Mangalore University

Department of Studies in Biochemistry, Mangalore University

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PREAMBLE

Revision of syllabi for the two years' Master Degree (Choice Based Credit System- Semester Scheme) Programme in Biochemistry.

PG BOS in Biochemistry has revised and prepared the syllabi (CBCS based) for the PG course in Biochemistry by giving certain guidelines to offer Hard Core, Soft Core and Open Elective courses with credits to each course amounting to 90 credits for the entire programme.
There are totally 9 Hard Core theory courses, 3 Hard Core practical courses and one Hard core project work in 4th semester with a total Hard Core credit of 53. In the 4th semester, each student has to take up a research project for which 5 credits are allotted. A total of 9 Soft Core theory courses and 3 Soft Core practical courses with a total of 31 Soft Core credits are being introduced. Board of Studies in Biochemistry has carefully chosen two Open Elective courses for the selection by the students from other disciplines, one each in 2ndand 3rd semester, with a total credits of 6. Therefore, grand total credits for the programme = **90.**

We have given choice for the soft core courses in the 1st, 2nd and 3rd semesters.

A detailed skeleton of the entire programme is tabulated for the benefit of the aspiring post graduates. Syllabi of four semesters is prepared and displayed.
Other important aspects such as University question paper pattern, internal assessment examinations, allotment of marks and the approximate dates of the internal exams are being tabulated with a discussion in the BOS.

Programme outcomes

- Skilled human resource development
- Creativity/Innovative thinking, problem solving skills
- Development of leadership quality
- Employability and entrepreneurship
- Communication skills

Programme specific outcomes

The program enables the students in

- Acquire necessary knowledge and skills to undertake a career in research either in industry or in an academic set up.
- Apply the knowledge of experimental approaches to solve problems in the field of core biochemistry.
- Integrate and apply the techniques in analytical biochemistry, Clinical biochemistry, Microbiology, Molecular biology and bioinformatics.
- Scientific knowledge in Cell biology, Diagnostic Biochemistry, Immunology, Enzymology and Genetic engineering.
- Awareness of the biochemical basis of human diseases, non-invasive diagnostics, drug development.

Two-year Master's Degree Programme (Four Semesters)

M Sc Biochemistry (CBCS)

S. No.	Semester	Hard core credits(H)	Soft core credits(S)	Open elective credits	Practical, Project*	Theory	Total credits
1.	I Semester	20	3	-	2 (H)	3(H) +1(S)	23
2.	II Semester	12	9	3	1 (H)	2(H)+4(S)	24
3.	III Semester	12	9	3	2(S)	3(H)+2(S)	24
4.	IV Semester	09	10	-	1(H)*+1(S)	1(H)+2(S)	19
	Total	53	31	6	7	18	90

MSc Biochemistry CBCS (All 4 Semesters)

HARDCORE

Serial No.	Paper code	Title of the paper
1.	BCH 401	Bioorganic & Biophysical Chemistry
2.	BCH 402	Biomolecules
3.	BCH 403	Analytical Biochemistry
4.	BCP 406	General Biochemistry
5.	BCP 407	Biochemical Techniques
6.	BCH 451	Enzymology
7.	BCH 452	Metabolism of Fuel Molecules
8.	BCP 458	Practical Enzymology
9.	BCH 501	Molecular Biology
10.	BCH 502	Immunology
11.	BCH 503	Metabolism of Nitrogen Containing Compounds
12.	BCH 551	Biotechnology
13.	BCH 555	Project

SOFTCORE

Serial No.	Paper code	Title of the paper
1.	BCS 404	Human Physiology
2.	BCS 405	General Microbiology
3.	BCS 453	Nutrition
4.	BCS 454	Plant Biochemistry
5.	BCS 455	Clinical Biochemistry
6.	BCS 456	Bioethics & Biosafety
7.	BCP 459	Experiments in Clinical Biochemistry
8.	BCS 504	Genetics
9.	BCS 505	Nanotechnology
10	BCS 506	Food Science
11.	BCP 508	Experiments in Molecular Biology & Immunology
12.	BCP 509	Experiments in Microbiology & CellBiology
13.	BCS 552	Cell Biology
14.	BCS 553	Bioinformatics & Biostatistics
15.	BCP 554	Experiments in Biotechnology

OPEN ELECTIVES FOR OTHER DISCIPLINES

Serial No.	Paper code	Title of the paper
1.	BCE 457	Biochemistry in Day-To-Day Life
2.	BCE 507	Health and Disease

FIRST SEMESTER

Serial No.	Code	Title	Instruction hours /week	Duration of Examination in hours	Marks	Credits	Theory(T)/ Practical(P)	Hardcore(HC) / Soft core(SC)
1.	BCH 401	Bioorganic & Biophysical Chemistry	4	3	70+30=100	4	T	HC
2.	BCH 402	Bio-molecules	4	3	70+30=100	4	T	HC
3.	BCH 403	Analytical Biochemistry	4	3	70+30=100	4	T	HC
4.	BCS 404	Human Physiology*	3	3	70+30=100	3	T	SC
5.	BCS 405	General Microbiology#						
6.	BCP 406	General Biochemistry	8	6	70+30=100	4	P	HC
7.	BCP 407	Biochemical Techniques	8	6	70+30=100	4	P	HC

*# There is a choice between BC S 404 and BC S 405.

SECOND SEMESTER

Serial No.	Code	Title	Instruction hours /week	Duration of Examination in hours	Marks	Credits	Theory(T)/ Practical(P)	Hardcore(HC) / Soft core(SC)
1.	BCH 451	Enzymology	4	3	70+30=100	4	T	HC
2.	BCH 452	Metabolism of Fuel Molecules	4	3	70+30=100	4	T	HC
3.	BCS 453	Nutrition*	3	3	70+30=100	3	T	SC
	BCS 454	Plant Biochemistry#						
4.	BCS 455	Clinical Biochemistry*	3	3	70+30=100	3	T	SC
7.	BCS 456	Bioethics & Biosafety#						
9.	BCE 457	Biochemistry in Day-To-Day Life	2	3	70+30=100	3	T	SC
8.	BCP 458	Practical Enzymology	8	6	70+30=100	4	P	HC
9.	BCP 459	Experiments in Clinical Biochemistry	8	6	70+30=100	3	P	SC

*# There is a choice between - 1. BCS 453 and BCS 454. & 2. BCS 455 and BCS 456. 3. BC E 457 is an open elective course for other disciplines.

THIRD SEMESTER

Serial No.	Code	Title	Instruction hours /week	Duration of Examination in hours	Marks	Credits	Theory(T)/ Practical(P)	Hardcore(HC) / Soft core(SC)
1.	BCH 501	Molecular Biology	4	3	70+30=100	4	T	HC
2.	BCH 502	Immunology	4	3	70+30=100	4	T	HC
3.	BCH 503	Metabolism of Nitrogen Containing Compounds	4	3	70+30=100	4	T	HC
4.	BCS 504	Genetics*	3	3	70+30=100	3	T	SC
5.	BCS 505	Nanotechnology#						
6.	BCS 506	Food Science $	3	3	70+30=100	3	T	SC
7.	BCE 507	Health and Disease	2	3	70+30=100	3	T	SC
8.	BCP 508	Experiments in Molecular Biology & Immunology	8	6	70+30=100	3	P	SC
9.	BCP 509	Experiments in Microbiology & Cell Biology @	8	6	70+30=100	3	P	SC

*# There is a choice between BCS 504 and BCS 505
$@ There is a choice between BCS 506 and BCP 509

FOURTH SEMESTER

Serial No.	Code	Title	Instruction hours /week	Duration of Examination in hours	Marks	Credits	Theory(T)/ Practical(P)	Hardcore(HC) / Soft core(SC)
1.	BCH 551	Biotechnology	4	3	70+30=100	4	T	HC
2.	BCS 552	Cell Biology	3	3	70+30=100	3	T	SC
3.	BCS 553	Bioinformatics & Biostatistics	3	3	70+30=100	3	T	SC
4.	BCP 554	Practical Biotechnology	8	4	70+30=100	4	P	SC
5.	BCP 555	Project Work *	10	-	70+30=100	5	Project	HC

*BC P 555 Research project work is compulsory to all students.

University theory question paper pattern

Ser. No.	Question type	Marks
1.	Answer any ten questions out of twelve	2 x 10= 20
2.	Answer any five questions out of eight	10 x 5 = 50
	Hard core: Two questions from each Unit and the remaining questions from any of the four units for short answers	
	Soft core: Three questions from each unit and the remaining questions from any of the three units for short answers.	

Internal Assessment (Theory & Practical) Examination

Ser. No.	Description	Test	Marks
1.	At the end of 8th week	C1	30
2.	At the end of 14th week	C2	30
		C1+C2 /2	Average of two

C1/ C2 Theory Marks Allotment

Ser. No.	Description	Marks
1.	Assignment	10
2.	Test	20
	Total	30

Allotment of C1/C2 Practical Marks

Ser. No.	Description	Marks
1.	Practical Test C1	30
2.	Practical Test C2 + Class Seminar	30

I SEMESTER
BIO-ORGANIC AND BIOPHYSICAL CHEMISTRY: BCH 401- HARD CORE

Total number of lecture hours: 56 **Total number of credits: 04**

Course objectives

- To study the acid base concept in bio-organic chemistry.
- To understand the nature of reaction intermediates and the factors affecting reaction conditions.
- To know about reaction types and their kinetics, thermodynamics and effect of thermodynamic parameters on reactions with kinetic aspects.
- To discover various aspects of stereochemistry.

Course outcome:

- The student would understand the acid base concept in bio-organic chemistry and would know the nature of reaction intermediates and the factors affecting reaction conditions.
- The kinetics and energetics of SN1, SN2, reactions, aromatic, nucleophilic and electrophilic substitution by understanding their mechanisms with factors affecting and related named reactions would be understood by the student.
- Basic concept of stereochemistry and applications of stereochemistry would be learnt by studying asymmetric synthesis and use of chiral reagents.

Unit I **14 hrs**

Properties of water: Physical and chemical properties of water, ionization and ionic product of water, structure of liquid water and ice. Unusual properties of water. Hydrophilic, hydrophobic and amphipathic molecules in aqueous solution. Effect of solutes on colligative properties of water. Importance of water in biological systems with special reference to the maintenance of native structure of biological molecules. Biological relevance of pH and pKa, determination of pKa of weak acid. Buffers, buffer action, and buffer capacity. Henderson–Hasselbalch equation, preparation of buffers. Importance of buffers in biological systems (cytosol and blood).

Unit II **14hrs**

Thermodynamics: First law of thermodynamics, basic concepts of entropy and second law of thermodynamics, free energy changes, standard free energy change and its relation to equilibrium constant. Oxidation – reduction reactions in biological systems. **Stereochemistry:** Optical isomerism, chirality, symmetry elements, enantiomers, dia-stereomers, DL and RS notations, racemization, stereoisomerism and geometrical isomerism, cis – trans and E – Z conventions. **Free radicals:** Introduction, formation – photolysis, thermolysis, redox reactions, radical reactions with biomolecules.

Unit III **14hrs**

Mechanism of Bio-organic reactions: Introduction, meaning of the term, kinetic and non-kinetic. Fundamental aspects: Homo and heterolytic cleavage, structure and reactivity of carbocation (C+), carbanion (C-) and carbon free radical (C**.**) characteristic aspects of ionic, radical and concerted reactions, substitution, addition, elimination and rearrangements. Energy profiles of reactions, transition state theory, kinetically and thermodynamically controlled reactions. Reactions SN1, SN2, SN1 neighbouring group participation. E2, Ei, Curtin-Hammett principle. Electrophilic addition to C=O, detailed discussion of all aspects of aldol condensation, related condensations, Michael addition. Esterification and hydrolysis.

Unit IV **14 hrs**

Heterocyclic systems: Occurrence in biological systems, structure and properties of furan, pyrrole, indole, thiazole, imidazole, pyridine, pyrimidine, purine, quinone, pteridine and isoalloxazine containing biomolecules.**Bioinorganic chemistry:** Ligand field theory of complexes, stability of complex ions in solution, kinetics and mechanism of reactions of complex ions. Ligand replacement reactions and electron transfer reactions of organometallic moieties of biological macromolecules (cytochromes, chlorophyll and hemoglobin).

References

1. Physical Biochemistry. Kansal Edward Van Halde. Prentice Hall.
2. Bioinorganic Chemistry; Ei-Ichiro Ochiai, Elsevier (2008).
3. Physical Biochemistry. David Frifielder. 2nd Edn. W.G.Freeman and Co
4. Biochemical Calculations, Irwin H. Segel (1976) 2nd Ed. John Wiley and Sons.
5. Organic Chemistry. R.T. Morrison and R.N.Boyd. 6th Edn. Prentice Hall, India.
6. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications (2012).
7. Principles and techniques of practical Biochemistry. K.Wilson and J. Walker. 4thEdn. Cambridge University press (2012).
8. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Edn. Karen C. Timberlake, Benjamin Cummings, (1999).
9. Physical Chemistry of Macromolecules, C. Tanford.
10. Molecular Cell Biology Baltimore et al., Scientific American Publication (1995).
11. Reaction Mechanisms at a glance, ed. M. Moloney, Blackwell Science (2000).

I SEMESTER- BIOMOLECULES: BCH 402- HARD CORE

Total number of lecture hours: 56 **Total number of credits: 04**

Course objectives:

- To know the various types of biomolecules.
- To understand the classifications and the properties of all the biomolecules.
- To learn the structures and functions of the biomolecules.
- To provide knowledge about the importance of biomolecules in the body.

Course outcome:

- Student will have a strong foundation of biomolecules with the knowledge of their structure, functions, classification and the properties.
- This will facilitate the student to easily grasp the mechanisms of actions and metabolic pathways in the body.
- Student will understand the importance of each type of biomolecule.

Unit I **14 hrs**

Carbohydrates: Structure and classification of carbohydrates, monosaccharides, disaccharides and polysaccharides. Monosaccharides and Disaccharides- Pentoses, hexoses, deoxysugars, amino sugars, muramic acid, neuraminic acid. Linkages in sucrose, lactose and maltose, trehalose and glycosides. Polysaccharides- Homopolysaccharides and heteropolysaccharides; starch, cellulose, glycogen, hyaluronic acid, chondroitin sulphate, chitin, xylans, bacterial cell-wall polysaccharides, blood group polysaccharides.Structure elucidation- degradation, graded acid hydrolysis, periodate oxidation, degradation of oxo-polysaccharides, methylation, acetylation, GC-MS. Glycoproteins- Glycosidic bond, N- and O-glycosylation, carbohydrates in tissue engineering. Proteoglycans- agreecan, syndecan, and decorin. Pectin and pectic polysaccharides. Lectins – characteristics and functions in biological system.

Unit II **14 hrs**

Amino acids -Nomenclature classification of amino acids, Zwitter ionic structure, reaction of amino acids, stereochemistry of amino acid D and L, R and S. physical and chemical properties. Non-standard, non–protein and biologically active amino acids. Essential/non-essential amino acids, Rare amino acids. Naturally occurring peptides. Peptide synthesis– reactive ester method and modified Merrifield solid phase synthesis. **Primary structure**: Elucidation of primary structure of proteins – Determination of amino acid composition, end group analysis, cleavage by enzymes and chemicals, separation of fragments. Manual and modern methods of sequencing and reconstructing the protein sequence. Assignment of disulfide bonds.**Secondary structure**: Peptide bond – structure and conformation, Ramachandran plot. Regularsecondary structure*:* α– helix and other types of helices, β – pleated sheet, irregular, turns, loops and triple helical structures. Helix stabilizing and destabilizing amino acids. Structure of fibrous proteins: K-keratin, silk fibroin and collagen. Motifs (super secondary structure – triose phosphate isomerase, concanavalin-A and Rossmann fold) and domain structure (glyceraldehyde-3-phosphate dehydrogenase). Secondary structure of insulin, ribonuclease.

Unit III **14 hrs**

Tertiary structure: Tertiary structure of lysozyme, myoglobin and chymotrypsin. Forces stabilizing tertiary structure of proteins. Protein denaturation and renaturation.**Quaternary structure and symmetry**: Structure and function of myoglobin and hemoglobin.Cooperative mechanism of oxygen binding to hemoglobin. Abnormal hemoglobin– sickle-cell hemoglobin.**Protein folding pathways**: Protein dynamics – kinetics of protein folding and disulfide bondformation, molecular chaperones and protein disulfide isomerase. Prediction of secondary and tertiary protein structure. Disease related to protein folding – Alzheimer's and mad cow disease. **Lipids-** Classification of lipids. Occurrence and Properties of Fatty Acids, Esters of Fatty Acids, Phospholipids Glycolipids, sphingolipids, gangliolipids, Ceramide, Sphingosine-1-p, LPA, essential/non-essential fatty acids terpenoids, micelles, vesicles, liposome, mixed micelles, trans fatty acids,Prostaglandins, Thromboxanes, Leukotrienes, Cys-leukotrienes, PAF.

Unit IV **14 hrs**

Nucleic Acids – Nucleoside, nucleotides of nucleic acids. Shorthand notation for nucleic acids.Physiochemical properties of nucleic acids- Melting of DNA, Tm, factors affecting Tm, Cot curve, classification of DNA based on cot curve. Chargaff's rule. Watson and Crick model. A, Z DNA other models of DNA structure, Hoogsten base pairing. Other secondary structural features in DNA-stem loop structure, Cruciform - Supercoiled, bend, triplex and G-DNA, DNA – RNA hybrids, forces stabilizing the structure of DNA. Denaturation- hypochromic and hyperchromic effect. Renaturation kinetics-effect of salts and complexity. Hybridization and its significance. Structures of different RNAs-mRNA, rRNA, tRNA, SnRNA, miRNA, SiRNA and parasitic RNAs (viroid and satellite RNA). Primary, secondary and tertiary structure of tRNA. Chemical method of synthesis of oligo nucleotides -phosphoramidite method. Sequencing of DNA- Maxam and Gilbert and Sangers method. Rapid sequencing methods and new generation DNA sequencers. RNA sequencing. Isolation of nucleic acids from natural sources.

References

1. Lehninger- Principles of Biochemistry-DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications (2012).
2. Biochemistry VI Edition; Jeremy M Berg, John L Toymoczko and LubertStryer, W H Freeman and Co. (2006).
3. Biochemistry; David Rawn, J, Neil Patterson Publishers (1989).
4. Complex Carbohydrates, Sharon, N. Addison Wisely, (1975).
5. Nucleic acid Biochemistry and Molecular Biology, Mainwaring et al., Blackwell Scientific (1982).
6. Principles of Biochemistry; Smith et al., McGarw Hill (1986).
7. Proteins Structures and Molecular Properties 2nd Edn. Thomas E. Creighton, W H Freeman and Co. (1993).
8. Principles of Protein Structure, Function, & evolution, Dickerson & Geis 2nd Ed. Benjamin-Cummings (1983).
9. Biochemistry Ed. Donald Voet& Judith G. Voet, John Wiley & Sons, Inc.(2010).

I SEMESTER –ANALYTICAL BIOCHEMISTRY: BCH 403 - HARD CORE

Total Number of Lecture Hours: 56 **Total Numbers of Credits: 04**

Course objectives

- To understand the use of animal models in various experiments
- To learn different techniques in cell fractionation
- To know various chromatographic techniques
- To study the principle and applications of different electrophoretic and spectroscopic techniques
- To have knowledge of use of isotopes in biochemistry.

Course outcome:

- Students get to learn how to measure errors in estimations
- Various techniques such as cell fractionation, centrifugation, chromatography, electrophoresis, spectroscopy would be known by the student
- Knowledge of isotopes and their applications in biochemistry would be clear.

Unit I **14 hrs**

Preliminary techniques in Biochemistry: Animal and plant models, Investigation with isolated organs and tissues, Introduction to animal and plant cell culture. Investigation with microorganism and their mutant (auxotroph), yeast, *Ceanorhabditis elegans*, *Arabidopsis thaliana* and *Drosophila melanogaster* as model specimen for biochemical investigations. **Cell fractionation techniques**: Cell lysis, homogenization, extraction, salting in, salting out, dialysis and ultra -filtration. **Centrifugation:** Basic principles of sedimentation, types of centrifuges and rotors. Preparative Centrifugation – Differential and Density gradient, Sub-cellular fractionation, Marker enzyme analysis, Analytical Centrifugation - application and design.

Unit II **14 hrs**

Chromatography: Introduction, partition coefficient, Modes of chromatography, liquid and solid phases, paper chromatography andThin-layer Chromatography (TLC):Principle, procedure and application, Column chromatography:Basic components, selection of stationary and mobile phase, matrices. Adsorption chromatography (hydroxyapatite and Hydrophobic interaction), Partition (normal phase and reverse phase) Ion exchange (Cation and anion exchange), Gel filtration, affinity chromatography, High performance liquid chromatography (HPLC), Fast protein liquid chromatography (FPLC), Gas liquid chromatography (GLC).

Unit III **14 hrs**

Electrophoretic techniques: Principle, Non-denaturing, denaturing electrophoresis, agarose gel electrophoresis, isoelectric focusing, pulsed field electrophoresis, capillary electrophoresis, Visualizing separated components - staining for proteins and nucleic acids, fluorescence, PAS staining, zymogram. **Spectroscopic techniques**: Beer-Lambert's Law and its limitations, Extinction coefficient, Principles& Applications: Colorimeter, UV-Vis Absorption spectroscopy, Fluorescence Spectroscopy, Mass spectrometry, Infrared and Raman Spectroscopy, Nuclear Magnetic Resonance, Electron Spin Resonance, Circular dichroism spectroscopy, X-ray crystallography.

Unit IV **14 hrs**

Isotopes in Biochemistry: Isotopes, Types of radioactive decay, Units of radioactivity, Interaction of radioactivity with matter, Detection and measurement of radioactivity: Methods based on gas ionization (Geiger-Muller counter), Excitation (Scintillation counting) and Photographic methods. Specific activity, commonly used isotopes (Tritium, Carbon-14, Phosporous-32, Sulfur-35, Iodine-131), Advantages and restriction of radiotracer experiments, safety aspects, Applications of radioisotopes in biological sciences.

REFERENCES:

1. Freifelder D. M. Physical Biochemistry- Application to Biochemistry and Molecular Biology, 2nd ed., W.H. Freeman, 1982.
2. Principles and Techniques of Biochemistry and Molecular Biology, ed., Keith Wilson & John Walker, March 2010, Cambridge Univ. Press.
3. West & Todd. Biochemistry. 4th ed., Oxford and IBH.
4. Upadhyay and Upadhyay. Biophysical Chemistry

I SEMESTER - HUMAN PHYSIOLOGY: BCS 404 SOFT CORE

Total Number of Lecture Hours: 42 **Total Number of Credits: 03**

Course objectives:

- To know the detailed account of blood and its components.
- To learn the origin of hormones and their functions.
- To understand the basic concepts of human body organs.
- To learn anatomy and physiology of each organ system.

Course outcome:

- Student will have a better understanding of the whole body.
- He would be able to correlate the functioning of the body with the basic knowledge on human physiology.
- Student would be able to take care of himself/herself and educate the people around for a healthy living.

Unit I **14 hrs**

Blood: Composition, cells, plasma proteins and lipoproteins. Erythrocytes-structure and function, WBC-types, differential count, functions. Platelets and function. Buffer systems, homeostasis, blood clotting, digestion of clot, anti-coagulants, blood volume, blood pressure and their regulation. Plasma lipoproteins and their function. HDL, LDL, VLDL, chylomicrons. CSF-composition and function. Physiological buffers, Acid-base balance, role of lungs and kidney. **Nervous System**: Divisions of the nervous system, receptors, neurons and other cells of nervous system. Types and structure of neuron. Resting membrane potential and action potential, neuronal transmitters, Membrane models: Fluid mosaic model, Singer and Nicholson model, post-synaptic potential. Autonomous nervous system. Brief account of central nervous system. **Biochemistry of Vision:** Different types of cells, Rhodopsin, cones rods, color vision, taste, olfactory organs and audio responses.

Unit II **14 hrs**

Muscular System: Smooth, skeletal and cardiac muscles. Contractile and other proteins of muscle. Fine structure of the muscle fibre, neuron-muscular junctions, Fast and slow muscle. Phosphagens. Muscle Biochemistry-excitation of striated muscle, changes occurring at sarcolemma, transverse-tubular system and sarcoplasmic reticulum, mechanism of muscle contraction. Regulations of contraction in striated and smooth muscle. Calmodulin and its regulatory role, muscular dystrophies. **Respiratory System:** Lungs, structure and functions. Gas exchange, oxygen binding by hemoglobin, factors affecting oxygenation. Acid-base balance. **Excretory System:** Kidney-structure of the nephron. Formation and composition of urine, urine analysis for abnormal constituents, tubular functions tests. Nephritis and nephrosis, Regulation if acid-base, electrolyte and water balance. Respiratory and metabolic acidosis and alkalosis.

Unit III **14 hrs**

Hepatobiliary System: Anatomy of the liver, blood supply, cells-hepatocytes, endothelial cell and Kupffer cell. Secretory and excretory function-formation of bile **Gastrointestinal System**: GI tract, digestion and absorption of carbohydrates, proteins and lipids. Mechanism of HCI production in the stomach. Gastrointestinal hormones. Role of pancreas. **Endocrine System**: Endocrine organs in man. Structure and control of hypothalamus. Role of receptors in hormones. Hormones produced GRH, Somatostatin, TRH, CRH, GnRH. Pituitary-anatomy and structure. Hormones of anterior, posterior and median lobes. Pro-opiomelanocortin. Thyroid, parathyroid, adrenal, Gonads -testes and ovaries. Menstrual cycle. Hypothalamus-Pituitary target organ axis and regulation by feed -back mechanism. Peptide hormones**.**

References:

1. Pal, G.K. Textbook of Medical Physiology, Ahuja Publishing House, Delhi, 2007.
2. Hall. J.E. Guyton and Hall Textbook of Medical Physiology. 12th ed. Saunders, Elsevier Inc., 2011.
3. Barrett KE, Brooks HL, Boitano S and Barman SM, Ganong's Review of Medical Physiology, 23rd Ed., McGraw-Hill Medical, 2009.

I SEMESTER- GENERAL MICROBIOLOGY: BCS 405- SOFTCORE

Total Number of Lecture Hours: **42 Total Numbers of Credits: 03**

Course objectives:

- To have an overall picture of Microbiology with the background of historical aspects.
- To know the techniques used in microbiology laboratories.
- To understand various microbes by their classification, properties, life cycles, growth media and so on.
- To cultivate and control microorganisms.

Course outcome:

- Student would learn the existence of microorganisms around us. This would facilitate each student to have awareness about havoc caused by pathogenic microbes present in the surrounding atmosphere.
- Student would be able to differentiate between the useful and harmful microorganisms.
- He /She would learn the structure and functions of microscopic organisms.

Unit I **14 hrs**

Introduction to Microbiology – Scope of Microbiology - Ancient Microbiology - Refutation of a biogenesis: discovery of penicillin: discovery of vaccination: proposal of one gene one enzyme hypothesis - Major contribution of scientists– Leeuwenhock, Edward Jenner, Alexander - Flemming, Joseph Lister, Robert Koch, Louis Pasteur, Hargobind Khorana. Modern Microbiology - Landmark achievements in 20th century - Microbial Taxonomy - Definition and systematics, Nomenclatural rules and identification. Haeckel's three kingdom classification.

Role of Microorganisms in Nature, Sterilization Techniques (Physical and Chemical methods) Microscope: Principles and working of Bright Field Microscope, Dark Field Microscope, Florescent, Phase Contrast, Confocal Microscopy, Electron Microscopy, Microscope (SEM and TEM), Instruments in Microbiology.

Unit II **14 hrs**

Biology of Microorganisms: Differences between prokaryotic and eukaryotic cell. Biology of bacteria - cell structure, size, shape, arrangement membrane, cell wall, cytoplasmic inclusions, mesosomes, flagella and motility, slime, capsule, pili, chemotaxis, endospore - biology of fungi, structure, physiology and classification – biology of yeast – reproduction - virus (bacteriophages) structure, life cycle (lytic and lysogenic) – biology of algae – Mycoplasma – prions.

Microbial nutrition: Microbial nutrient requirements – macro-nutrients, micro-elements – growth factors - sources of nutrients – nutritional classification of bacteria - Phototroph, Chemotroph, Autotroph (lithotroph), Heterotroph (organotroph), Photoautotroph, Photoheterotroph, Chemoautotroph, Chemoheterotroph - Nutritional patterns of pathogens – Saprophytes - Auxotroph

Unit III **14 hrs**

Extremophiles: Diversity of microorganisms of arctic, Antarctic and hydrothermal vents – Archaeal biology - Acidophile, Alkaliphile, Anaerobe, Cryptoendolith, Halophile, Hyperthermophile, Hypolith, Lithoautotroph, Metal-tolerant microbes, Oligotroph, 4 Osmophile, Piezophile, Polyextremophile, Psychrophile/Cryophile, Radioresistant, Thermophile, Thermoacidophile, Xerophile – mechanism of extremophiles.

Cultivation and control 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 microbes- Sterilization, disinfection, antiseptic, tyndallisation, pasteurization: Physical- dry heat, moist heat, UV light, ionizing radiation, filtration, HEPA filter, Chemical methods. Biofilms & Quorum Signaling.

References:

1. Pelczar Jr, M.J. Chan, E.C.S. and Kreig, N.R. (1993). Microbiology, Mc. Graw Hill.Inc.New York.
2. Ginsberg (1990). Microbiology (4th edition).J.B. Lippincott company, New York.
3. Heritage,J. Evans E.G.V. and Killington, R.A. (1996). Introductory Microbiology. Cambridge University Press.
4. Prescott LM Harley JP and Klein DA (2006). Microbiology (7th edition) McGraw Hill, New York.
5. Schaechter M and Leaderberg J (2004). The Desk encyclopedia of Microbiology. Elseiver Academic Press, California
6. Elizabeth Moore-Landecker. (1996). Fundamentals of the fungi (4th edition). Prentice Hall International, Inc, London.
7. Madigan MT Martinko.JM and Parker J Brock TD (1997). Biology of Microorganisms (8th edition). Prentice Hall International Inc, London.

I SEMESTER - GENERAL BIOCHEMISTRY: BCP 406

PRACTICAL - HARD CORE: 4 **CREDITS-8 HOURS/WEEK**

Course objectives:

- To establish broad knowledge of general biochemistry.
- To impart the basic analytical and technical skills to work effectively in biochemistry laboratories.
- To perform accurate quantitative measurements with an understanding of the theory and use of instrumentation, interpret experimental results, perform calculations on these results and draw reasonable accurate conclusion.

Course outcome:

- Students will have the ability to think critically and analyze biochemical problems.
- They can present scientific and technical information resulting from laboratory experimentation in both written and oral formats.
- They are in a position to explain the principle, instrumentation and applications of colorimetric analysis of various biochemical compounds.

Experiments:

1. Buffers: a) Introduction b) Preparation
2. Quantitative determination of protein concentration by Biuret method.
3. Estimation of proteins by Lowry's method.
4. Estimation of proteins by Bradford method.
5. Bicinchonic acid protein assay.
6. Measurement of protein concentration by UV spectroscopy.
7. Estimation of glucose by Dinitrosalicylic acid method.
8. Estimation of glucose by Anthrone method.
9. Estimation of ascorbic acid by DNPH method.
10. Estimation of inorganic phosphate by Fiske- SubbaRaw's method.

REFERENCES:

1. Introduction to practical Biochemistry. David T. Plummer
2. Lab Manual of Biochemistry. By Nigam. 2007. Tata McGraw-Hill Education, USA.

I SEMESTER - BIOCHEMICAL TECHNIQUES: BCP 407

PRACTICAL - HARD CORE: 4 CREDITS-8 HOURS/WEEK

Course objectives:

- To use different types of chromatographic techniques to detect amino acids, lipids and carbohydrates.
- To characterize oil and fat to check their purity.
- To use various techniques to purify proteins.
- To separate and detect proteins using electrophoretic techniques.

Course outcome:

- Students would gain knowledge about the biochemical techniques and their applications in day to-day life.
- Students will also learn skills to detect, characterize, purify and separate various biomolecules using different techniques which will be helpful in their research after PG course and also while working in R & D departments of pharmaceutical companies.

Experiments:

1. Detection of amino acids by circular chromatography
2. Detection of amino acids by ascending chromatography.
3. Detection of amino acids by descending chromatography.
4. Detection of amino acids by 2D- paper chromatography.
5. Detection of amino acids by thin layer chromatography.
6. Detection of lipids by thin layer chromatography.
7. Detection of carbohydrates by paper chromatography.
8. Saponification number of oil and fat.
9. Iodine number of oil and fat.
10. Acid precipitation of proteins.
11. Preparation of casein from milk and qualitative estimation of proteins.
12. Purification of proteins: Ammonium sulphate precipitation (salting out), Dialysis, Ion exchange, Gel filtration.
13. Separation and detection of proteins – Native PAGE, Denaturing PAGE, IEF.
14. Agarose gel electrophoresis – DNA.

REFERENCES:

1. Practical Clinical Biochemistry, Harold Varley, Interscience Publishers Inc, 2002
2. Clinical Chemistry: Theory, Analysis and Correlation. Kaplan, L.A. and Pesce, A.J., 4th ed. Mosby, 2003.
3. Introduction to practical Biochemistry. David T. Plummer
4. Nigam. 2007. Lab Manual of Biochemistry. By. Tata McGraw-Hill Education, USA

II SEMESTER- ENZYMOLOGY: BCH 451-HARD CORE

Total Number of Lecture Hours: 56 **Total Number of Credits: 04**

Course objectives

- To study the isolation, characterization of enzymes and enzyme kinetics
- To learn various types of inhibitions of enzymes and nature of enzyme catalysis
- Cooperativity and mechanism of action of enzymes
- Fast reactions, multienzyme complex and isoenzymes

Course outcome

- The student understands the isolation, characterization of enzymes and enzyme kinetics
- Various types of inhibitions of enzymes and nature of enzyme catalysis
- Mechanism of enzyme action, cooperativity, multimolecular forms of enzymes.

Unit I **14 hrs**

Introduction to enzymes: Nomenclature and IUB classification of enzymes. Nature of enzymes, localization, isolation, precautionary techniques for purification, characterization of enzymes. Criteria of purity for enzymes. Active site structure. Methods of determining active site, Structure-isolation of ES complex, affinity labeling, chemical modification studies. Active site structure investigation. Units of enzyme activity, specificity and specific activity of enzymes. Assay methods-coupled enzyme assays, continuous, end point and kinetic assay. **Enzyme Kinetics**: Rate of reaction, order and molecularity. Michaelis-Menton equation, initial velocity approach, steady state approach. Vmax, Km and their significance. Linear transformation of Michaelis-Menton equation- Line weaver Burk plot, Eddie Hofstee, Haynes- Wolf and Cornish-Bowden plot. Turnover number.

Unit II **14 hrs**

Inhibition-Competitive, non-competitive, un-competitive and product inhibition. Irreversible inhibition-suicide inhibition. Determination of Ki. **Bi-substrate Reaction**- Cleland's notation with examples or ordered, Ping-Pong, and random. General rate equation. Primary and secondary plots. **Nature of Enzyme Catalysis**-Transition state theory, proximity and orientation, orbital steering, acid base catalysis, covalent catalysis, metal ion catalysis, nucleophilic catalysis, intermolecular catalysis, entropy effects. Effect of temperature and pH on enzyme catalyzed reaction.

Unit III **14 hrs**

Cooperativity- Binding of ligands to macromolecules-scatchard plot, cooperativity, positive and negative cooperativity. Oxygen binding to hemoglobin. Hill equation, homotropic and heterotrophic effectors, aspartyl transcarbamoylase as an allosteric enzyme. ATCase. **Mechanisms of Action of Specific Enzyme**- Chymotrypsin, zymogen activation, acid-base catalysis, charge relay network. Lysozyme, Alcohol dehydrogenase, Ribonuclease, Carboxypeptidase A, RNA as enzyme, Co-enzymic action of NAD, FAD, TPP, PLP, biotin, CoA, Folic acid, Lipoic acid.

Unit IV **14 hrs**

Multimolecular Forms-LDH, multifunctional enzyme (DNA polymerase), multi enzyme complex (PDC), feedback regulation. **Metabolic Regulation of Enzyme Activity**- Feedback regulation, fine control of enzyme activity. **Fast Reactions**- Stopped flow, temperature jump method with examples of enzymes. Immobilization of enzymes, Applications of enzymes in medicine and industries, synzymes, abzymes.

References

1. Fundamentals of Enzymology; 3rd Edn. Nicholas C. Price and Lewis Stevens, Oxford University Press (2012).
2. Enzymes; Trevor Palmer, East – West Press Pvt. Ltd., Delhi (2004).
3. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis; Robert A.Copeland , Wiley-VCH Publishers (2000).
4. Enzyme Kinetics and Mechanism; Paul F. Cook, W. W. Cleland, Garland Science (2007).
5. Biochemical Calculations, Irwin H. Segel (1976) 2nd Ed. John Wiley and Sons.
6. Methods in Enzymology; Colowick S.P. et al., Vol. 152, Academic Press, (1987).
7. Methods of Enzymatic Analysis; Berg Meyer Vol. 1-X, (1974).
8. Basic Biochemical Laboratory Procedures and Computing, R. Cecil Jack (1995) OxfordUniversity.
9. Enzyme Kinetics; Roberts, D.V. (1977), Cambridge University Press.
10. The Enzymes; Boyer, Academic Press, (1982).
11. Enzyme Kinetics; Irwin H. Segel (1976) Interscience-Wiley.
12. Enzyme Kinetics; the Steady state approach; Engel, P.C. (1981) 2nd Edn. Champman andHall.
13. Nature of Enzymology; Foster, (1980), Croom Helm.
14. Principles of Enzymology for Food Sciences; Whitaker, Marcel Dekker (1972) AcademicPress.
15. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry; Trevor Palmer (Edn)Horwood Chemical Science Series.
16. Introduction to Enzyme and Co-enzyme Chemistry. Ed. T. Bugg, (2000), BlackwellScience.
17. An Introduction to Enzyme and Coenzyme Chemistry; Timothy B. Bugg, (1997) and Bartlett publishers.
18. Lehninger Principles of Biochemistry; D.L.Nelson and M.M. Cox, 6th Edn. MacMillanPublications (2012).
19. Principles of Biochemistry; Smith *et al*., Ed. McGraw Hill,(1986).

II SEMESTER- METABOLISM OF FUEL MOLECULES: BCH 452- HARD CORE

Total Number of Lecture Hours: 56 **Total Number of Credits: 04**

Course objectives:

- To learn basic concepts of bioenergetics
- To know the mitochondrial electron transport
- To understand the metabolic pathways of carbohydrates and lipids
- To study the synthesis and breakdown of phospholipids

Course outcome:

- Studentlearns basic concepts of bioenergetics such as high energy phosphate donors, biological redox couplers, anabolism, catabolism, etc.,
- To know the mitochondrial electron transport which comprises cytochromes, proton transfer, P/O ratio and so on.
- To understand the metabolic pathways of carbohydrates and lipids.
- To study the metabolic pathways of phospholipids, sphingolipids, glycolipids such as

Unit I **14 hrs**

Bioenergetics-Basic concepts of metabolic energy capture and transfer. Biochemical energetics, group transfer reactions of ATP, phosphate group transfer potential of ATP and other high energy phosphate donors. Stages inextraction of energy from fuel molecules. Biological redox couplers, participation in oxidative metabolism. Free energy changes in electron transfer reactions. Catabolism, anabolism, catabolic, anabolic and amphibolic pathways. **Carbohydrates-** Glycolysis, energetics, regulation. Pathways of utilization of pyruvate, lactate, ethanol, gluconeogenesis, regulation, Cori cycle, citric acid cycle, its regulation, energetics, anapleurosis, glyoxylate cycle, HMP shunt pathway interconversion of hexoses. Biosynthesis of sucrose, starch and glycogen.

Unit II **14 hrs**

Mitochondrial Electron transport- Entry of reducing equivalents for oxidation-malate aspartate shuttle, glycerol phosphate shuttle. Organization of respiratory chain complexes, structure and function of the components Fe-s proteins, cytochromes, Q cycle, proton transfer, P/O ratio, respiratory control, oxidative phosphorylation, un-couplers and inhibitors, sequence of electron carriers based on redox potentials. ATP synthesis, ATP synthase complex, binding change mechanism, proton motive force, Mitchell's hypothesis.

Unit III **14 hrs**

Lipids- Degradation of triacylglycerols and phospholipids- lipase, hormone sensitive lipase phospholipases. Fatty acid degradation -Beta oxidation, Knoop's experiment, saturated and unsaturated FA, Regulation, α and ω oxidation, Energetics, Biosynthesis of FA- FA synthetase complex, chain elongation and desaturation. Pathways in animals, conversion of linoleate to arachidonate (scheme only). Cholesterol Biosynthesis and Dehydration, regulation, Metabolism of circulating lipids-chylomicrons, HDL, LDL and VLDL. Reverse cholesterol transport by HDL. Oxidized lipids and their metabolism.

Unit IV **14 hrs**

Phospholipid Biosynthesis- *De novo* pathway and inter conversion, biosynthesis of sphingolipids ether lipids and glycolipids. Degradation and biosynthesis of gangliosides and cerebrosides disorders. Tay Sach's disease, Nieman-Pick disease. Fabry's disease. Biosynthesis of prostaglandins, thromboxanes, leukotrienes. Integration of carbohydrate and lipid metabolism, glucose paradox.

References:

1. Biochemistry, Zubey GL. 1998 4th Ed. WCB London.
2. Biochemistry; David Rawn, J, Neil Patterson Publishers (1989).
3. Biochemistry, Ed. Donald Voet& Judith G. Voet, John Wiley & Sons, Inc.(2010).
4. Lehninger, Principles of Biochemistry; D.L.Nelson and M.M. Cox, 6th Edn. MacMillan Publications (2012).
5. Principles of Biochemistry; Smith *et al*., Ed. McGraw Hill,(1986).

II SEMESTER –NUTRITION: BCS 453 SOFTCORE

Total Number of Lecture Hours: 42 **Total Number of Credits: 03**

Course Objectives

- To study the role and importance of different food components.
- Study the dietary formulation for different age groups.
- Importance of micronutrients and trace elements.
- Study the food and drug interaction

Course outcomes

- Expertise in food component in metabolism and physiology.
- Expertise in principles of techniques used in food industries
- Expertise in Pharmacological aspects of food-drug interaction
- Know the importance of vitamins in health and disease.

Unit I **14 hrs**

Nutrition-Concepts of nutrients, essential nutrients and their classification. Proximate analysis of foods. Chemical and biological analysis of nutrients. Methods of determining energy value of foods, calorimetry, Basal Metabolic Rate (BMR), factors affecting BMR. Specific dynamic action of foods. **Macro and micronutrients**: Sources, requirements, functions and deficiency symptoms, biochemical role, assay procedures. **Water***:* Distribution in the body, function, special properties of water, water balances and factors affecting water balance. **Carbohydrates**-Dietary sources, Essentiality of carbohydrates, Dietary fibres.

Unit II **14 hrs**

Proteins-Essential amino acids, nutritional classification of proteins, supplementary value of proteins, protein calorie malnutrition, PER, EV and chemical score, Kwashiorkor and Marasmus, Nitrogen balance, Malnutrition, protein calorific value. **Fats**-Sources, invisible fat, essential fatty acids, PUFA. **Dietary formulation** for different age groups: children, adults, old age and pregnancy.

Unit III **14hrs**

Vitamins-Fat soluble and water-soluble vitamins, pro-vitamins, antivitamins, dietary sources, structure, daily requirement, function and deficiency symptoms of vitamins. Hyper-vitaminosis, vitamin-like compounds. Biochemical role, Assay methods, Disorders. **Food Drug Interaction:** Pharmacological aspects of food-drug interaction, Risk factors, Effect of Drugs on food and nutrition, Modification of drug action by food and nutrition.

References:

1. Nutritional Biochemistry, Tom Brody (1994) Academic Press.
2. Frontiers in Nutrition, Ed. T. Wilson and N.J. Temple, (2000), Humana
3. Nutrition & Health in Developing Countries, eds. R. Semba and M.W. Bloem, (2000), Humana.

II SEMESTER – PLANT BIOCHEMISTRY: BCS 454 SOFTCORE

Total Number of Lecture Hours: 42 **Total Number of Credits: 03**

Course Objectives

- To study the overall plant metabolism and physiology
- Assessment of the plant respiratory mechanism in detail
- To study photosynthesis (light reactions and carbon cycle)
- Evaluation ofassimilation of mineral nutrients.

Course Outcomes

- Knowledge in plant cell structure, metabolism and physiology.
- Familiarity in photosynthetic pathway and regulation.
- Awareness in plant defense and secondary metabolites.
- Familiarity in stress physiology and host parasite interaction

Unit I **14 hrs**

Plant cell: Overview of plant structure, major tissues in plant, structure and components of a plant cell, plant cell membrane and constituents, transport systems across cell membrane, genome organization in plant (nucleus, plastids and mitochondrial). **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 assimilation. **Respiration**: Plant Glycolysis-cytosolic and Plastidic process; plant mitochondrial electron transport and regulation.

Unit II **14 hrs**

Photosynthesis (Light reactions and carbon cycle): Photosynthetic apparatus in plants, photosystems I and II, light harvesting antenna complex. Electron flow and phosphorylation; cyclic and noncyclic, oxygen evolution, Calvin cycle, C3, C4, and CAM cycle. Photorespiration, regulation of photosynthesis, RUBISCO. **Plant hormones**: Biosynthesis, storage, breakdown and transport. Physiological effects and Mechanisms of action of auxins, gibberlins, cytokinins, ethylene, abscisic acid. **Plant defense and secondary metabolites**- Terpenes, phenols, flavonoids and nitrogenous compounds and their roles in plant physiology. Methods in phytochemicals: extraction, fractionation and characterization.

Unit III **14 hrs**

Assimilation of mineral nutrients: Nitrogen metabolism- Importance of nitrogen in biological systems, nitrogen cycle. Nitrogen fixation; symbiotic and non-symbiotic, nitrogenase complex, energetics and regulation. Formation of root nodules in legumes. Assimilation of nitrate and ammonium ion. Sulfur assimilation. **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.**Host parasite interaction**: Recognition and entry processes of different pathogens like bacteria, Viruses, alteration of host cell behavior by pathogens, virus-induced cell transformation, pathogen induced diseases in plants, cell-cell fusion in both normal and abnormal cells.

References

1. Principles of Biochemistry; David L. Nelson and Michael M. Cox, 6th Edition,
2. W. H. Freeman (2013).
3. Biochemistry; Donald Voet, Judith G. Voet, 4th Edition, John Wiley and sons (2010). PM, Plant Biochemistry, Harborne JB (1997) Academic Press.
4. Introduction to Plant Biochemistry, Goodwin TW, Mercer EI (1983)
5. Plant Physiology; Taiz and Zeiger, 3rd Edition
6. Plant Biochemistry; Hans Walter Heidt, 3rd Edition, Elsevier Publishers
7. Biochemistry & Molecular biology of Plants: Buchanan BB, Gruissem W, Jones RL (2000) American Society of Plant Physiologists Rockville
8. Singhal G (1999) Concepts in Photobiology: photosynthesis and photomorphogenesis: Springer Science & Business Media.

II SEMESTER – CLINICAL BIOCHEMISTRY: BCS 455 SOFTCORE

Total Number of Lecture Hours: 42 **Total Number of Credits: 03**

Course objectives

- To understand the role of enzymes in the diagnosis of diseases.
- Disorders of Hemoglobin, liver diseases
- Disorders of kidney, GIT and endocrine glands, metabolic disorders
- To study the disorders of amino acid & protein metabolism, purine & pyrimidine metabolism, lipid metabolism.
- To know the causes of cardiovascular disorders and cancer

Course outcome

- Student understands the significance of diagnostic enzymes.
- Further, he will know the disorders of Hemoglobin such as sickle cell anemia, thalassemia, liver diseases such as hepatitis, jaundice, cholestasis, cirrhosis, gall stones, etc.,
- Biochemical tests to diagnose the disorders of kidney, GIT and endocrine glands, metabolic disorders, such as inborn errors of carbohydrate metabolism.
- Student studies the disorders of amino acid & protein metabolism, purine & pyrimidine metabolism, lipid metabolism.
- Student learns the causes of cardiovascular disorders and cancer

Unit I **14 hrs**

Basic Concepts- Health and disease. Normal and pathological changes affecting cells in the body-cell death and the physiological causes – Physical, chemical and biological agents. **Diagnostic Enzymology**- Mechanisms of elevated enzyme activities. Some important enzymes -Alkaline phosphatase, Creatine Kinase, LDH, AST, ALT-isoenzyme changes, Acid phosphatase. **Blood**- Composition, cells, function of plasma proteins and lipoproteins in diseases. Disorders of Hemoglobin-Thalassemia, Sickle cell anemia, Dengue. Anemias-Microcytic, normocytic & macrocytic. **Liver**- Biochemical indices of hepatobiliary diseases. Bile pigments-formation of bilirubin, urobilinogen bile acids, jaundice-pre-hepatic, hepatic and post-hepatic. Diagnosis: liver function tests, diseases of the liver –Hepatitis, Cholestasis, Cirrhosis, Gallstones, Acute phase proteins.

Unit II **14 hrs**

Kidney-Assessment of renal function-creatinine clearance, renal calculi, uremia, laboratory investigation of kidney disorders. Urea, creatine, creatinine, serum and blood urea. **Gastrointestinal Disorders-** Fractional gastric analysis, hypo and hyper acidity, gastric ulcers, malabsorption syndrome, steatorrhea, 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. **Metabolic Disorders**- Disorders of carbohydrate metabolism -Diabetes mellitus, classification, etiology, laboratory investigations-GTT, HbA1c, diabetic complications. Inborn errors of carbohydrate metabolism, glycogen storage diseases, galactosemia, lactose intolerance, pentosuria.

Unit III **14 hrs**

Disorders of Amino Acid and Protein Metabolism- Inborn errors of amino acid metabolism -Phenyl ketonuria (PKU), Alkaptonuria, disorders of protein pattern studies. **Disorders of Purine and Pyrimidine Metabolism-** Gout, Lesch-Nyhan syndrome, Orotic aciduria. **Disorders of Lipid Metabolism**- Determination of lipids and lipoproteins. Hyper

lipoproteinemia-types of modification of lipoproteins-glycation, oxidations, and consequences on metabolism- foam cell formation. **Cardiovascular Disorders**- Major cardiovascular system -Atherosclerosis-risk factors, Pathogenesis. Diagnosis and Prognosis. **Cancer**-Apoptosis, Oncogenesis, Necrosis, Angiogenesis, Carcinogens, mechanisms.

References:

1. Applied Biochemistry of Clinical disorders – Gomal A.G.(Ed.)
2. Textbooks of Biochemistry with clinical Correlations-Devlin
3. Clinical Biochemistry- Albert L. Latner.
4. Handbook of Clinical Biochemistry, Swaminathan, R. 2nd ed. Oxford University Press; 2011.
5. Textbook of Medical Biochemistry, Chatterjee, M.N. and Rana Shinde, 8th ed. Jaypee Medical Publishers, 2012.
6. Lecture Notes Clinical Biochemistry (8th Edition). Simon Walker, S., Ashby, P., Rae, P., and Beckett, G., Blackwell, 2010.
7. Textbook of Biochemistry with Clinical Correlations. Devlin, D.M., (Ed). Wiley-Liss, 2010.

II SEMESTER –BIOETHICS AND BIOSAFETY: BCS 456 SOFTCORE

Total Number of Lecture Hours: 42 **Total Numbers of Credits: 03**

Course objectives

- To know the basic concepts of bioethics.
- To understand human rights, human dignity, equality, justice and equity.
- To learn good laboratory practices, regulations of FDA, clinical trials and so on.
- To study risk assessment, work planning, biological waste disposal

Course outcome

- Student understands the basic concepts of bioethics.
- He will have knowledge of human rights, human dignity, equality, justice and equity.
- Good laboratory practices, regulations of FDA, clinical trials and so on.
- Risk assessment, biological waste disposal, biosafety containment levels and so on.

Unit I **16 hrs**

Introduction to Ethics -The moral point of view, The nature of moral judgements, An ethical method of reasoning, The birth of bioethics, Health and disease as values, Principles of bioethics, Ethics committees, Medical professionalism. **Human dignity and human rights -** Concepts of dignity in the history of ideas, Equality in dignity of all human beings, Respect and care, Ethical aspects of health care provider-patient relations in regard to human dignity and human rights. Benefit and harm - Autonomy and individual responsibility - Consent - Persons without the capacity to consent- Respect for human vulnerability and personal integrity- Privacy and confidentiality.

Unit II **16 hrs**

Equality, justice and equity- Non-discrimination and non-stigmatization - Respect for cultural diversity and pluralism- Solidarity and cooperation- Social responsibility and health - Sharing of benefits -Protecting future generations- Protection of the environment, the biosphere and biodiversity.**Regulatory Procedures**: Good laboratory practice, Good manufacturing practice and FDA regulations - Regulations for recombinant DNA research and manufacturing process - Regulations for clinical trials, Documentation and Compliance, in India and selected countries - Rules for import and export of biological materials.

Unit III **10 hrs**

Work planning and risk assessment -Biosafety containment levels - Personal Protective Equipment and clothing - Biosafety labels and signs - Facilities, equipment, and practices - Biological Spills and Decontamination, Biological waste disposal and pests - Transport and shipping - Emergency and incident response- Competency and responsibilities.

References:

1. The Bioethics Core Curriculum of UNESCO.
2. Raymond J. Devettere, Practical Decision Making in Health Care Ethics 2nd Edition. Washington, D.C.: Georgetown University Press, 2002. (ISBN 0-87840-763-4).
3. Weston, Anthony. A Rulebook for Arguments, 3rd Edition. Hackett, 2000. ISBN 0-87220-552-555.
4. Richmond JY, McKinney RW. Primary containment for biohazards: selection, installation and use of biological safety cabinets, 2nd ed. Washington, DC, United States Department of Health and Human Services/Centers for Disease Control and Prevention/National Institutes of Health, 2000.

5. Furr AK. CRC handbook of laboratory safety, 5th ed. Boca Raton, FL, CRC Press, 2000.
6. Springthorpe VS, Sattar SA. Chemical disinfection of virus-contaminated surfaces. CRC Critical Reviews in Environmental Control, 1990, 20:169–229.
7. Recommendations on the transport of dangerous goods, 13th revised edition, New York and Geneva, United Nations, 2003, (http://www.unece.org/trans/danger/publi/unrec/rev13/ 13files_e.html).
8. Technical instructions for the safe transport of dangerous goods by air, 2003–2004 Edition. Montreal, International Civil Aviation Organization, 2002.
9. Economic Commission for Europe Inland Transport Committee. Restructured ADR applicable as from 1 January 2003. New York and Geneva, United Nations, 2002, (http:// www.unece.org/trans/danger/publi/adr/adr2003/ContentsE.html).

OPEN ELECTIVE FOR OTHER DISCIPLINES

II SEMESTER

BIOCHEMISTRY IN DAY- TO- DAY LIFE: BCE 457- SOFTCORE

Total Number of Lecture Hours: 34 **Total Number of Credits: 03**

Course objectives

- To know the basic concepts of nutrition.
- To learn about macro and micronutrients, importance of water
- To study the significance of carbohydrates, proteins, fats and vitamins
- To bring awareness about effect of drugs on food and nutrition

Course outcome

- Student learns the basic concepts of nutrition.
- Further he learns about macro and micronutrients, importance of water
- Also studiesthe importance of carbohydrates, proteins, fats and vitamins
  Learns about drug- drug reaction, food-drug reaction.

Unit I **12 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**: Sources, requirements, functions and deficiency symptoms. **Water***:* Distribution in the body, function, special properties of water, water balances and factors affecting water balance. **Carbohydrates**-Dietary sources, Essentiality of carbohydrates, Dietary fibres.

Unit II **12 hrs**

Proteins-Essential amino acids, nutritional classification of proteins, supplementary value of proteins, protein calorie malnutrition, PER, EV and chemical score, Kwashiorkor and Marasmus, Nitrogen balance, Malnutrition, protein calorific value. **Fats**-Sources, invisible fat, essential fatty acids, PUFA. **Dietary formulation** for different age groups: children, adults, old age and pregnancy.

Unit III **10 hrs**

Vitamins-Fat soluble and water-soluble vitamins, pro-vitamins, antivitamins, dietary sources, daily requirement, function and deficiency symptoms of vitamins. Hyper-vitaminosis, vitamin-like compounds, Disorders. **Food Drug Interaction:** Effect of drugs on food and nutrition.

References:

1. Nutritional Biochemistry, Tom Brody (1994) Academic Press.
2. Frontiers in Nutrition, Ed. T. Wilson and N.J. Temple, (2000), Humana
3. Nutrition & Health in Developing Countries, eds. R. Semba and M.W.Bloem, (2000), Humana.

II SEMESTER PRACTICAL ENZYMOLOGY: BCP 458

Practical-Hard Core: 4 credits **8 hours/week**

Course objectives

- To have practical knowledge about enzyme kinetics
- To purify the enzymes by ammonium sulphate fractionation
- To calculate Km, Vmax of enzymatic reaction.
- To characterize invertase, acid phosphatase, protease and esterase from different sources

Course outcome

- Student will have a practical knowledge about enzyme kinetics
- He is able to purify the enzymes by ammonium sulphate fractionation
- and calculate Km, Vmax of enzymatic reactions.
- Characterization of invertase, acid phosphatase, protease and esterase from different sources

Salivary Amylase: Activity, Specific activity, Optimum pH and Temperature, pH and Temperature Stability, energy of activation, Km, Vmax, effect of metal ions, Purification by ammonium sulphate fractionation and enzyme characterization.
Assay methods and some characterization of invertase from yeast, acid phosphatase from potato, protease from papaya and esterase from peas.
References:

1. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis; Robert A. Copeland , Wiley- VCH Publishers (2000).
2. Enzyme Kinetics and Mechanism; Paul F. Cook, W. W. Cleland, Garland Science (2007).
3. Biochemical Calculations, Irwin H. Segel (1976) 2nd Ed. John Wiley and Sons.
4. Methods in Enzymology; Colowick S.P. et al., Vol. 152, Academic Press, (1987).
5. Methods of Enzymatic Analysis; Berg Meyer Vol. 1-X, (1974).
6. Basic Biochemical Laboratory Procedures and Computing, R. Cecil Jack (1995) OxfordUniversity.
7. Enzyme Kinetics; Roberts, D.V. (1977), Cambridge University Press.

II SEMESTER

EXPERIMENTS IN CLINICAL BIOCHEMISTRY: BCP 459

Practical- Soft Core: 3 credits8 hours/week

Course objectives

- To have a practical knowledge about estimations of various parameters
- To analyze normal and abnormal constituents of urine
- To measure different diagnostic enzymes using kits.
- To run electrophoresis for the separation of isoenzymes and hemoglobin

Course outcome

- Student willhave a practical knowledge about estimations of various parameters using different methods.
- He will be able to analyze normal and abnormal constituents of urine
- He will measure different diagnostic enzymes using kits.
- Electrophoresis for the separation of isoenzymes and hemoglobin

Experiments:

1. Urinanalysis – Normal and Abnormal.
2. Estimation of serum cholesterol by Zak's method.
3. Estimation of serum proteins by Lowry's method
4. Isolation and estimation of DNA by Diphenylamine (DPA) method
5. Isolation and estimation of RNA by Orcinol method
6. Estimation of protein and A-G ratio by biuret method
7. Isolation and estimation of Casein in milk
8. Estimation of free proline by Bate's method
9. Serum SGOT, SGPT, LDH, ALP, urea, uric acid, creatinine, TAG, Cholesterol estimation using kits. Determination of HDL and LDL cholesterol.
10. Electrophoresis of hemoglobin and isoenzymes.

References:

1. TietzFundamentals of Clinical Chemistry and Molecular Diagnostics, Carl A. Burtis, David E. Bruns. 7th ed. Elsevier, 2014.
2. Practical Clinical Biochemistry, Harold Varley, Interscience Publishers Inc, 2002
3. Clinical Chemistry: Theory, Analysis and Correlation. Kaplan, L.A. and Pesce, A.J., 4th ed. Mosby, 2003.
4. Introduction to Practical Biochemistry. David T. Plummer
5. Lab Manual of Biochemistry. By Nigam. 2007. Tata McGraw-Hill Education, USA.

III SEMESTER – MOLECULAR BIOLOGY: BCH 501- HARD CORE

Total number of lecture hours: 56 **Total number of credits: 04**

Course objectives

- To study the mechanism of replication in prokaryotes and eukaryotes and its regulation
- To study the transcription in prokaryotes and eukaryotes and transcription regulation
- Genetic code, protein synthesis in prokaryotes and eukaryotes.
- Post translational modification, translational regulation and molecular biology of development.

Course outcome

- The student understands the process of replication, transcription and translation in prokaryotes, eukaryotes and virus.
- Regulation of gene expression at different levels in prokaryotes and eukaryotes
- Post translational modification and the role of different genes in the development of Drosophila

Unit I **14 hrs**

Introduction- Historical perspective. Central dogma of molecular biology.**Replication of DNA** semiconservative nature-Messelson and Stahl experiment. Mechanism of replication, the replicons, origin, primosome and replisomes,properties of prokaryotic and eukaryotic DNA polymerases, synthesis of leading and lagging strands,difference between prokaryotic and eukaryotic replication.-direction of replication discontinuous replication-Okazaki fragments, Trombone model. DNA polymerase I, II and III, DNA ligase and topoisomerases., Fidelity of replication. Replication in viruses- φ X174, single4 stranded DNA virus, rolling circle model. Replication of mitochondrial DNA.**Regulation of gene expression** at the level of DNA structure; super coiling, DNA methylation. Role of nucleosome structure in eukaryotic gene expression; glucocorticoid gene, DNA kinking, bending and gene regulation.

Unit II **14hrs**

Transcription- RNA biosynthesis in prokaryotes and eukaryotes; initiation, elongation and termination. RNA dependent RNA synthesis-RNA replicase of QB virus. Processing of eukaryotic RNA cap addition, poly A tail addition, RNA editing, Processing of tRNA and rRNA transcripts.**Regulation at the level of transcription:**Operon model; Lac operon, structure and regulation. Galactose operon; role of two promoters. Arabinose operon; positive control. Tryptophan operon; T attenuation control. Transcription factors, TF II, NF-kB, regulation of NF-kB and its activation.

Unit III **14hrs**

Translation- Genetic code, triplet codon, universal features of the genetic code, assignment of codon, studies of Khorana, Nirenberg, triplet binding techniques, degeneracy, Wobble hypothesis, evolution of genetic code and codon usage, variation in the codon usage. 3D structure of prokaryotic and eukaryotic ribosome, **Protein synthesis-** initiation, elongation and termination in prokaryotes and eukaryotes. Inhibitors of translation. **Regulation at the level of translation:** Secondary structure in the 5' and 3' untranslated region; regulation of ferreting and transferring, m-RNA. Role of upstream AUG codons. (GCN 4 gene regulation), transplanting and translational introns, protein splicing inteins.

Unit IV **14 hrs**

Post translational modification of proteins-signal cleavage, di-sulphide bond formation, O and N-glycosylation, folding of nascent protein, the role of chaperones, attachment of glucose anchor, and other modifications.**Regulation at the level of post translational modification:** proteins stability, N-end rule, PEST and other sequences, ubiquitin mediated degradation. **Molecular biology of Drosophila development;** Overview of *D. Melanogaster* development. Differential development by Morphogenic gradient, dorso-ventral patterning of the embryo.Regulatory DNAs, role of snail and twist proteins in patterning.

REFERENCES:

1. LEWINS Gene XI; J.E. Krebs, E.S. Goldstein, and S.T. Kilpatrick, Jones and Barttlett Publishers (2012).
2. Molecular Biology of the Cell, Alberts *et al*., Garland Publications, (2012).
3. Molecular Biology, David Freifelder, Narosa Publishers, (1997).
4. Molecular Biology Robert F. Weaver, McGraw Hill (2012).
5. Microbial Genetics; Maloy*et al.*, Jones and Bartlett Publishers, (1994).
6. Principles of Developmental Genetics; S.A. Moody, Academic Press (2007).
7. Developmental Biology; S. P. Gilbert, 8th Edn, Sinauer Associates Inc.,(2006)
8. Molecular biology and Biotechnology; 4th Edn., J.M. Walker and R. Rapley, RSC (2000).
9. Molecular Biology of Gene; Watson, J.D. et al., 5th Edn. Pearson Education; (2004).
10. Molecular Cell Biology; Harvey Lodish 5th Edn. (2010).

III SEMESTER-IMMUNOLOGY: BCH 502-- HARDCORE

Total number of lecture hours: 56 **Total number of credits: 04**

Course objectives:

- To understand the basic concepts of immunology.
- To know the cellular basis of immunity.
- To study transplantation and tumor immunology.
- To learn disorders of immunity.

Course outcome:

- Student will learn the basics of immunology such as antigenicity, antibodies, haptens, epitopes and so on.
- Primary and secondary immune response, T cells and B cells, cytokines, lymphokines, interleukins, and so on.
- Students will learn the terminologies such as MHC, inflammation, hypersensitivity reactions, transplantation and graft rejection.
- In addition to the above, student will have a thorough knowledge of vaccines, hybridoma technology, polyclonal and monoclonal antibodies.

Unit I **14 hrs**

Introduction to Immunology: Historical development and milestones in immunology. Definitions-antigenicity, immunogenicity, primary and secondary lymphoid organs, self and non-self-discrimination. **Innate and acquired immunity**: Antigens and antibodies, haptens and determinants, epitopes and paratopes. Antigenicity of carbohydrates, proteins, nucleic acids and cells as antigens. Valency of antigen. Epitope analysis. Classes and subclasses of immunoglobulins, structure of immunoglobulins, hyper variable region isotypic, allotypic and idiotypic variation.

Unit II **14 hrs**

Cellular Basis of Immunity- Primary and secondary immune response. Reticuloendothelial system, T, B and accessory cells. Development of T and B cells, Subsets of T and B cells. T-helper cells, T-killer cells, T-suppressor cells. T and B cell receptors, antigen processing and presentation. Cytokines and co-stimulatory molecules, Lymphokines and interleukins structure, functions of IL-1B, IL-2 and TNFα. T and B interaction. Suppression of immune response, immunoglobulin gene- immunoglobulin diversity, gene rearrangement and other mechanisms, clonal selection, theory of Burnet.

Unit III **14 hrs**

MHC-MHC gene and its polymorphism, role of MHC in immune response and transplantation.**Non-specific Defense in Man-** Barriers to infection-skin, mucous membrane, inflammation, complement hypersensitivity reactions (Type I, II, III and IV). **Transplantation-** Autograft, isograft, allograft and Xenograft. Graft rejection, the reaction b/t graft and host tissue. **Tumor immunology-**tumor associated antigens, factors favoring tumor growth, immune surveillance. Tumor necrosis factors α and β.

Unit IV **14 hrs**

Disorders of Immunity- Immunological tolerance, auto immune disorders, Acquired Immuno-Deficiency syndrome (AIDS), Severe Combined Immune Deficiency (SCID). **Vaccines-** adjuvants, Vaccines and their preparations. Polyclonal and monoclonal antibodies, Hybridoma technique. ***In vitro*** **antigen-antibody reaction,** precipitation, agglutination, complements fixation, immunodiffusion, immuno-electrophoresis, immunofluorescence, RIA, ELISA. **Defense system in plants**: Host parasite interaction and defense system in plants.

REFERENCES:

1. Kuby- Immunology; Goldsby *et al.,* (2000), W H Freeman and Co.
2. Immunology by Ivan Roitt, Jonathan Brostoff and David Male, Mosby, London. 6th Edition, 2001
3. Basic Immunology by Abul K. Abbas and Andrew H. Lichtman, Saunders, 2001.
4. Immunology by William L. Anderson. Fence Creek Publishing (Blackwell) 1999.
5. Immunobiology; Charles *et al.,* (2001), Garland Science.
6. Immunobiology;Dulsy Fatima and, N Arumugam (2014)., Sara publication.
7. Basic and Clinical immunology; Stites*etal.,* [ED.] (1982) Lange
8. Immunology, Boitt*et al*., (2001), Mosby.

III SEMESTER - METABOLISM OF NITROGEN CONTAINING COMPOUNDS: BCH 503HARDCORE

Total number of lecture hours: 56 **Total number of credits: 04**

Course objectives:

- To have a clear picture of nitrogen cycle.
- To learn amino acid metabolism and also urea cycle.
- To have a knowledge of degradation and biosynthesis of individual amino acids.
- To understand metabolisms of heme and nucleotides.

Course outcome:

- Student learns the various aspects of nitrogen cycle.
- Different pathways involved in amino acid metabolism.
- Biosynthesis and degradation of individual amino acids.
- Heme metabolism and nucleotide metabolism and disorders associated with their metabolism.

Unit I **14 hrs**

Nitrogen Cycle: Introduction, biological and non-biological nitrogen fixation, *nif*genes, regulation and utilization of nitrate and nitrite, regulation of nitrate reductase. Assimilation of ammonia, formation of amino acid amides by glutamine synthetase and its regulation. **Amino acid Metabolism:** General metabolic reaction of amino acids–transamination, pseudo-transamination, glucose – alanine cycle, oxidative deamination (glutamate dehydrogenase), minor pathways of amino acid degradation – trans-deamination, amino acid oxidase, and non – oxidative deamination (α–deaminase, dehydratase, asparaginase and glutaminase). Urea cycle– regulation and metabolic disorders. Biosynthesis of creatine and creatine phosphate, polyamines– putrescine, spermidine and spermine, glutathione (γ-glutamyl cycle), physiologically active amines (γ-amino butyric acid, serotonin, histamine and catecholamines – dopamine, epinephrine and epinephrine).

Unit II **14 hrs**

Degradation of the individual amino acids: Pathways in animal, plant and microbial systems; Amino acids forming from pyruvate (alanine, glycine, threonine, serine, cystine and cysteine), oxaloacetate (aspartic acid and asparagine), α-ketoglutarate (glutamic acid, glutamine, arginine, histidine and proline), succinyl CoA (valine, isoleucine and methionine), acetoacetate and/or acetyl CoA (leucine and lysine), pyruvate, formaldehyde, acetoacetate and/or acetyl CoA (tryptophan), and fumarate, acetoacetate and/or acetyl CoA (phenyl alanine and tyrosine). Inherited disorders associated with glycine, aromatic, branched chain, basic and sulfur containing amino acid metabolism.**HemeMetabolism:** Biosynthesis and degradation of porphyrin and their regulation, porphyrias, jaundice and Hemoglobinopathies.

Unit III **4 hrs**

Biosynthesis of the individual amino acids: Pathways in animal, plant and microbial systems–biosynthesis of non – essential amino acids from pyruvate (alanine), intermediates of glycolysis (serine) and TCA cycle (aspartic acid, asparagine, glutamic acid and glutamine), essential amino acid (tyrosine), non – essential amino acid (glycine, proline and arginine), and essential & 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 (phenylalanine, tyrosine and tryptophan) and histidine. Regulation of amino acid biosynthesis by sequential & concerted feedback inhibition.

Unit IV **14 hrs**

Nucleotide Metabolism: Biosynthesis of purine and pyrimidine nucleotides and their inter conversion, regulation of biosynthesis. Other pathways of purine nucleotideformation.Biosynthesis of deoxyribonucleotides and coenzyme nucleotides. Chemical inhibition of the biosynthesis of nucleic acid precursors. Degradation of purine and pyrimidines, and disorders associated with their metabolism; gout, Lesch-Nyhan syndrome, orotic aciduria, and xanthinuria.

REFERENCES:

1. Biochemistry; Geoffrey Zubey, (1998), WCB Publishers.
2. Biochemistry; David Rawn, Panima Publishers, (1989).
3. TextBook of Biochemistry with Clinical correlations; 6th Edn. Thomas M. Devlin (2012), Wiley-Liss.
4. Lehninger- Principles of Biochemistry; D. L. Nelson and M.M. Cox 6th Edn. Macmillan Publications (2012).
5. Principles of Biochemistry; Smith *et al*., [Ed.] (1986) McGarw Hill.
6. Bioenergetics; A Practical Approach, G.C. Brown and C.E. Cooper (1995) IRL-Oxford University Press.
7.Biochemistry Ed. Donald Voet& Judith G. Voet, John Wiley & Sons, Inc. (2010).

III SEMESTER –GENETICS: BCS 504 SOFT CORE

Total number of lecture hours: 42 **Total number of credits: 03**

Course objectives

- To study the basic principles of genetics, gene linkage and X-linked inheritance and cytoplasmic inheritance
- To study the organization of chromosomes in prokaryotes and eukaryotes
- Causes of mutation and repair mechanism
- Various diseases associated with anomalies in chromosome number and structure.

Course outcome

- The student understands the basic principles of genetics, gene linkage and X-linked inheritance and cytoplasmic inheritance
- Various causes of mutation and their repair mechanism
- Diseases associated with changes in chromosome number and structure.

Unit I **14 hrs**

Basic Principles of Mendelism- Laws of Inheritance, dominance, codominance, epistasis, (e.g., Comb shape in chicken) Pleiotropism. Cytoplasmic inheritances (e.g., Male sterility in plants, Shell Coiling). **Gene Linkage and Chromosome-** Linkage and recombination of genes in a chromosome. Crossing over gene mapping with three -point test cross, mapping by tetrad analysis. X-linked inheritance. Polygenic inheritance, mitochondrial inheritance, Y-chromosome inheritance.

Unit II **14 hrs**

Organization of Genes in Prokaryotic and Eukaryotic Chromosome-Genome size and evolutionary complexity, C-value paradox, structure of bacterial chromosome, structure of eukaryotic chromosome, nucleosome organization, arrangement of chromatin fibers in a chromosome. Polytene chromosomes, Centromere and telomere structure. **Organization of Genes in Chromosomes-** Single copy gene, gene families, tandemly repeating genes, pseudo genes, **Chromosome Number-**ploidy, Karyotyping, sex chromosome and dosage compensation. Mobile genetic elements, transposons, allocating genes to chromosomes- chromosome walking, RFLP and RAPD.

Unit III **14 hrs**

Molecular Genetics- Mutations-nature of Mutations, spontaneous and induced mutation, conditional, lethal (eg. Temperature sensitive) mutation. Biochemical basis of mutation. Point mutation, base substitution mutation, missense, nonsense and silent mutation. Mutation rates. Chemical mutagens, radiation induced mutation, reverse mutations and suppressor mutations- intergenic and intragenic suppression, reversion as a means of detecting mutagens- Ame's test. **Repair Mechanism-** Reciprocal recombination, site specific recombination, *E.coli* rec system. Holliday model of recombination. **Chromosomal Basis ofHuman Diseases-** Extra or missing chromosome, abnormality in chromosome structure – deletion duplication, inversion, translocation

REFERENCES:

1.Genetics, Strick Berger, M.W. (1990) 3rd edn. McMillan.
2. Human Molecular Genetics; Peter Sudbery, (2002) Printice Hall.
3. Introduction to Genetics: A Molecular Approach; T A Brown, Garland Science (2011).
4. Molecular Biology of the Cell; 7th Edn. Bruce Alberts et al., Garland Publications (2008).
5. Human Genetics; Lewis, 7th Edn. WCB & McGraw Hill (2007).
6. Molecular Cell Biology; Lodish et al., 7th Edn. W.H. Freeman and Co. (2012).
7. Essential Genetics: A Genomics Perspective; Daniel L. Hartl, 6th Edition, Jones and BarlettLearning (2012).

III SEMESTER –NANOTECHNOLOGY: BCS 505 SOFT CORE

Total number of lecture hours: 42 **Total number of credits: 03**

Course objectives:

- To understand the basic concept of nanotechnology.
- To synthesize nanoparticles and know their applications.
- To study the applications of nanotechnology in food industries.
- To learn its use in agriculture, farming.
- Use of nano-fertilizers too.

Course outcome:

- Student gets to know the biological nanoparticles.
- Synthesis of nanoparticles using bacteria, fungi, plants and so on.
- Student learns about biosensors, nanotechnology and its applications.
- Nanotechnology in Food packaging, agriculture, farming,
- Potential of nanofertilizers.

Unit I **14 hrs**

Biological nanoparticles and their applications: Introduction to biological nanoparticles and their applications: Exosomes, lipoproteins, ferritin, magnetite viruses. Biological nanomotors and machines, mechanisms of biological machines, protein assemblies: muscle myosin, kinesin, nerve, ATPase, bacteriorhodopsin, haemoglobin dynein, cilia. Bacterial flagella: structure and function; nanomotor. Ion channels: nanopores of high specificity. Bioinspired nanomaterials: DNA and peptide based. Interaction between biomolecules and nanoparticle surfaces.

Unit II **14 hrs**

Biological synthesis: Biological synthesis of nanoparticles using bacteria, fungi, plants, purified enzymes and biological templates, Slayer. Silver nanoparticles, gold nanoparticles, cerium oxide nanoparticles, titanium oxide and zinc oxide nanoparticles. Application of inorganic nanoparticles.

Unit III **14 hrs**

Biosensor and nanobiosensor: Biosensor and nanobiosensor basic concepts, characterization, perception, Enzyme–metal NP hybrids for bio-sensing and for the generation of nanostructures, Biomolecule–semiconductor NPs for biosensing, Different types of nanobiosensors; Nanobiosensors for medical diagnostics. Nanoprobes for analytical applications.**Nanotechnology and its application in food industry:** Nanotechnology and food packaging, natural biopolymers, advantages of nanomaterials in food packaging applications, nanosensors, outstanding issues, risks and regulations, public perception.Nanotechnology in Agriculture, Precision farming, Smart delivery system, Insecticides using nanotechnology, Potential of nanofertilizers.

REFERENCES:

1. K. Youell and Firman, Nanotechnology perception 3 (2007) 75,96. Comprehensive overview of motors in biology
2. Jeremy Ramsden, Essentials of nanotechnology
3. RammohanDevulapally and Ramasamy Paulmurugan Polymer nanoparticles for drug and small silencing RNA delivery to treat cancers of different phenotypes *WIREs NanomedNanobiotechnol*2014, 6:40–60. doi: 10.1002/wnan.
4. ItamarWillner, Bernhard Basnar and BilhaWillner Nanoparticle–enzyme hybrid systems for nanobiotechnology FEBS Journal 274 (2007) 302–309.
5. Nanotechnology: Technology Revolution of 21st Century by Rakesh Rathi, published by S.Chand.
6. Introduction to Nanoscience, by Stuart Lindsay.
7. Introduction to Nanomaterials and nanotechnology by Vladimir Pokropivny, RynnoLohmus, Irina Hussainova, Alex Pokropivny and Sergey Vlassov.
8. Nanomaterials by A.K. Bandyopadhyay; New Age International Publishers.
9. Nanotechnology by Mark Ratner and Daniel Ratner, Pearson Education.
10. Nano Essentials, T.Pradeep/TMH
11. Bharat Bhusan, "Springer Handbook of Nanotechnology", springer, Newyork, 2007.
12. Hari Singh Nalwa, "Encyclopedia of Nanotechnology", USA 2011.
13. James A. Schwarz, Cristian I. Contescu, Karol Putyera, "Dekker encyclopedia".

III SEMESTER -FOOD SCIENCE: BCS 506 SOFT CORE

Total number of lecture hours: 42 **Total number of credits: 03**

Course objectives

- To study the different molecular components in food
- To study the importance of proteins, carbohydrates and fatty acids
- Nutritional management during lifestyle associated disorders and gastrointestinal disorders.
- Food spoilage by microbes and their management, food borne diseases.

Course outcomes

- The student learns about the molecular components in food like carbohydrates, proteins, lipids, fatty acids, macronutrients and micronutrients
- The sources and physiological role of proteins, carbohydrates and fatty acids
- Management of gastrointestinal disorders and other metabolic disorders through diet
- Microbes - spoilage of foods, food borne diseases and fermented food products.

Unit I 14hrs.

Basic concept on Food. Nutrients. Nutrition, Classification of Food. Classification of Nutrients. Carbohydrates - Sources, daily requirements, functions. Effects of too high - too low carbohydrates on health. Digestion & Absorption. Blood glucose and effect of different carbohydrates on blood glucose. Glycaemic Index. Functional role of Sugars in food, Fermentation of Sugar. Proteins - Sources, daily requirements, functions. Effect of too high - too low proteins on health. Digestion & absorption.Assessment of Protein quality (BV, PER, NPU). Factors affecting protein bioavailability including anti-nutritional factors. Lipids - Sources, daily requirements, functions. Digestion & Absorption. Role & nutritional significances of PUFA, MUFA, SFA, W-3 fatty acid. Dietary Fiber - Classification, sources, composition, properties & nutritional significance. Minerals & Trace Elements, Bio-Chemical and Physiological Role, bioavailability & requirements, sources, deficiency & excess(Calcium, Sodium, Potassium Phosphorus, Iron, Fluoride, Zinc, Selenium, Iodine, Chromium). Vitamins - Bio-Chemical and Physiological Role Physiological role, bioavailability and requirements, sources, deficiency & excess.Water - Functions, daily requirements, Water balance. Elementary idea of Probiotics, Prebiotics, Organic Food.

Unit II 14 hrs.

Therapeutic nutrition, complications, prevention and recent advances in nutritional management of GIT disorders, Gastritis, types, dietary modification, peptic ulcer, etiology, symptoms, dietary modification, Diarrhea – Classification, dietary consideration, Constipation, classification, dietary consideration, Ulcerative colitis symptom, dietary treatment, Disease of liver and gall bladder. Diseases of liver and gall bladder, Jaundice – classification and dietary treatment, Hepatitis – types and dietary management. Hepatic coma – causes and dietary management, Cirrhosis- Type and dietary management, Cholecystitis- Types and dietary management, Pancreatic disorders: etiology, pathogenesis and nutritional care. Cardiovascular diseases: Classification. Hyperlipidemia, Classification and nutritional care. Atherosclerosis – Etiological factors, pathogenesis dietetic management. Hypertension – Classification, etiology, nutritional care.

Unit III **14 hrs**

Growth and Nutrition of Bacteria: Intrinsic and extrinsic parameters that affect microbial growth. Importance of microorganisms in food microbiology - Mold, yeast, bacteria. Spoilage of different groups of foods: Cereals and cereal products, vegetables and fruits, Fish and fish products, Meat and meat products, Eggs and poultry, Milk and milk products, Canned foods. Contamination of foods, Food Preservation, General principles of food preservation, preservation methods (High temperature, low temperature, drying, food additives and radiation), Foods in relation to disease, Food

borne illness, Bacterial and viral food borne disorders, Food borne important animal parasites, mycotoxins. Fermented Foods, Role of microbes in fermented foods, Fermented dairy products, Fermented vegetables, Fermented meat, Fermented fish, Beverage and distilled products.

REFERENCES:

Block, J.G. (1999) Microbiology Principles and Exportations, 4th Edition John Wiley and Sone Inc.
Jay, James, M. (2000) Modern Food Microbiology, 6th Edition, Aspen publishers, Inc.,Maryland.
Bansart, G. (1989) Basic Food Microbiology, 2th Edition, CBS Publisher.
Frazier, W.C. and Westhoff, D.C. (1998): Food Microbiology. Tata McGraw Hill Book Company, New Delhi, 4th Edition.
James, M.J. (1987): Modern Food Microbiology, CBS Publishers, New Delhi, 3rd edition.
Pelezar, M.I. and Reid, RD. (1993): Microbiology, McGraw Hill Book Company, New York,5th edition.
Adams, M.R., Moss, M.O. (1995): Food Microbiology, New Age International (P.) Ltd., Delhi.
Banwart G.J. (1987): Basic Food Microbiology, CBS Publishers and Distributors, Delhi.

III SEMESTER- HEALTH AND DISEASE: BCE 507 SOFTCORE

Total number of lecture hours: 36 **Total number of credits: 03**

Course objectives

- To study the basic concept on health, hygiene and dimension of health
- To study the communicable, non-communicable and lifestyle diseases and disorders
- Drug abuse, oral hygiene, chain of infections and infection control

Course outcome

- The student understands the basic concept of health, hygiene and dimension of health.
- Basics of communicable diseases such as STD, no communicable diseases such as cancer and genetic as well as lifestyle disorders.
- Maintenance of proper mental and oral health, chain of infections.

Unit I **12 hrs**

Introduction: WHO definition of health, Health and hygiene, General Health care, Factors affecting health, Indices and evaluation of health, Disease patterns in developed and developing world; Classification of diseases - Endemic, Epidemic, Pandemic; Professional Health hazards. **Disease condition:** Acute disease, Chronic disease, Incurable disease, Terminal disease, Illness, disorders, Syndrome, Pre-disease. **Treatment:** Psychotherapy, medications, surgery, medical devices, and self-care**.** **Dimensions of Health:** physical, mental, social, spiritual, emotional, vocational, political, cultural, socioeconomic, environmental, philosophical, educational, nutritive, curative and preventive.

Unit II **12 hrs**

Communicable diseases - Tuberculosis, Cholera, Typhoid, Conjunctivitis. ***Sexually transmitted diseases (STD)***, Information, statistics, and treatment guidelines for *STD*, Prevention: Syphilis, Gonorrhea, AIDS etc. **Non-communicable diseases**- Malnutrition- Under nutrition, Over nutrition, Nutritional deficiencies; Anemia, Stroke, Rheumatic heart disease, Coronary heart disease, Cancer, blindness, accidents, mental illness, Iodine deficiency, Fluorosis, Epilepsy, Asthma. **Genetic disorders-** Down's syndrome, Klinefelter's syndrome, Turner's syndrome. **Lifestyle disorders-** Obesity, Liver cirrhosis**,** Diabetes mellitus, Hypertension (Causative agents, symptoms, diagnosis, treatment, prognosis, prevention)

Unit III **12 hrs**

Health promotion: preventing drug abuse, Oral health promotion by tobacco control. **Mental Hygiene** and Mental Health - Concepts of mental hygiene and mental health Characteristics of mentally healthy person - Warning signs of poor mental health - Promotive and preventive mental health – strategies and services - Ego defense mechanisms and implications -Personal and social adjustments - Guidance and Counseling. **Infection control** - Nature of infection - Chain of infection transmission - Defenses against infection transmission

REFERENCES:

1. Modern Nutritionin Health and Disease**.** 10th Edition by Maurice E.Shils, Moshe Shike, A Catharine Ross.
2. Krause's Food and Nutrition Therapy. 12th Edition by Janice L. Raymond, L. Kathleen Mahan, Sylvia Escott Stump.
3. Diagnostic Microbiology and Infectious Disease by Mark Holodniy(2016).
4. Health and Disease by Sarah Levete
5. Health and Disease by Adam Hook
6. Public Health and Private Wealth by Sarah Hodges & Mohan Rao

III SEMESTER

EXPERIMENTS INMOLECULAR BIOLOGY & IMMUNOLOGY: BCP 508SOFT CORE

PRACTICAL- 3 CREDITS 8 HOURS/WEEK

Course objectives

- To study the preparation of media for bacterial and fungal growth.
- To learn the techniques of isolating plasmid, and genomic DNA
- Separation of DNA by electrophoresis
- Immunological techniques

Course outcome

- The student understands the basic concept of the preparation of media for bacterial and fungal growth.
- Isolation and separation of plasmid and genomic DNA.
- Immunological techniques.

Experiments:

1. Preparation of media, culturing of transgenic *E.coli* and Yeast. Preparation of competent cells.
2. Isolation of DNA and RNA from plant and animal source, purity of DNA.
3. Spectroscopic determination of melting temperature(Tm) of calf thymus DNA.
4. Electrophoresis of DNA and RNA.
5. Restriction digestion of DNA.
6. Radial immunoassay.
7. Ouchterlony double diffusion
8. Rocket immune electrophoresis
9. Dot ELISA.
10. Blood group testing.
11. Separation of serum proteins by electrophoresis.
12. Isolation of plasmid

REFERENCES:

1. Principles and Techniques of Biochemistry and Molecular Biology; 7th Edn. Keith Wilson and John Walker (2012).
2. Principles of Gene Manipulations; 6th Edn. S.B. Primrose, R.M. Twyman, and R.W. Old, Blackwell Science (2012).
3. Gene Cloning Laboratory Manual 4thEdn. Michael R. Green and Joseph Sambrook,CSHL Press (2014).
4. Current Protocols in Molecular Biology; S Gallaghar, Wiley Interscience (2008).

III SEMESTER

EXPERIMENTS IN MICROBIOLOGY & CELL BIOLOGY: BCP 509 SOFT CORE

PRACTICAL- 3 CREDITS 8 HOURS/WEEK

Course objectives:

- To have hands on experience in microbiological staining techniques
- To know the biochemical tests pertaining to microorganisms.
- Air and water microbiological experiments
- Mounting of polytene chromosomes and also Barr bodies.
- Isolation of nucleus, mitochondria, chloroplast and their purification
- Study of mitosis and meiosis.

Course outcome:

- Student will have a knowledge of all the basic experiments in Microbiology
- He/she will understand the load of microbes in water and air.
- Polytene chromosomes and Barr bodies are mounted and identified.
- Cell organelles and cell divisions are observed

1. Staining techniques (a) Simple staining (b) Gram staining (c) Endospore staining (d) Capsule staining (e) AFB staining (f) negative staining
2. Biochemical tests (a) Indole test (b) Methyl red test (c) Voges Proskaeur test (d) Citrate utilization test (e) Starch hydrolysis test (f) Gelatin hydrolysis test (g) Catalase test (h) Oxidase test
3. Air Microbiology Isolation of air microflora (a) exposure plate method (b) rotorod sampler method.
4. Water Microbiology: Testing of quality of water (coliform test), H_2S strip method.
5. Estimation of lactate/ Citrate from bacterial culture media.
6. Mounting of polytene chromosomes
7. Mounting of Barr bodies
8. Study of mitosis by using onion root tips
9. Study of meiosis
10. Isolation of nucleus and determination of its purity
11. Isolation of mitochondria and determination of purity
12. Isolation of chloroplast by sucrose density gradient and determination of its purity
13. Visit to Industry/ Institution/Clinical Laboratory.

REFERENCES:

1. Pelczar Jr, M.J. Chan, E.C.S. and Kreig, N.R. (1993). Microbiology, Mc. Graw Hill.Inc.New York.
2. Molecular Cell Biology, Lodish, Berk *et al.*,

IV SEMESTER BIOTECHNOLOGY: BCH 551 HARDCORE

Total Number of Lecture Hours: 56 hours **Total Number of Credits: 04**

Course objectives

- To study the concept of gene cloning.
- To elucidate the sequence and identify the clones using various molecular techniques.
- Maintenance of animal cell and plant tissue culture laboratory.
- Applications of fermenter.

Course outcome:

- The student would understand the methods involved in gene cloning in using vectors in various host cells.
- Selection and identification of clone by different methods of transformation in plants and animals
- DNA isolation, amplification of DNA by PCR, blotting techniques and applications of bioengineering.
- Positive and negative impacts of genetic engineering.

Unit I **14 hrs**

Basic Principle of Gene Cloning: Isolation and purification of nucleic acids (DNA and RNA) from living cells. DNA manipulative enzymes - ligases, polymerases, endonucleases Type II, Sticky and blunt ends, isoschizomers. Vectors: Plasmids, Lambda phage, Cosmid, phagemid, Yeast cloning vectors, bacterial artificial vectors, plant vectors, SV 40, expression vectors, Ligation: blunt end and sticky end ligation, use of linkers and adopters, homo polymer tailing, cDNA cloning.

Unit II **14 hrs**

Clone identification – Direct selection, insertional inactivation of marker gene, visual screening, immunological detection method, colony and plaque hybridization. Transformation: Microinjection, electroporation, lipofection, calcium phosphate method, protoplast fusion, biolistic method. Cell culture techniques: Introduction to plant and animal tissue/cell culture, Laboratory design, aseptic conditions, equipment and materials for cell culture. Different constituents of culture medium, types of media.

Unit III **14 hrs**

Animal cell culture: Preparation of primary culture; disaggregation of tissue and primary cultures, chick embryo, HUVEC, characterization of cultures, ploidy, cell doubling time. Cell lines: Characteristics and routine maintenance, cell separation techniques. Measurement of viability and cytotoxicity. Scaling-up of animal cell culture; bioreactors used in animal cell culture and their applications. Industrial applications: Fermenter - stirred fermenter, micro-carrier, encapsulation, hollow fiber chambers, packed glass bead reactors. Cell immobilization techniques. Plant cell culture: Micro propagation, callus culture, haploid production, somatic embryogenesis, somatic hybridization, cybridization and somaclonal variation. Production of disease-free plants.

Unit IV **14 hrs**

Techniques: DNA sequencing, shot gun sequencing, chromosome walking, PCR, applications of PCR, RT-PCR technique and applications, Real time PCR for quantification. Blotting Techniques - Dot blot, Southern, Northern, Western blot, DNA footprint assay, DNA fingerprint assay, gel retardation assay, nuclease protection assay. RFLP, RAPD. Applications in agriculture medicine, industry, GM foods, negative impact of genetic engineering, gene knock out.

REFERENCES:

Gene cloning and DNA Analysis: An Introduction, Sixth edition, T A Brown

Molecular Biotechnology: Principles and Application of Recombinant DNA, Glick and Pasternak

Culture of Animal Cells, Ian Freshney

Plant Tissue culture, S. S. Purohith

IV SEMESTER CELL BIOLOGY: BCS 552 SOFTCORE

Total Number of Lecture Hours: 42 hours **Total Number of Credits: 03**

Course objectives

- To study the structure of cell, different organelles and structure of cell membrane.
- To study the various microscopic techniques.
- Mechanism of transport of molecule across the membrane.
- Signaling molecules and their receptors, conduction of nerve impulse

Course outcome:

- The student would understand the organization of cell and their components and division of cell.
- Various microscopic techniques used for visualizing different types and stages of cells and sub-organelle structure
- Mechanism of transportation of nutrients and other molecules against the membrane.
- Conduction of nerve impulse and transmission of signal to various cells

Unit I **14 hrs**

Cell structure: Diversity of cell shape and size, ECM, cytoskeletal elements. Cell motility, cell-cell interaction, adhesion cell-matrix interaction. Integrins and selectins and their interaction. Structural organization and function of intracellular organelles: Cell wall, cell membrane, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast. Cell division, cell cycle and regulation: Mitosis and meiosis, phases of cell cycle. Cell necrosis and programmed cell death. Techniques in cell biology: Visualization of cells and sub cellular components by light microscopy, microscopy of living cells, resolving powers of different microscopes, scanning and transmission electron microscopy, confocal microscopy and atomic force microscopy.

Unit II **14 hrs**

Bio-membranes: Physicochemical properties of biological membranes; compositions, supra molecular organization. Models of membrane; Singer and Nicholson's model, Newer models. Membrane asymmetry; lipids, proteins and carbohydrates and their lateral diffusion. Membrane domains; caveolae, rafts, membrane lipid and protein turnover, intracellular targeting of proteins. Membrane transport: 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.

Unit III **14 hrs**

Cell Signaling: Modes of cell signaling, Signaling molecules and their receptors; Peptide hormones and growth factors, Cell surface receptors: G protein coupled receptors and receptor tyrosine kinase, Second messengers: IP3, DAG, calcium, cAMP. Nitric oxide signaling; generation and action. Steroid hormones, Mechanism of action of steroid hormones. Receptor down regulation, desensitization and up regulation. Nerve transmission: Acetylcholine and other neurotransmitters, mechanisms of nerve conduction, resting and action potential.

REFERENCES:

The Cell: A Molecular Approach, Cooper and Hausman

Molecular Biology of The Cell, Bruce Alberts

Molecular Cell Biology, Lodish, Berk *et al*.,

IV SEMESTER BIOINFORMATICS & BIOSTATISTICS: BCS 553 SOFTCORE

Total Number of Lecture Hours: 42 **Total Number of Credits: 03**

Course objectives:

- To learn the all the basic concepts of statistics.
- To have a basic knowledge of computers
- To understand the fundamental and necessary aspects of bioinformatics.

Course outcome:

- Student will have knowledge of statistics such as measures of central value, coefficient of variation, sampling, probability, tests of significance and analysis of variance. This would help the student during data analysis especially if he intends to do MPhil/PhD.
- Student will become more computer savvy after knowing the hardware and software.
- Use of bioinformatic tools to substantiate the results especially during research.
- This paper will have a lot of impact on the student to critically analyze the data and draw a conclusion of the experimental results.

Unit I **14 hrs**

Measures of central value - Mean, mode and median; Statistics of Dispersion; Coefficient of variation; Concepts of moments, skewness and kurtosis; Simple correlation and regression; Concept of sampling and sampling methods. Probability and law of probability; Probability distributions (binomial, poisson and normal); Tests of statistical significance (t –Test, Chi-square test); Analysis of variance.

Unit II **14 hrs**

Computer fundamentals: Binary, Octal, Hexadecimal number system, compliment number representation; components of a digital computer, I/O devices, storage devices, MS -Office (MS-Word, MS-excel, MS-power point).

Unit III **14 hrs**

Bioinformatics: Introduction; Biological Databases (GenBank, Swiss Prot and PDB). Sequence Comparison Methods: Needleman Wunch & Smith Waterman algorithms. Database search algorithms: BLAST and FASTA. Multiple Sequence Alignment. Gene Prediction. Protein Structure Prediction. Use of Clustal and PHYLIP.

REFERENCES:

1. Fundamentals of Computers (Second Edition) by V. Rajarama, PHI (P) Ltd., New Delhi
2. MS-Office-2000 BPB Publications
3. Elementary Statistical Methods by S.P. Gupta, Sultan Chand & Sons
4. Introduction to computers (Fourth Edition), Peter Norton's Tata McGraw Hill
5. Research and Documentation in the Electronic Age by Diana Hacker and Barbara Fister, 2006, Bedford/St. Martin's publisher.
6. Little, Brown Guide to Research & Documentation by Aaron, 2004, McGraw Hill
7. Bioinformatics for Dummies, Jean-Michel Claverie, Cedric Notredame (2003) John Wiley & Sons
8. Bioinformatics Computing, Bryan P. Bergeron (2002) Prentice Hall
9. Introduction to Bioinformatics, Arthur M. Lesk (2002) Oxford University Press
10. Introduction to Bioinformatics, Teresa Attwood, David Parry-Smith (2001) Prentice Hall
11. Fundamental Concepts of Bioinformatics, Dan E. Krane, Michael L. Raymer, Michaeel L. Raymer, Elaine NicponMarieb (2002) Benjamin/Cummings (2002) Benjamin/Cummings

IV SEMESTER PRACTICAL BIOTECHNOLOGY: BC P 554HARDCORE

PRACTICAL- 4 CREDITS 8 HOURS/WEEK

Course objectives

- To isolate the DNA from microbial, plant and animal source by various methods
- To quantify the DNA and assess the purity of nucleic acids.
- To prepare competent cells
- Isolate the plasmids from *E. coli* and ligation of gene into vector and transformation.

Course outcome

- The students would be able to isolate DNA from microbial, plant and animal, employing suitable method.
- Assess the purity and quantify the nucleic acids.
- Steps involved in gene cloning.

Experiments

1. Isolation of DNA from animal source
2. Estimation of DNA by diphenylamine method
3. Isolation of RNA from yeast
4. Estimation of RNA by orcinol reaction
5. UV absorption of nucleic acids
6. Estimation of phosphorous content in nucleic acids
7. Electrophoresis of DNA and RNA nucleotides
8. Preparation of media, culturing of transgenic *E. coli* and Yeast.
9. Preparation competent cells.
10. Isolation of plasmids, ligation, transformation.
11. Restriction digestion of DNA.
12. PCR: Primer design and amplification.
13. RT-PCR

REFERENCES:

An introduction to Practical Biochemistry, David T Plummer

Molecular Cloning: A laboratory manual, Sambrook and Russell