory, digestive and muscle physiology.

Total number of lecture hours: 64 **Total number of credits: 04**

Unit I **16 hrs.**

Blood: Composition, cells, plasma proteins and lipoproteins [High-density lipoprotein (HDL), low-density lipoprotein (LDL), very-low-density lipoprotein (VLDL) and chylomicrons] and their functions. Buffer systems, hemostasis, blood volume, blood pressure and their regulations. Erythrocytes- shape, formation and function. WBC - types, formation, differential count and functions. Platelets - formation and its function. Blood clotting- mechanism of blood clotting, role of vitamin K, clot dissolution and anticlotting factors.

Unit II **18 hrs.**

Respiratory system: Pulmonary and alveolar ventilation and its control, transport of respiratory gases, exchange of gases and respiratory mechanism of acid-base balance. Neural and chemical regulation of respiration.

Nervous system: Divisions of the nervous system, Neurons and other cells of nervous system. Types and structure of neuron. Resting membrane potential and action potential. Mechanism of initiation and propagation of action potential. Voltage gated ion channels (sodium, potassium and calcium). Synaptic transmission. Mechanism of synaptic transmission.

Neurotransmitters- biogenic amines, amino acids and neuropeptides.

Unit III **14 hrs.**

Muscular system: Ultra structure of smooth, skeletal and cardiac muscle fibers. Contractile and other proteins of muscle. Phosphagens and neuro-muscular junctions. Mechanism of muscle contraction. Regulation of contraction in striated and smooth muscle. Calmodulin and its regulatory role.

Unit IV **16 hrs.**

Digestive system: Composition and functions of saliva, gastric, pancreatic and intestinal juices and bile. Gastro-intestinal hormones. Digestion, absorption and transport of carbohydrates, proteins and lipids.

Hepatobiliary system: Anatomy of the liver, hepatocytes, endothelial cells and Kupffer cells. Secretory and excretory function of liver. Formation of bile. Detoxification mechanism of liver.

Excretory system: Structure of the nephron. Composition of urine and mechanism of urine formation. Regulation of acid-base, electrolyte and water balance.

Text Books:

1. Human physiology. Chatterjee CC (1951), Medical Allied Agency, Calcutta.
2. Text of book of Biochemistry for Medical Students, DM Vasudevan, S Sreekumari and K Vaidyanathan, 6th ed., Jaypee Brothers Medical Publishers (P) Ltd. New Delhi.
3. Essentials of Medical Physiology. K Sembulingam and P Sembulingam. 8th ed., Jaypee Brothers Medical Publishers.
4. Principles of Anatomy and Physiology. GJ. Tortora, B Derrickson,13th ed., John Wiley and Sons, Inc.
5. Text book of Medical Physiology. Guyton Aurcher C, Hall John E (2006), Elsevier India Pvt. Ltd. New Delhi.

22BCSCT206 - Nutritional Biochemistry
(Soft Core)

Course objective

- To study the nutritional aspects for the functioning of the body.

Course outcome

The student will understand the following:

- Nutritional values of carbohydrates, lipids, proteins, vitamins, and minerals.
- The various factors affecting the basal metabolism and their physiological functions.
- Beneficial effects of food components in the management of disorders.

Total number of lecture hours: 64 **Total number of credits: 04**

Unit I **16 hrs.**

Nutrition: Concepts of macro and micro nutrients, essential nutrients and their classification. Proximate analysis of foods, chemical and biological analysis for nutrients. Food as source of energy. Methods of determining energy value of foods, calorimetry, Analysis of calorific value of carbohydrates, protein and fats, daily requirement of energy, high and low-calorie diets. Basal Metabolic Rate (BMR) and factors affecting BMR. Specific dynamic action of foods.

Unit II **16 hrs.**

Carbohydrates: Dietary sources, dietary fiber and essentiality of carbohydrates.

Proteins: Essential amino acids, evaluation of nutritive value of dietary proteins, PER, BV, nutritional classification of proteins, supplementary value of proteins and protein calorie malnutrition - Kwashiorkar and Marasmus.

Fats: Sources, invisible fat, essential fatty acids and polyunsaturated fatty acids (PUFA).

Unit III **16 hrs.**

Vitamins: Dietary sources, daily requirements, structure and function of fat-soluble and water-soluble vitamins. Pro-vitamins and anti-vitamins. Hypervitaminosis. Deficiency symptoms of vitamins B1, B2, B3, B5, B6, B7, B9, B12 and C and fat-soluble vitamins.

Minerals: Dietary sources, requirements, functions and deficiency symptoms of macro (sodium, potassium, calcium, magnesium and phosphorus) minerals and micro minerals (chloride, iron, zinc, iodine, copper, molybdenum, and manganese).

Unit IV **16 hrs.**

Diet: Balanced diet, role of different nutrients in health and disease (diabetes and cardiovascular disease patients), bioavailability, energy balance and weight control.

Special dietary needs: Nutritional requirements and dietary management for infants, pregnant and lactating women and elderly.

Nutraceuticals and functional foods: Definition, probiotics and prebiotics as nutraceuticals. Nutritive and non-nutritive food components with potential health effects.

Text Books:

1. Essentials of Food and Nutrition. M. Swaminathan, Ganesh Publishers, India.
2. Biochemistry-The Chemical Reactions of Living Cells. David Metzler, 2nd ed., Academic Press.
3. Nutrition Science. V. Sreelakshmi, revised 2nd ed., New Age International Publishers.
4. Nutritional Biochemistry. Tom Brody (1994), Academic Press.
5. Text of book of Biochemistry for Medical Students, DM Vasudevan, S Sreekumari and K Vaidyanathan, 6th ed., Jaypee Brothers Medical Publishers (P) Ltd. New Delhi.

SEMESTER - III
22BCHCT301 - Molecular Biology
(Hard Core)

Course objective

- To study basics of molecular biology and to know the molecular mechanism involved in the storage and transfer of information from one generation to next generation.

Course outcome

The student will understand the following:

- Historical discovery made and the methodology employed to establish that DNA is the genetic material.
- Molecular process of replication, transcription, translation process while transferring genetic information from DNA to protein via RNA molecules.
- Enzymatic steps involved in each process and their regulations.

Unit I **16 hrs**

DNA Replication: Central dogma of Molecular biology. Experimental evidences - DNA as the genetic material. Messelson and Stahl experiment. Replication of double stranded DNA, direction of replication, discontinuous replication, Okazaki fragments. Prokaryotic and eukaryotic DNA polymerase I, II and III (proof reading activity), DNA ligase, DNA topoisomerases, DNA primase, DNA helicase. Trombone model and rolling circle model. Translesion synthesis (DNA pol IV and V).

Unit II **18 hrs**

Transcription: RNA polymerase I, II and III. Sigma factors, Significance of sigma factor. RNA biosynthesis in prokaryotes and eukaryotes; initiation, elongation and termination (rho-dependent and independent termination). RNA dependent RNA synthesis. Transcription factors and machinery, formation of initiation complex, transcription activator and repressor. Processing of eukaryotic RNA, cap addition, poly A tail addition, RNA editing and splicing. Processing of tRNA and mRNA transcripts. RNA transport.

Unit III **18 hrs**

Translation: Genetic code, triplet codon, universality features of genetic code, assignment of codons, degeneracy of genetic code, wobble hypothesis. Co-linearity of genes and proteins. Ribosomal protein synthesis - formation of initiation complex (40S and 80S), initiation factors and their regulation, elongation and elongation factors, termination. Aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthesis and its role in translation accuracy.

Unit IV **12 hrs**

Post-translation modification of proteins - Phosphorylation, glycosylation, acetylation, sumoylation and ubiquitination. Folding of nascent protein, types and role of chaperones.

Enzymes in DNA and RNA degradation: Nucleases, ribonucleases, classification and role.

Text Books:

1. Molecular Biology of the Cell. Alberts B, Bray D, Lewis J, Raff M, Roberts K, Peter Walter (1995) 5th ed., Garland Science. Taylor & Francis Group, LLC.
2. Essentials of Cell and Molecular Biology. De Robertis ED, De Robertis EM 1981, Saunders College.
3. Molecular Cell Biology. Lodish HF, Berk A, Zipursky SL, Matsudaira P, Baltimore D, et al. (2000), WH Freeman New York.
4. Molecular biology of the gene. Watson JD (1970).
5. Karp's Cell and Molecular Biology. Karp G, Iwasa J, Marshall W. (2019)., 9th ed., New York: Wiley & Sons

22BCHCT302 - Immunology
(Hard Core)

Course objective

- To study basics of immune system including cellular basis and humoral basis of immunity, and immune systems during transplantation.

Course outcome

The student will understand the following:

- Basics involved in cell mediated and humoral mediated defense mechanism.
- Primary and secondary immune response in cell mediated responses and production of cytokines and co-stimulatory molecules in humoral mediated responses.
- Immune response during transplantation and disorders of immunity.
- Vaccines types and their development.

Unit I **16 hrs**

Introduction: History of Immunology, Innate and adaptive immune system. Antigens, antigenicity and immunogenicity. Primary and secondary lymphoid organs. Antigens and antibodies, haptens, epitopes and paratopes. Valency of antigen and epitope analysis.
Classes and subclasses of immunoglobulins. Structure of immunoglobulins, hyper variable region - isotypic, allotypic and idiotypic variation.

Unit II **16 hrs**

Cellular basis of immunity: Humoral and cell mediated immune responses, primary and secondary immune modulation. B, T and accessory cells. Development of B and T cells. Sub sets of B and T cells (T-helper cells, T-killer cells, T-suppressor cells). B and T cell receptors, Toll-like receptors, MHC molecules, antigen processing and presentation. B and T cells interaction.

Unit III **16 hrs**

Non-specific defenses in man: Barriers to infection - skin, mucous membrane, inflammation, complement hyper sensitivity reactions (Type I, II, III and IV).
Cytokines and co-stimulatory molecules - lymphokines, interleukins and functions of TNF-α, IL-lβ and IL-10.
Transplantation: Autograft, isograft, allograft and xenograft. Graft rejection, graft *vs.* host reaction. Immunosuppressive drugs.

Unit IV **16 hrs**

Disorders of immunity: Congenital and acquired immunodeficiencies. Immunological tolerance, autoimmunity, auto immune disorders, AIDS and SCID.
Vaccines: Adjuvants, vaccines and their preparations. Polyclonal and monoclonal antibodies. Hybridoma technique. Recombinant DNA/RNA and protein-based vaccines, plant-based vaccines, and peptide vaccines.
***In vitro* antigen-antibody reaction:** Precipitation, agglutination, complement fixation, immuno diffusion, immunoelectrophoresis, immunofluorescence, RIA, ELISA and ELISPOT assay.

Text Books:

1. Kuby Immunology. Owen JA, Punt J, Stranford SA, Jones PP (2013), WH Freeman New York.

2. Roitt's essential immunology. Delves PJ, Martin SJ, Burton DR, Roitt IM (2011), John Wiley & Sons.
3. Cellular and Molecular Immunology: with student consult. Abbas AK, Lichtman AH, Pillai S (2014), Online Access: Elsevier Health Sciences.

22BCHCT303 - Metabolism II
(Hard Core)

Course objective

- To study high energy compounds, energy utilization, amino acid metabolism, intermediate metabolism and its regulation.

Course outcome

The student will understand the following:

- Hormonal regulation of carbohydrate metabolism during the synthesis of high energy compounds and their utilization.
- Biosynthesis and degradation of amino acids in animals.
- Integration of carbohydrate and lipid metabolism pathways and its regulation

Total number of lecture hours: 64 **Total number of credits: 04**

Unit I **16 hrs.**

High energy compounds: ATP, ADP, creatine phosphate and phosphoenol pyruvate as energy rich compound.

Carbohydrate metabolism - Hormonal regulation of carbohydrate metabolism - insulin, glucagon, catecholamines, growth hormones, corticosteroids and thyroid hormones.

Unit II **16 hrs.**

Lipid metabolism - Biosynthesis of prostaglandins, leukotrienes and thromboxanes. Regulation of fatty acid metabolism. Metabolism of circulating lipids - chylomicrons, HDL, LDL and VLDL. Reverse cholesterol transport by HDL.

Integration of metabolic pathways: Integration of carbohydrate and lipid metabolism, and their regulation and manipulation.

Unit III **16 hrs.**

Biosynthesis of amino acids in animal, plant and microbial systems: Biosynthesis of non - essential amino acids from pyruvate (alanine), intermediates of glycolysis (serine, tyrosine) and TCA cycle (aspartic acid, asparagine, glutamic acid and glutamine), non- essential amino acids (glycine, proline and arginine), and essential and non - essential amino acid (cysteine). Biosynthesis of essential amino acids from aspartate family of amino acids (threonine, lysine and methionine), pyruvate family of amino acids (valine and leucine), pyruvate and α-ketobutyrate family of amino acid (isoleucine) aromatic family of amino acids, glycolysis intermediates (phenylalanine, and tryptophan) and histidine.

Unit IV **16 hrs.**

Catabolism of amino acids in animals: Glucogenic and ketogenic amino acids and their significance. Degradation of amino acids forming pyruvate (alanine, glycine, threonine, serine, cysteine, cysteine and tryptophan) oxaloacetate (aspartic acid and asparagine), α-ketoglutarate (glutamic acid, glutamine, arginine, histidine and proline), succinyl CoA

(valine, isoleucine, threonine and methionine), fumarate (phenylalanine, tyrosine) acetoacetate and/or acetyl CoA (leucine and lysine).

Text Books:

1. Fundamentals of Biochemistry. JL Jain (2018), 7th ed., S Chand & Company Limited, New Delhi.
2. Biochemistry. U Satyanarayana and U Chakrapani 5th ed., Elsevier
3. Lehninger Principles of Biochemistry. Nelson DL, Lehninger AL, Cox MM (2008), 6th ed., Macmillan.
4. Biochemistry. Voet D, Voet JG (1995) New York: J. Wiley & Sons.
5. Biochemistry. Zuby G (1988), New York. MacMillan.
6. Harper's Illustrated Biochemistry. Murray R, Granner D, Mayes P, Rodwell V (2003) (LANGE basic science): McGraw-Hill Medical.
7. Biochemistry. Jeremy M Berg, John L Toymoczko and Lubert Stryer, 6th ed., W H Freeman and Co. (2006).

22BCSCT304 - Advanced Biochemical Techniques
(Soft Core)

Course objective

- To study various advanced techniques involving biochemical principles, microscopy and molecular biology techniques.
- To study isotopes and its application in understanding biological process.

Course outcome

The student will understand the following:

- Different spectral analysis involved in determining the size, shape and structure of different biomolecules.
- Principle and biological application of microscopy.
- Molecular biology techniques in sequencing and amplification of nucleic acids.
- Different types of isotopes and its applications in biological reactions and pathways.

Unit I **16 hrs**

Modern developments in microscopy: FRET microscopy, confocal microscopy, atomic force microscopy and freeze-fracture electron microscopy.

Electron microscopy: Transmission and scanning electron microscopy - principle and applications.

Polarized light: Plane and circularly polarized light, ORD, CD and their applications.

Unit II **16 hrs**

Biochemical methods: Flame photometry, atomic absorption spectroscopy, X-ray crystallography, turbidimetry, nephelometry and immunoturbidimetry.

Flow Cytometry: Principle and design of flow cytometer and cell sorting.

Unit III **16 hrs**

Radioisotope techniques: Heavy isotopes and radio isotopes, nature of radiation sources, radioactive decay, units of radiation, detection and measurement of radioactivity - GM counter and solid and liquid scintillation counter and autoradiography and their applications.

Applications of ^{3}H, ^{14}C, ^{32}P, ^{131}I, and ^{35}S.

Radiolabeling: Labeling of nucleic acids, pulse chase method and carbon dating.

Unit IV **16 hrs**

Electrophoresis: Gradient electrophoresis, isoelectric focusing, two-dimensional gel electrophoresis, diagonal gel electrophoresis, capillary electrophoresis and gel retardation.

Electroblotting: Northern, Southern and Western blotting and their applications.

Molecular biology techniques: DNA fingerprinting, DNA foot printing, nuclease protection assay, RFLP, RAPD, AFLP, PCR, RT-PCR, qPCR, gradient PCR and nested PCR.

N-terminal and C-terminal sequencing of proteins.

Nucleic acid sequencing: Maxam-Gilbert method and dideoxy method.

Text Books:

1. Biophysical Chemistry: Principles and Techniques, A. Upadhyay, K. Upadhyay and N. Nath. 2nd ed., Himalaya Publishing House, Delhi.
2. Physical Biochemistry: Applications to Biochemistry and Molecular Biology. David Freifelder (1982). W. H. Freeman Publishers.
3. Principles and Techniques of Biochemistry and Molecular Biology. Wilson K, Walker J (2010). Cambridge University Press.
4. Principles and Techniques of Practical Biochemistry. Wilson K, Walker JM (2000), Cambridge University Press.
5. Techniques in Molecular Biology, Walker and Gastra (1983) Croom Helm.
6. The Tools of Biochemistry, Cooper TG (1977), John Wiley and Sons, Inc. New York
7. Radiochemical methods (analytical chemistry by open learning) W. Geary, Wiley-India publishing.
8. Fundamental of Light Microscopy & Electron Imaging. Murphy D. B (2001). 1st ed. Wiley-Liss.

22BCSCT305 - Plant Biochemistry
(Soft Core)

Course objectives

- To study photosynthesis, phytohormones, sensory photobiology, secondary metabolites and their role in stress physiology within plant system.

Course outcome

The student will understand the following:

- Harvesting solar energy to chemical energy by photosynthesis, solute transport, photo-assimilate translocation process, nitrogen metabolism, role of plant hormones in different stages of plant development, phytochemicals as secondary metabolites and their role in plant defense system.

Total number of lecture hours: 64 **Total number of credits: 04**

Unit I **16 hrs.**

Photosynthesis: Photosystem I and II, mechanisms of electron transport. Photophosphorylation - cyclic and non-cyclic. Oxygen evolution.

CO_2 fixation in plants - C_3, C_4 and CAM pathways. RUBISCO.

Photorespiration, plant mitochondrial electron transport and ATP synthesis.

Unit II **16 hrs.**

Nitrogen metabolism: Nitrogen cycle, nitrogen fixation - symbiotic and non-symbiotic, formation of root nodules in legumes. Assimilation of nitrate and ammonium ion.

Solute transport and photo-assimilate translocation - uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem. Transpiration. mechanisms of loading and unloading of photo-assimilates.

Unit III **16 hrs.**

Plant hormones: Biosynthesis, mechanisms of action and physiological effects of auxines, gibberlines, cytokinins, ethylene and abscisic acid.

Sensory photobiology: Structure, functions and mechanisms of action of phytochromes, cryptochromes and phototropins.

Stomatal movement, photoperiodism, seed dormancy, juvenility and vernalization.

Unit IV **16 hrs.**

Phytochemicals: Extraction and its types and choice of solvent.

Secondary metabolites: Biosynthesis of terpenes, phenols (flavonoids) and nitrogenous compounds (alkaloids) and their roles as alternative medicine.

Stress physiology: Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses. Mechanisms of resistance to biotic stress and tolerance to abiotic stress. Defense system in plants.

Text Books:

1. Plant Biochemistry. Dey PM, Harborne JB (1997), Academic Press.
2. Introduction to Plant Biochemistry. Goodwin TW, Mercer EI (1983).
3. Biochemistry and Molecular Biology of Plants. Buchanan BB, Gruissem W, Jones RL (2000), American Society of Plant Physiologists Rockville.
4. Concepts in Photobiology: Photosynthesis and Photomorphogenesis. Singhal G (1999) Springer Science and Business Media.
5. Biochemistry and Physiology of Plant Hormones. Moore TC (1979), Springer-Verlag.
6. Plant Physiology. Taiz and Zeiger, 3rd ed., Sinauer Associates, Inc Pub. Massachusetts, USA.
7. Lehninger Principles of Biochemistry. Nelson DL, Lehninger AL, Cox MM (2008), 6th ed., Macmillan.
8. Biochemistry and Physiology of Plant Hormones. Moore, Springer Verlag, New York, U.S.A.
9. A Text book of Plant Physiology and Biochemistry S.K. Verma, S. Chand & Comp., New Delhi.
10. Plant Biochemistry - Bonner and Varner, Academic Press, New York.

22BCSCT306 - Cell culture and Genetic Engineering
(Soft Core)

Course objective

- To study the methodology used in animal cell culture.
- To study the basics of recombinant DNA technology and applications of transgenic animals and plants.

Course outcome

The student will understand the following:

- Basic structure, function and maintenance of an BSL cabinet and be able to work in a good sterilisation technique.
- Basic cell-culture techniques, such as calculation, harvesting of cells, sub-culturing, cryopreservation, etc.
- Importance of animal cell culture for *in vitro* testing of drugs and to produced human and animal viral vaccines and pharmaceutical proteins.
- Principle and methodology employed in DNA recombinant technology.
- The various plasmids/vectors in cloning.
- Importance of restriction enzymes and ligation enzymes in the process of cloning.
- Applications of transgenic animals, plants, gene therapy and their negative impact.

Unit I **14 hrs**

Cell culture techniques: Introduction to plant and animal tissue/cell culture. Laboratory design, aseptic conditions, equipment's and materials used in cell culture. Biosafety Levels (BSL 1-4)

Nutritional requirements of cells and growth media: Types of cell culture media. Basic constituents of media. Balance salt solutions, Minimum essential medium, antibiotics, growth supplements - fetal bovine serum and horse serum. Serum free media. Selection of medium and serum. Conditioned media. Preparation and sterilization of cell culture media.

Physiochemical properties - pH, buffers and temperature.

Unit II **18 hrs**

Animal cell culture: Primary culture, secondary culture, cell line and cell strain. Finite and continuous cell line, morphology of cells in culture. Types of cell cultures - Monolayer, adherent culture, suspension culture, clone culture, mass culture - microcarrier culture (monolayer), stem cell culture and organotypic culture.

Development, characterization and maintenance of cell lines. Phases of cell growth, cell doubling time, trypsinization and cell counting. Cryopreservation and thawing frozen cells. Biological contamination - Bacteria, yeast, mold, virus and mycoplasma.

Applications of cell culture: Importance of plant and animal cell culture to produced therapeutically important secondary metabolites. Application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.

Unit III **16 hrs**

Genetic Engineering: Definition, aims and objectives of recombinant DNA technology, restriction-modification systems, restriction enzymes; type I, II and III, specificity, sticky ends and blunt ends. Gene cloning; genomic cloning, shot gun cloning, cDNA cloning.

Vectors: Plasmids, phage, cosmids and phagemid. Yeast cloning vectors, plant vectors, bacterial artificial chromosome, SV40, shuttle vectors, construction of expression vectors.

Unit IV **16 hrs**

Ligation: Blunt end and sticky end ligation, use of linkers and adopters, homo polymer tailing, colony hybridization, plaque hybridization.

Transformation: Micro injection, electroporation, lipofection, calcium phosphate method, protoplast fusion/somatic cell hybridization and biolistic methods. Transgenic plants and animals, gene knock out.

Applications: Gene therapy, applications in agriculture medicine, industry. GM foods, terminator gene, negative impact of genetic engineering.

Text Books:

1. Principles of gene manipulation and genomics. Primrose SB, Twyman R (2013), John Wiley & Sons.
2. Culture of Animal cells, Freshney, R.I, Wiley Publications, New York.
3. Masters: Animal cell culture- practical approach. Ed. Jhon R.W., Oxford University press, Oxford.
4. Animal cell culture techniques. Ed. Martin Clynes, Springer- Verlag, New York.

SEMESTER - IV
22BCOET401 - Research Methodology
(Open Elective)

Total number of lecture hours: 64 **Total number of credits: 04**

Unit I: **16 hrs**

Introduction to Research Methodology. Meaning, objectives and types of research (qualitative, quantitative, cross sectional, longitudinal, pure, applied, evaluation, historical, survey, exploratory and case study). Significance of Research. Criteria of Good Research.

Methods of research: Qualitative and Quantitative. Systematic review of literature, Features of good research study. Research Ethics (issues relating to referencing and documentation, copyrights, plagiarism, royalty, Intellectual property rights). Reproducibility and accountability.

Unit II **16 hrs**

Definition and kinds of scientific documents – research paper, review paper, book reviews, theses, conference and project reports (for the scientific community and for funding agencies). Components of a research paper – the IMRAD system, title, authors and addresses, abstract, acknowledgements, references, tables and illustrations. Impact Factor, *h*-Index, Citation Index, references and bibliography.

Interpretation and Report Writing: Meaning of interpretation, technique of interpretation, Precaution in interpretation. Significance of report writing, Different steps in writing report, layout of the research report, types of reports, mechanics of writing a research report. Precautions for writing research reports.

Unit III: **16 hrs**

Statistical Methods: Measures of Central tendency and Dispersion. Probability distribution: Binomial, Poisson and Normal. Difference between parametric and non-parametric statistics, Confidence Interval, Errors. Sampling: types, sampling errors.

Quantitative Techniques: Levels of significance, standard deviation, test of significance based on large samples and small samples. Student t test. Regression and Correlation, Chi square test.

Unit IV **16 hrs**

Research Techniques: Computer applications in Biology. Spreadsheet tools: Introduction to spreadsheet, using formulas and functions, Diagrammatic and graphical representation of data. Significance and limitations of diagrammatic and graphical representation of data. Line diagram and bar diagram (simple bar diagram, divided bar diagram, percentage bar diagram, multiple bar diagram and pie diagram), generating charts / graph, Presentation of Power Point Presentation, customizing presentation.

22BCOET402 - Biochemistry in Health and Disease
(Open Elective)

Unit I: **16 hrs**

Introduction: WHO definition of Health and Hygiene, General health care, Factors effecting health and evaluation of health.

Classification of diseases: endemic, epidemic and pandemic.

Disease condition: acute disease, chronic disease, incurable disease, terminal disease, illness, disorder, syndrome and pre-disease.

Biochemistry of life style disorder: Obesity, diabetes millitus, hypertension and myocardial infraction.

Unit II **16 hrs**

Nutrition: Concepts of nutrients, essential nutrients and their classification. Basal Metabolic Rate (BMR), factors affecting BMR. Specific dynamic action of foods. Macro and micronutrients. Food as source of energy. Methods of determining energy value of foods, calorimetry, Analysis of calorific value of carbohydrates, protein and fats.

Carbohydrates: Dietary sources, Essentiality of carbohydrates, Dietary fibers.

Proteins: Essential amino acids, nutritional classification of proteins, supplementary value of proteins, protein calorie malnutrition, PER, EV and chemical score. Kwashiorkor and Marasmus.

Unit III: **16 hrs**

Fats: Sources, invisible fat, essential fatty acids, PUFA.

Vitamins: Fat soluble and water-soluble vitamins, pro-vitamins, antivitamins, dietary sources, daily requirement, function and deficiency symptoms of vitamins. Hyper-vitaminosis.

Unit IV **16 hrs**

Dietary formulation for different age groups: children, adults, old age and pregnancy.

Organ function tests: Liver function tests, Kidney function tests, Thyroid function tests, Adrenal function tests, Pancreatic function tests and Gastric function tests.

Project work
22BCPR403 - Research Work

Major Project

The candidate should submit a project report by the end of final year course on a topic relevant Biochemistry, based on the laboratory experiments/case studies/field studies carried out in a Biochemistry/related industry and should give a power point presentation on the project work.

Adichunchanagiri University

School of Natural Sciences

Question Paper Pattern for Internal Assessment

Time: 1.30 Hours **Max Marks: 30**

I. Answer *any Five* of the following **2 × 5 = 10**

1.
2.
3.
4.
5.
6
7

II. Write notes on *any two* of the following **2 × 10 = 20**

6.
7.
8.

Note: Three tests to be conducted for 30 marks each and the average of the best two will be considered. In addition, assignments and seminars given by each student will be evaluated for 5 marks each. Finally accounted to 40 (30+5+5) Marks as Internal Assessment.

Adichunchanagiri University

School of Natural Sciences

Question Paper Pattern for University Examination

Time: 3 Hours **Max Marks: 60**

I. Answer *any five* of the following **2 × 5 = 10**

1.
2.
3.
4.
5.
6
7

II. Write notes on *any four* of the following **5 × 4 = 20**

8.
9.
10.
11.
12.

II. Write notes on *any three* of the following **10 × 3 = 30**

13.
14.
15.
16.

Note: While setting question paper equal weightage will be given to all the units of the paper.