ಮಂಗಳೂರು ವಿಶ್ವವಿದ್ಯಾನಿಲಯ

MANGALORE UNIVERSITY

(Accredited by NAAC with 'A' Grade)

ಕ್ರಮಾಂಕ/ No. : MU/ACC/CR 11/2022-23/A2

ಕುಲಸಚಿವರ ಕಛೇರಿ
ಮಂಗಳಗಂಗೋತ್ರಿ – 574 199
Office of the Registrar
Mangalagangothri – 574 199
ದಿನಾಂಕ/Date:10.10.2022

NOTIFICATION

Sub: Revised syllabus of M.Sc. in Biochemistry programme.
Ref: Academic Council approval vide agenda
No.: ಎಸಿಸಿ:ಶೈ.ಸಾ.ಸ.2:24(2022–23) dtd 27.09.2022

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The revised syllabus of M.Sc. in Biochemistry programme which is approved by the Academic Council at its meeting held on 27.09.2022 is hereby notified for implementation with effect from the academic year 2022-23.

Copy of the Syllabus should be downloaded from the University Website (www.mangaloreuniversity.ac.in)

REGISTRAR

1. The Registrar (Evaluation), Mangalore University.
2. The Chairman, Dept. of Studies in Biochemistry, Jnana Kaveri P.G. Centre, Chikka Aluvara, Kodagu.
3. The Chairman, P.G. BOS in Biochemistry, Jnana Kaveri P.G. Centre, Chikka Aluvara, Kodagu.
4. The Superintendent (ACC), O/o the Registrar, Mangalore University.
5. The Asst. Registrar (ACC), O/o the Registrar, Mangalore University.
6. The Director, DUIMS, Mangalore University – with a request to publish in the website
7. Guard File.

Mangalore University

Department of Studies in Biochemistry, Mangalore University Jnanakaveri

Campus, Chikka Aluvara, Kodagu District, Karnataka, 571 232

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. The Choice Based Credit System (CBCS) comprises Hard Core, Soft Core courses for Biochemistry and Open Elective for students other than Biochemistry.

The credit pattern of PG programme in Biochemistry includes **Hard core, Soft core and Open elective. There are totally 14 Hard core courses (10** Hard Core theory courses, 03 Hard Core practical courses from $1-3^{rd}$ semester and 01 Hard core project work in 4^{th} semester**)** with a total credits of 56, 09 Soft core courses (06 theory soft core courses, 03 soft core practicals) with a total of 28 credits and 02 Open elective courses (2^{nd} and 3^{rd} semester) for other disciplines with a total credits of 6. The project work is compulsory in the 4^{th} semester for which 4 credits are allotted.

- The total credits of the PG Programme in Biochemistry (Hard core, soft core and Open elective courses) = **90.**
- The PG programme in Biochemistry also provides choices for the soft core courses in all the semesters.
- A detailed skeleton of the PG programme in Biochemistry is provided for aspiring post graduates.

M.SC. BIOCHEMISTRY PROGRAMME

Learning objectives

1. Program outcomes

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

- Employability and entrepreneurship
- Communication skills

2. Program specific outcomes

The program enables the students to

- 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, Protein chemistry, Clinical Biochemistry, Microbiology, Molecular biology and Bioinformatics.
- Acquire scientific knowledge in Cell biology, Diagnostic Biochemistry, Immunology, Enzymology and Genetic engineering.
- Obtain awareness of the biochemical basis of human diseases, non-invasive diagnostics, and drug development.

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

M Sc Biochemistry (CBCS)

S. No.	Semester	Hard core credits(HC)	Soft core credits(SC)	Open elective credits (OE)	Total credits	Practical/ Project*	Theory
1.	I	16	6	-	**22**	1 (HC) 1 (SC)	3(HC) +1(SC)
2.	II	16	6	3	**25**	2 (HC)	2(HC)+2(SC) + 1(OE)
3.	III	12	10	3	**25**	2(SC)	3(HC)+1(SC) +1(OE)
4.	IV	12	6	-	**18**	1(HC)*	2(HC)+2(SC)
	Total	56	28	6	**90**	04(HC) +03 (SC)=7	10(HC) + 06(SC) +02(OE)=18

M.Sc. Biochemistry CBCS Courses (All 4 Semesters)

HARDCORE COURSES

Serial No.	Paper code	Title of the paper
1.	BCH 401	Bioorganic & Biophysical Chemistry
2.	BCH 402	Chemistry of Biomolecules
3.	BCH 403	Biochemical Techniques
4.	BCP 408	Practical Bioanalytical Techniques
5.	BCH 451	Enzymology
6.	BCH 452	Clinical Biochemistry
7.	BCP 458	Practical Enzymology
8.	BCP 459	Practical Clinical Biochemistry
9.	BCH 501	Molecular Biology
10.	BCH 502	Immunobiology
11.	BCH 503	Cell Biology
12.	BCH 551	Genetic Engineering
13.	BCH 552	Metabolism of nitrogen containing compounds
14.	BCPR/D 557	Project work / Dissertation

SOFTCORE COURSES

Serial No.	Paper code	Title of the paper
1.	BCS 404	Human Physiology
2.	BCS 405	General Microbiology
3	BCP 406	Practical Biochemical Methods
4	BCP 407	Practical General Biochemistry
5.	BCS 453	Nutritional Biochemistry
6.	BCS 454	General Virology
7.	BCS 455	Metabolism of fuel molecules
8.	BCS 456	Bioethics & Bio-safety
9.	BCS 504	Molecular Genetics
10.	BCS 505	Food Science
11.	BCP 506	Practical Microbiology
12	BCP 507	Practical CellBiology
13.	BCP 509	Practical Molecular Biology & Immunology
14.	BCP 510	Practical BioprocessTechnology

15	BCS 553	Plant Biochemistry
16.	BCS 554	Microbial Biochemistry
17.	BCS 555	Bioinformatics, Biostatistics & Nano-biotechnology
18.	BCS 556	Nanotechnology

OPEN ELECTIVES COURSES

Sl No.	Paper code	Title of the paper
1.	BCE 457	Biochemistry in Day-To-Day Life
2.	BCE 508	Health and Disease

FIRST SEMESTER

Sl No.	Paper Code	Title of the paper	Instruction hours /week	Credits	Exam hours	Marks Exam + IA = Total	HC / SC
1.	BCH 401	Bioorganic & Biophysical Chemistry	4	4	3	70+30=100	HC
2.	BCH 402	Chemistry of Biomolecules	4	4	3	70+30=100	HC
3.	BCH 403	Biochemical Techniques	4	4	3	70+30=100	HC
4.	BCS 404*	Human Physiology	3	3	3	70+30=100	SC
5.	BCS 405*	General Microbiology					
6.	BCP 406**	Practical Biochemical Methods	8	3	6	70+30=100	SC
7.	BCP 407**	Practical General Biochemistry					
8.	BCP 408	Practical Bioanalytical Techniques	8	4	6	70+30=100	HC

Note: * Choice between BCS 404 and BCS 405, **BCS 406 & BCP 407. HC/SC: Hard Core/Soft Core.

SECOND SEMESTER

SL No.	Paper Code	Title of the paper	Instruction hours /week	Credits	Exam hours	Marks Exam + IA = Total	HC / SC
1.	BCH 451	Enzymology	4	4	3	70 + 30 = 100	HC
2.	BCH 452	Clinical Biochemistry	4	4	3	70 + 30 = 100	HC
3.	BCS 453*	Nutritional Biochemistry	3	3	3	70 +30 = 100	SC
4	BCS 454*	General Virology					
5.	BCS 455**	Metabolism of fuel molecules	3	3	3	70 +30 = 100	SC
6.	BCS 456**	Bioethics & Bio-safety					
7.	BCE 457	Biochemistry in Day-To-Day Life	3	3	3	70 + 30 = 100	OE
8	BCP 458	Practical Enzymology	8	4	6	70 + 30 = 100	HC
9	BCP 459	Practical Clinical Biochemistry	8	4	6	70 + 30 = 100	HC

Note: * There is a choice between BCS 453 and BCS 454, **BCS 455 & BCS 456. BCE 457 is an open elective course for other disciplines. HC/SC: Hard Core/Soft Core.

THIRD SEMESTER

SL No.	Paper Code	Title of the paper	Instruction hours /week	Credits	Exam hours	Marks Exam + IA = Total	HC / SC
1.	BCH 501	Molecular Biology	4	4	3	70+30=100	HC
2.	BCH 502	Immunobiology	4	4	3	70+30=100	HC
3.	BCH 503	Cell Biology	4	4	3	70+30=100	HC
4.	BCS 504*	Molecular Genetics	3	3	3	70+30=100	SC
5.	BCS 505*	Food Science					
6.	BCP 506**	Practical Microbiology	8	3	6	70+30=100	SC
7	BCP 507**	Practical Cell Biology					
8.	BCE 508	Health and Disease	3	3	3	70+30=100	OE
9.	BCP 509***	Practical Molecular Biology & Immunobiology	8	4	6	70+30=100	SC
10.	BCP 510***	Practical Bioprocess Technology					

Note: *There is a choice between BCS 504 and BCS 505, $BCS 506 & BCP 507, **BCP 509 & BCP 510. BCE 508 is an open elective course for other disciplines. HC/SC: Hard Core/Soft Core.

FOURTH SEMESTER

SL No.	Course Code	Title of the paper	Instruction hours /week	Exam hours	Credits	Marks Exam + IA = Total	HC / SC
1.	BCH 551	Genetic Engineering	4	3	4	70+30=100	HC
2.	BCH 552	Metabolism of Nitrogen Containing Compounds	4	3	4	70+30=100	HC
3.	BCS 553*	Plant Biochemistry	3	3	3	70+30=100	SC
4.	BCS 554*	Microbial Biochemistry					
5.	BCS 555**	Bioinformatics, Biostatistics & Nano-biotechnology	3	3	3	70+30=100	SC
6.	BCS 556**	Nanotechnology					
7.	BCPR/D 557***	Project Work /Dissertation	8	-	4	70+30=100	HC

Note: *There is a choice between BCS 553 & BCS 554, ** BCS 555 & BCS 556. ***BCPR 557 is compulsory to all the students. HC/SC: Hard Core/Soft Core.

University theory question paper pattern

Sl. No.	Question type	Marks
1.	Answer any TEN out of 12 questions	2 x 10= 20
2.	Answer any FIVE questions out of seven	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.	

University Practical question paper pattern

Sl. No.	Question type	Marks (70)
1.	Procedure writing	10
2.	Major Experiment	25
3.	Minor Experiment	15
4.	Record	10
5.	Viva-Voce	10

University Project work Evaluation pattern

Sl. No.	Details	Marks (70)
1.	Presentation	25
2.	Viva-Voce	20
3.	Report	25

Internal Assessment (Theory & Practical) Examination

Sl. 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

Sl. No.	Description	Marks
1.	Test	30
	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

I SEMESTER

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

Lecture hours: 56 **Total 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.

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: **14 hrs.**

Thermodynamics, stereochemistry and Radical chemistry: 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: **14 hrs.**

Mechanism of Bio-organic reactions: Introduction, meaning of the term, kinetic and non-kinetic.Fundamental aspects: Homo and heterolytic cleavage, structure and reactivity ofcarbocation (C+), carbanion (C-) and carbon free radical (C.) characteristic aspects of ionic,radical and concerted reactions, substitution, addition, elimination and rearrangements. Energyprofiles of reactions, transition state theory, kinetically and thermodynamically controlledreactions. Reactions SN1, SN2, SN1 neighbouring group participation. E2, Ei, Curtin-Hammettprinciple. 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 and bioinorganic chemistry: 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).

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.

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.
7. Principles and techniques of practical Biochemistry. K.Wilson and J. Walker. 4thEdn. Cambridge University press
8. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Edn. Karen Timberlake, Benjamin Cummings, (1999).

BCH 402: CHEMISTRY OF BIOMOLECULES: HARD CORE

Lecture hours: 56 **Total Credits: 04**

Course objectives:

- To know the various types of biomolecules
- To understand the classification and properties of all the biomolecules
- To learn the structures and functions of biomolecules
- To provide the knowledge of importance of biomolecules in the biological system

Unit I **14 hrs.**

Carbohydrates: Structure and classification of carbohydrates, monosaccharides, disaccharides and polysaccharides. Monosaccharides and Disacharides- 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, bacterial cellwall polysaccharides, blood group polysaccharides.Glycoproteins- Glycosidic bond, N- and O-glycosylation, Proteoglycans- agreecan, syndecan, and decorin.Lectins – characteristics and functions in biological system.**Structure elucidation:** degradation, graded acid hydrolysis, periodate oxidation, degradation of oxopolysaccharides, methylation, acetylation, GC-MS.

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 including pKa values. 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 disulfidebonds.**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 destablizing 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).

Unit III **14 hrs.**

Protein folding and lipids: 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 disulfidebondformation, molecular chaperones and protein disulfideisomerase, Disease related to protein folding – Alzheimer's and mad cow disease.**Lipids-** Classification of lipids. Occurrence and Properties of Fatty Acids , Phospholipids Glycolipids, sphingolipids, gangliolipids, Ceramide, Sphingosine, essential/non-essential fatty acids, micelles, vesicles, liposome, mixed micelles, trans fatty acids,Prostaglandins, Thromboxanes.

Unit IV **14 hrs.**

Nucleic Acids – Nucleoside, nucleotides of nucleic acids. short hand 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. Types of 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.

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.

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. Nucleicacid 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).

BCH 403: BIOCHEMICAL TECHNIQUES **HARD CORE**

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

Course objectives

- Integrates theoretical principles and experimental techniques common in biochemical sciences
- To understand the use of animal models and cell culture techniques
- 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.

Unit I **14 hrs**

Separation techniques: Animal and plant models, Investigation with microorganism and their mutant (auxotroph), yeast, *Ceanorhabditis elegans*, *Arabidopsis thaliana* and *Drosophila melanogaster* as model specimen for biochemical investigations. Introduction to animal and bacterial cell culture, potential uses of cell culture. **Techniques for separation of cell components**. Cell disruption and production of initial crude extract, precipitation of proteins (salt, acid, organic solvent, isoelectric precipitation, immunoprecipitation), dialysis and ultra filtration. Principle in isolation of DNA and RNA. **Centrifugation:** Basic principles of sedimentation, types of centrifuges and rotors. Preparative centrifugation – differential and density gradient, Sub-cellular fractionation, Analytical Centrifugation - application and design.

Unit II **14 hrs**

Chromatographic techniques: Introduction, partition coefficient, Modes of chromatography, liquid and solid phases, paper chromatography and Thin-layer Chromatography (TLC). Principle, procedure and applications- 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 (immunoaffiniy and IMAC), High performance liquid chromatography (HPLC), Fast protein liquid chromatography (FPLC), Gas liquid chromatography (GLC).

Unit III **14hrs**

Electrophoretic and spectroscopic techniques: Principle, PAGE, Native PAGE, zymogram, gradient gels, 2-D gel electrophoresis, isoelectric focusing, agarose gel electrophoresis, pulsed field electrophoresis, DNA sequencing gels, capillary electrophoresis. Visualizing separated components - staining for proteins nucleic acids, fluorescence, PAS staining. Spectroscopic techniques: Beer-Lambert's Law and its limitations, Molar extinction coefficient. Principle & applications in biochemical and biomedical sciences- Colorimeter, UV-Vis Absorption spectroscopy, Fluorescence Spectroscopy, Circular

dichroism spectroscopy, Mass spectrometry, Infrared and Raman Spectroscopy, Nuclear Magnetic Resonance, 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: Geiger-Muller counter, Scintillation counter. 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.

Course outcome:

- Motivates students by learning cutting-edge topic in biochemical techniques
- Promotes problem solving skill by students
- 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.

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
5. Ian M. Rosenberg. Protein Analysis and Purification, Benchtop techniques, 2nd ed, Birkhäuser

BCS 404: HUMAN PHYSIOLOGY: SOFTCORE

Lecture Hours: 42 **Total 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.

Unit I **14 hrs.**

Blood, nervous system and biochemistry of vision: Composition, cells, plasma proteins. Erythrocytes-structure and function, WBC-types, differential count, functions. Platelets and function. 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.Post-synaptic potential. Autonomous nervous system. A 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, respiratory and excretory 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.**Respiratory System:** Lungs, structure and functions. Gas exchange, oxygen binding by hemoglobin, factors affecting oxygenation. **Excretory System:** Kidney- structure of the nephron. Formation and composition of urine, urine analysis for abnormal constituents, tubular functions tests. Regulation of acid-base, electrolyte and water balance. Respiratory and metabolic acidosis and alkalosis.

Unit III **14 hrs.**

Hepatobiliary, gastrointestinal and endocrine 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. Thyroid, parathyroid, adrenal, Gonads -testes and ovaries. Menstrual cycle. Hypothalamus- Pituitary target organ axis and regulation by feed -back mechanism. Peptide hormones**.**

Course outcome:

- Student will have a better understanding of the whole body.
- He would be able to corelate 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.

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.

BCS 405: GENERAL MICROBIOLOGY: SOFTCORE

Lecture Hours: 42 **Total 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.

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– Leeuwenhoeck, Edward Jenner, Alexander - Flemming, Joshep 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.

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.
- Students would learn the structure and functions of microscopic organisms.

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.

BCP: 406: PRACTICAL BIOCHEMICAL METHODS: SOFT CORE

Practical: 8 hours/week **Total credits: 03**

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.

EXPERIMENTS

1. Extraction of carotenes from natural source and their estimation by UV-Vis spectroscopy
2. Extraction of Lycopenes from natural source and their estimation by UV-Vis spectroscopy

3. Extraction of Chlorophylls from natural source and their estimation by UV-Vis spectroscopy
4. Separation of protein by Ion exchange chromatography
5. Separation of protein by Gel filtration chromatography
6. Purification of immunoglobulin by Affinity chromatography
7. Estimation of Phosholipids
8. Extraction and estimation of Phoshotidylcholine from egg yolk
9. Determination of pKa of an acid
10. Estimation of calcium from natural source (Ragi)

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.

REFERENCES:

1. Introduction to practical Biochemistry. David T. Plummer
2. Lab Manual of Biochemistry. By Nigam. 2007. Tata McGraw-Hill Education, USA.
3. Biochemical Methods. S. Sadasivam and A. Manickam. 3rd ed, New Age International P.

BCP 407: PRACTICAL GENERAL BIOCHEMISTRY: SOFT CORE

Practical: 8 hours/week **Total credits: 03**

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.

EXPERIMENTS

1. Buffers: a) Introduction b) Preparation of acetate, citrate and phosphate buffers
2. Quantitative determination of protein concentration by Biuret method.
3. Estimation of protein by Lowry's method.
4. Estimation of protein by Bradford method.
5. Bicinchonic acid protein assay.
6. Measurement of protein concentration by UV spectroscopy.
7. Estimation of glucose from natural or synthetic source by Dinitrosalicylic acid method.
8. Estimation of total carbohydrates from natural source by Phenol sulphuric acid method.
9. Estimation of starch by Anthrone method
10. Estimation of ascorbic acid from natural source (guava, green chilli, orange etc.) by DNPH method.
11. Estimation of inorganic phosphate by Fiske- Subba Rao's method.
12. Estimation of DNA by Diphenylamine method
13. Estimation of RNA by Orcinol acid method

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.

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.

REFERENCES:

1. Introduction to practical Biochemistry. David T. Plummer
2. Lab Manual of Biochemistry. By Nigam. 2007. Tata McGraw-Hill Education, USA.
3. Biochemical Methods. S. Sadasivam and A. Manickam. 3rd ed, New Age International P.

BCP 408: PRACTICAL BIOANALYTICAL TECHNIQUES: HARD CORE

Practical: 8 hours/week **Total Credits: 04**

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.

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. Detection of carbohydrates by thin layer chromatography.
9. Saponification number of oil and fat.
10. Iodine number of oil and fat.
11. Trichloroacetic acid precipitation of proteins.
12. Preparation of casein from milk.
13. Acetone precipitation of proteins
14. Purification of proteins: Ammonium sulphate precipitation (salting out), Dialysis,.
15. Separation and detection of proteins – Native PAGE, Denaturing PAGE.

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

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

BCH451: ENZYMOLOGY: **HARD CORE**

Lecture Hours: 56 **Total 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

Unit I **14hrs.**

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 sitestructure-isolation of ES complex, affinity labeling, chemical modification studies. Units of enzyme activity, specificity and specific activity of enzymes. Assay methods-coupled enzyme assays, continuous, end point and kinetic assay.

Unit II **14 hrs.**

Enzyme Kinetics: Rate of reaction, order and molecularity. MichaelisMenton 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. **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.

Unit III **14 hrs.**

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. **Mechanisms of Action of Specific Enzymes-** Chymotrypsin, zymogen activation, acid-base catalysis, charge relay network. Lysozyme, Alcohol dehydrogenase, Ribonuclease, Carboxypeptidase A, RNA as enzyme,

Unit IV **14 hrs.**

Co-enzymic action of NAD, FAD, TPP, PLP, biotin, CoA, Folic acid, Lipoic acid. **Multimolecular Forms-** LDH, multifunctional enzyme (DNA polymerase), multi enzyme complex (PDC), **Metabolic Cooperativity-** Binding of ligands to macromolecules-scatchard plot, cooperativity, positive and negative cooperativity. Oxygen binding to hemoglobin. Hill equation, homotropic and heterotrophic effectors, aspartyltranscarbamylase as an

allosteric enzyme. **Fast Reactions**- Stopped flow, temperature jump method with examples of enzymes. Immobilization of enzymes,applications of enzymes in medicine and industries, synzymes, abzymes.

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.

References

1. Fundamentals of Enzymology; 3rd Edn. Nicholas C. Price and Lewis Stevens, OxfordUniversity Press (2012).
2. Biochemical Calculations, Irwin H. Segel (1976) 2nd Ed. John Wiley and Sons.
3. Methods in Enzymology; Colowick S.P. et al., Vol. 152, Academic Press, (1987).
4. Methods of Enzymatic Analysis; Berg Meyer Vol. 1-X, (1974).
5. The Enzymes; Boyer, Academic Press, (1982).
6. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry; Trevor Palmer (Edn)Horwood Chemical Science Series.
7. Lehninger Principles of Biochemistry; D.L.Nelson and M.M. Cox, 6th Edn. MacMillanPublications (2012).
8. Principles of Biochemistry; Smith *et al*., Ed. McGraw Hill,(1986).

BCH 452: CLINICAL BIOCHEMISTRY: HARD CORE

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

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

Unit I **14 hrs.**

Diagnostic enzymes and hematological disorders - 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**- Function of plasma proteins and lipoproteins in diseases. Disorders of Hemoglobin-Thalassemia, Sickle cell anemia. Anemias-Microcytic, normocytic & macrocytic.

Unit II **14 hrs.**

Biochemical indices of hepatobiliary and renal diseases- Metabolism of circulating lipids-chylomicrons, HDL,

LDL and VLDL. Reverse cholesterol transport by HDL. Oxidized lipids and their metabolism. 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. **Kidney**-Assessment of renal function-creatinine clearance, renal calculi, uremia, laboratory investigation of kidney disorders. Urea, creatine, creatinine, serum and blood urea. **Gastrointestinal Disorder-** Fractional gastric analysis, hypo and hyper acidity, gastric ulcers, malabsorption syndrome, steatorrhea, diarrhea.

Unit III **14 hrs**

Endocrine Disorders- Laboratory diagnosis. 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. **Cancer**-Apoptosis, Oncogenesis, Necrosis, Angiogenesis, Carcinogens, mechanisms.

Unit IV **14 hrs.**

Disorders of nitrogen and lipoProtein 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.

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.

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.

BCS 453: NUTRITIONAL BIOCHEMISTRY: SOFTCORE

Lecture Hours: 42 **Total 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 druginteraction

Unit I **14 hrs.**

Concepts in 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, physiological fuel value, daily requirement of energy, high and low calorie diets. Basal Metabolic Rate (BMR), factors affecting BMR. Specific dynamic action of foods. **Macro and micronutrients**: Sources, requirements, functions, biochemical role and deficiency symptoms.

Unit II **14 hrs.**

Carbohydrates and fats-Dietary sources, Essentiality of carbohydrates, dietary fibres. **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. **Water**: Distribution in the body, function, special properties of water, water balances and factors affecting water balance.

Unit III **14 hrs**

Vitamins, interaction of food and drug-Fat soluble and water-soluble vitamins, pro-vitamins, antivitamins, dietary sources, structure, function, daily requirements and Deficiency symptoms of B and C vitamins and fat soluble vitamins, hypervitaminosis, vitamin - like compounds, hyper-vitaminosis, vitamin-like compounds.. **Food Drug Interaction:** Pharmacological aspects of food-drug interaction, risk factors. Diet: Recommended daily allowances, special nutrition for infants, children, during pregnancy, lactation and old age. Nutrition for diabetes and cardiovascular disease patients. Wellness diets, fitness diets, obesity and BMI.

Course outcome

- 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.

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.
4. Food and Nutrition, Swminathan

BCS 454: GENERAL VIROLOGY: SOFT CORE

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

Course Objectives

- To study the properties, nomenclature and classification of viruses
- To isolate, cultivate and purify different types of viruses
- To detect viruses by various assay methods
- To study the major characteristics of different families of viruses

UNIT-I **14 Hours**

Discovery of viruses and development of Virology- Nature, origin and evolution of viruses. Properties of viruses : Physical- morphology and structure, sedimentation, electrophoretic mobility, buoyant density. Biochemical- chemical composition, nucleic acids, proteins, enzymes, lipids, carbohydrates, polyamines, cations. Antigenic nature of viruses. Biologicalhost range, transmission (vector and non-vector), virus stability. Nomenclature and classification of viruses: Criteria used for naming and classification. Current ICTV classification of viruses of bacteria, plants and animals and humans.

UNIT-II **14 Hours**

Bacterial, plant and animal viruses-Isolation, cultivation, assay and maintenance of bacterial, plant and animal viruses : Experimental plants and tissue cultures. Experimental animals, embryonated eggs, organ cultures, primary and secondary cell cultures, suspension and monolayer cell cultures, cell strains, cell lines. Purification of viruses : Need for virus purification. Extraction of viruses from tissues, clarification, concentration of viruses in clarified extracts by physical and chemical methods, further purification of viruses by rate zonal / equilibrium density gradient centrifugation. Criteria of virus purity. Quantitation and preservation of purified virus preparations.

UNIT-III **14 Hours**

Quantification of viruses: Infectivity assay methods (plaque, pock, end point, local / systemic assay of plant viruses), physical (EM), serological (HA, HI, immunofluorescence, ELISA) and chemical (viral protein and nucleic acid based) approaches. Major characteristics of the following virus families / genera / groups : Adenoviridae, Bromoviridae, Bunyaviridae, Caulimoviridae, Flaviviridae, Geminiviridae, Hepadnaviridae, Herpesviridae, Orthomyxoviridae, Paramyxoviridae, Parvoviridae, Picornaviridae, Potyviridae, Poxviridae,

Reoviridae, Retroviridae, Rhabdoviridae,Coronaviridae,Tobamovirus, Insect Viruses: Biology of major RNA and DNA viruses of insects and their applications.

Course Outcome

- Knowledge in properties, nomenclature and classification of viruses
- Familiarity in isolation, cultivation and purification different types of viruses
- Detection of viruses by various assay methods
- Familiarity in major characteristics of different families of viruses.

References

1. Virology: Principles and Applications: John B Carter Reviews, John Wiley & Sons, Limited, 08- Mar-2013 - 400 page
2. Principles of Virology: 2000. by S.J. Flint et al., ASM Press.
3. Introduction to Modern Virology. 2001. 5th ed. Dimmock et al., Blackwell Sci. Publ. Principles of Molecular Virology. 1997. 2nd ed. A. Cann. Academic Press.
4. Basic Virology, 1999. By Waginer and Hewelett, Black Well Science Publ.
5. Medical Virology. 1994. 4th edition. D.O. White and F.J. Fenner. Academic Press. Plant Virology. 2001. 4th edi. By R. Hull. Academic Press.
6. Fundamental Virology, 4th ed. 2001. D.M. Knipe and P.M. Howley.

BCS 455: METABOLISM OF FUEL MOLECULES: SOFT CORE

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

Course objectives:

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

Unit I **14 hrs.**

Metabolism of carbohydrates: Catabolism, anabolism, catabolic, anabolic and amphibolic pathways**.** Glycolysis, energetics, regulation. Pathways of utilization of pyruvate, lactate, ethanol, gluconeogenesis, regulation, citric acid cycle, its regulation, energetics, anapleurosis, glyoxylate cycle, HMP pathway, Enter – Doudoroff, Glucuronate and Glyoxylate pathway, Cori cycle, Futile cycles and anaplerotic reactions. Interconversion of hexoses. Biosynthesis of sucrose. **Glycogen and starch** degradation, synthesis and regulation, glycogen storage disorders.Regulation of blood glucose level, hypoglycemia and hyperglycemia. Pentosuria, fructose and lactose intolerance, fructosuria, galactosemia.

Unit II **14 hrs.**

Lipid metabolism- 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, 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.

Unit III **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.

Course outcome:

- Student learns 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

]

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).

BCS 456: BIOETHICS AND BIOSAFETY: SOFTCORE

Lecture Hours:42 **Total 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

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.

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& recombinant DNA research.
- Risk assessment, biological waste disposal, biosafety containment levels and so on.

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

BCE457: BIOCHEMISTRY IN DAY-TO-DAY LIFE: SOFTCORE

Lecture Hours: 36 **Total 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

Unit I **12 hrs.**

Concepts of Nutrition- Concepts of nutrients, essential nutrients and their classification. Basal Metabolic Rate (BMR), factors affecting BMR. Specific dynamic action (SDA) 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 and lipids-Essential amino acids, nutritional classification of proteins, supplementary value of proteins, protein calorie malnutrition. Kwashiorkor and Marasmus, Nitrogen balance, Malnutrition, protein calorific value. **Fats**-Sources, invisible fat, essential fatty acids. **Dietary formulation** for different age groups: children, adults, old age, pregnancy and lactating mother.

Unit III **12 hrs.**

Vitamins, and food-drug interaction-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.

Course outcome

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

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.

BCP 458: PRACTICAL ENZYMOLOGY: HARD CORE

Practical: 8 hours/week: **Total Credits: 04**

Course objectives

• To have practical knowledge about enzyme kinetics

• To purify the enzymes by ammonium sulphate fractionation

• To calculate Km, V_{max} of enzymatic reaction.

• To characterize invertase, acid phosphatase, protease and esterase from different sources

EXPERIMENTS

Salivary Amylase: Activity, Specific activity, Optimum pH and Temperature, pH and Temperature Stability, energy of activation, Km, V_{max}, 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. Immobilization of enzymes

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, V_{max} of enzymatic reactions.

• Characterization of invertase, acid phosphatase, protease and esterase from different sources

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).

BCP 459: PRACTICAL CLINICAL BIOCHEMISTRY: HARD CORE

Practical: 8 hours/week **Total Credits: 04**

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

EXPERIMENTS

1. Urine analysis – Normal and Abnormal.
2. Estimation of serum cholesterol by Zak's method.
3. Estimation of serum proteins by Lowry's method
4. Estimation of protein and A-G ratio by biuret method
5. Estimation of free proline by Bate's method
6. Serum SGOT, SGPT, LDH, ALP, urea, uric acid, creatinine, TAG, Cholesterol estimation using kits.

   Determination of HDL and LDL cholesterol.

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.

References:

1. Tietz Fundamentals 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

BCH 501: MOLECULAR BIOLOGY: HARD CORE

Lecture hours: 56 **Total Credits: 04**

Course objectives

- To study the mechanism of replication in prokaryotes and in virus
- To study the transcription in prokaryotes and eukaryotes
- Genetic code, protein synthesis in prokaryotes and eukaryotes.
- Post translational modification and protein targeting

Unit I **14hrs.**

Replication and regulation of gene expression- Historical perspective. Central dogma of molecular biology. **Replication of DNA** semi conservative 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, single stranded DNA virus, rolling circle model. Replication of mitochondrial DNA. **Regulation of gene expression**,super coiling, DNA methylation. Role of nucleosome structure in eukaryotic gene expression; glucocorticoid gene.

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, attenuation control. Transcription factors, TF II, NF-kB.

Unit III **14 hrs.**

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 ferretin and transferrin m-RNA. Inteins.

Unit IV **14 hrs.**

Post translational modification of proteins-signal cleavage, disulphide 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.

Course outcome

- The student understands the process of replication, transcription and translation in prokaryotes, eukaryotes and virus.
- Transcription in prokaryotes and eukaryotes and RNA virus

- Deciphering of genetic code, translation in prokaryotes and eukaryotes
- Post translational modifications and protein targeting

References:

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

BCH 502: IMMUNOBIOLOGY: HARDCORE

Lecture hours: 56 **Total 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.

Unit I **14 hrs.**

Introduction to immunology: Historical development and milestones in immunology. Definitions; antigenicity, immunogenicity, innate and acquired immunity. Primary and secondary lymphoid organs, self and non-self- discrimination. 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 TNF□. T and B interaction. Suppression of immune response, immunoglobulin gene- immunoglobulin diversity, gene rearrangement, clonal selection theory.

Unit III **14 hrs.**

MHC molecules and transplantation: Role of MHC in immune response and transplantation. **Non-specific Defense in Man-** Barriers to infection-skin, mucous membrane, inflammation, complement hyper sensitivity 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.

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, and interleukins.
- 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.

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)., saras publication.
7. Basic and Clinical immunology; Stites*et.al;* [ED.] (1982) Lange
8. Immunology, Boitt*et al*. (2001), Mosby.

BCH503: CELL BIOLOGY: HARD CORE

Lecture hours: 56 **Total Credits: 04**

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

Unit I **14 hrs.**

Cell structure and function: 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. Cellmdivision, 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.**

Membrane biochemistry: 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, Ca2+ ATPase, Na+ -K+ ATPase (Structure and mechanism of action). Endocytosis, receptor mediated endocytosis, exocytosis, ion channels; gated and non-gated, aquaporin channel.

Unit III **14hrs**

Mechanism of peptide hormone action: General mechanisms of cell signaling by hydrophilic factors, transmembrane receptors, transmembrane receptors, G protein coupled receptors, receptor tyrosine kinase. **Second messengers:** 1P3, DAG, cAMP, protein kinases. Nitric oxide signaling; generation and action. **Growth factors:** Structure, mechanism of action and receptors of EGF, PDGF, NGF and IGF. Insulin receptor. Receptor down regulation, desensitization and up regulation.

Unit IV **14 hrs.**

Mechanism of action of steroid hormone action: Conversion of cholesterol to steroid hormone. Steroid receptors, isolation and characterization of steroid receptors. Chemistry and action of prostaglandins, prostacyclins and thromoxanes, eicosanoid receptors. Newly discovered hormones. Insect **hormones:** Structure and function of moulting hormone, ecdysone, juvenile hormones, Pheromones. Application of insect hormones, plant hormones.

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

REFERENCES:

1. The Cell: A Molecular Approach, Cooper and Hausman
2. Molecular Biology of The Cell, Bruce Alberts
3. Molecular Cell Biology, Lodish, Berk *et al.*,

BCS 504: MOLECULAR GENETICS: SOFT CORE

Lecture hours: 42 **Total 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.

Unit I **14 hrs.**

Basic Principles of Mendelism- Laws of Inheritance, dominance, codominance, epistasis, (eg., Comb shape in chicken) Pleiotropism. Cytoplasmic inheritances (eg. 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. X-linked inheritance. Polygenic inheritance, mitochondrial inheritance, Y-chromosome inheritance.

Unit II **14 hrs.**

Organization of Genes in Prokaryotic and Eukaryotic genes-Genome size and evolutionary complexity, C-value paradox, structure of bacterial chromosome, structure and organization of eukaryotic chromosome, nucleosome organization, arrangement of chromatin fibers in a chromosome, Polytene chromosomes, Centromere and telomere structure,Karyotype, Epigenetic modifications on chromatin

Unit III **14 hrs.**

Mutations and Repair mechanisms- 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 of Human Diseases-** Extra or missing chromosome, abnormality in chromosome structure – deletion duplication, inversion, translocation

Course outcome

• The student understands the basic principles of genetics, gene linkage and X-linked inheritance and cytoplasm inheritance

• Various causes of mutation and their repair mechanism

• Diseases associated with changes in chromosome number and structure.

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).

BCS 505: FOOD SCIENCE: SOFT CORE

Lecture hours: 42 **Total 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.

Unit I **14 hrs.**

Basic concept of nutrition- 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. Glycemic 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 bio-availability 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, bio-availability & requirements, sources, deficiency & excess(Calcium, Sodium, Potassium Phosphorus, Iron, Fluoride, Zinc, Selenium, Iodine, Chromium). Vitamins - Bio-Chemical and Physiological Role Physiological role, bio-availability and requirements, sources, deficiency & excess.Water - Functions, daily requirements, Water balance. Elementary idea of Probiotics, Prebiotics, Organic Food.

Unit II **14 hrs.**

Dietics-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.**

Microbial Nutrition: 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.

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

REFERENCES:

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

BCP 506: PRACTICAL MICROBIOLOGY: SOFT CORE

Practical: 8 hours/week **Total Credits: 03**

Course objectives:

- To have hands on experience in microbiological staining techniques
- To know the biochemical tests pertaining to microorganisms.
- Air and water microbiological experiments

EXPERIMENTS

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
3. (a) Starch hydrolysis test (b) Gelatin hydrolysis test
4. (a) Catalase test (b) Oxidase test.
5. Air Microbiology: Isolation of air microflora (a) exposure plate method (b) rotorod sampler method.
6. Water Microbiology: Testing of quality of water (coliform test), H2S strip method.
7. Estimation of lactate
8. Citrate from bacterial culture media.

Course output:

- Student will have knowledge of all the basic experiments in Microbiology
- He/she will understand the load of microbes in water and air.

References

1. Pelczar Jr, M.J. Chan, E.C.S. and Kreig, N.R. (1993). Microbiology, Mc. Graw Hill.Inc. New York.
2. Principles of Gene Manipulations; 6th Edn. S.B. Primrose, R.M. Twyman, and R.W. Old, Blackwell Science (2012).

BCP 507: CELL BIOLOGY: SOFT CORE

Practical: 8 hours/week **Total Credits: 03**

Course objectives:

- Mounting of polytene chromosomes and also Barr bodies.
- Isolation of nucleus, mitochondria, chloroplast and their purification
- Study of mitosis and meiosis.

EXPERIMENTS

1. Mounting of polytene chromosomes
2. Mounting of Barr bodies
3. Study of mitosis by using onion root tips
4. Study of meiosis
5. Isolation of nucleus and determination of its purity
6. Isolation of mitochondria and determination of purity
7. Isolation of chloroplast by sucrose density gradient and determination of its purity
8. Visit to Industry/ Institution/Clinical Laboratory.

Course outcome:

- Polytene chromosomes and Barr bodies are mounted and identified.
- Cell organelles and cell divisions are observed

REFERENCES:

1. Principles and Techniques of Biochemistry and Molecular Biology; 7th Edn. Keith Wilson and John Walker (2012).
2. Molecular Cell Biology, Lodish, Berk et al., 1996.

OPEN ELECTIVE FOR OTHER DISCIPLINES

BCE 508: HEALTH AND DISEASE: SOFTCORE

Lecture hours: 36 **Total 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

Unit I **12 hrs.**

Introduction to health and diseases: 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 and life style 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. **Life style 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

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 structures.

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

BCP 509: PRACTICAL MOLECULAR BIOLOGY & IMMUNOBIOLOGY: SOFT CORE

Practical: 8 hours/week **Total Credits: 04**

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

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

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.

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).

BCP: 510: BIOPROCESS TECHNOLOGY: SOFT CORE

Practical: 8 Hours / Week **Total Credits: 04**

Course objectives

- To study industrially important organisms
- To understand the improvement of microorganisms to increase byproduct
- To study the industrially important enzymes from microorganisms
- To study the production of commercial products from microorganisms

EXPERIMENTS

1. Isolation of industrially important microorganisms for citric acid production and improvement of strain for increase yield by mutation.
2. Isolation of industrially important microorganisms for Lactic acid production and improvement of strain for increase yield by mutation.
3. Isolation of industrially important microorganisms for alpha amylase production and improvement of strain for increase yield by mutation.
4. Isolation of industrially important microorganisms for ethanol production and comparison of ethanol production using various Organic wastes / raw Material (Free cells / immobilized cells).
5. Isolation of industrially important microorganisms for production of glutamic acid.
6. Isolation of industrially important microorganisms for production of antibiotics.

Course outcome:

- Students gain the knowledge of industrially and economically important microorganisms and their products.
- Students gain the knowledge of producing cost effective products from cheaper resources.

References

1. **Principles of Fermentation Technology,** Peter F Stanbury, Allan Whitaker, Stephen J Hall,
2. Industrial Microbiology by L.E.J.R. Casida, New Age International publishers, Delhi.
3. Food Microbiology by William C. Frazier , Dennis C. Westhoff , N.M. Vanitha, 4th edition, New Age International publishers, Delhi.

IV SEMESTER

BCH 551: GENETIC ENGINEERING: HARDCORE

Lecture Hours: 56 hours **Total 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 fermentor.

Unit I **14 hrs**

Principle of Gene Cloning I: 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. Ligation: blunt end and sticky end ligation, use of linkers and adopters, homo polymer tailing, Vectors: Plasmids (construction of pBR322, pUC8 and pUC18 plasmids), virus based vectors (lambda phage and M13), phagemid, cosmid, Yeast cloning vectors, bacterial artificial vectors, plant vectors, expression vectors, cDNA cloning.

Unit II **14 hrs.**

Principle of Gene Cloning II–Gene library construction, 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. Introduction to plant tissue culture and animal cell culture, Laboratory design, aseptic conditions, equipment and materials for cell culture. Different constituents of culture medium, types of media.

Unit III **14 hrs**

Cell culture techniques: 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**

Molecular Techniques: Polymerase chain reaction, reverse transcriptase-PCR, qPCR, technique and applications, applications of PCR, concepts of DNA sequencing, Sanger's method, automated fluorescent DNA sequencing shot gun sequencing, chromosome walking, Blotting Techniques - Dot blot, Southern, Northern, Western blot, DNA foot print assay, DNA finger print assay, gel retardation assay, nuclease

protection assay. RFLP, RAPD. Applications in agriculture medicine, industry, GM foods, negative impact of genetic engineering, gene knock out.

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.

References:

1. Gene cloning and DNA Analysis: An Introduction, Sixth edition, T A Brown
2. Molecular Biotechnology: Principles and Application of Recombinant DNA, Glick and Pasternak
3. Culture of Animal Cells, Ian Freshney
4. Plant Tissue culture, S. S. Purohith
5. Principles and Techniques of Biochemistry and Molecular Biology, ed., Keith Wilson & John Walker, March 2010, Cambridge Univ. Press.

BCH 552: METABOLISM OF NITROGEN CONTAINING COMPOUNDS: HARDCORE

Lecture hours: 56 **Total 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.

Unit I **14 hrs.**

Overview of nitrogen metabolism: 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 **14 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 nucleotide formation. Biosynthesis of deoxyribonucleotides and coenzymes 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.

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.

REFERENCES:

1. Biochemistry; Geoffrey Zubey, (1998), WCB Publishers.
2. Biochemistry; David Rawn, Panima Publishers, (1989).
3. Text Book 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).

BCS 553: PLANT BIOCHEMISTRY: SOFTCORE

Lecture Hours: 42 **Total 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 of assimilation of mineral nutrients.

Unit I **14 hrs.**

Plant cell biology: 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 and plant secondary metabolites: 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.**

Stress biology and host parasite interaction: 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.

Course Outcome

- 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.

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.

BCS: 554: MICROBIAL BIOCHEMISTRY: SOFT CORE

Lecture hours: 42 **Total Credits: 03**

Course Objectives

- To give the students an advanced level knowledge about microbial biochemistry
- To understand the genetic constituents of bacteria with special emphasis on inheritance and mutations
- To understand the mechanism of genetic transfers in microbes.

Unit I 14 hrs

Nutrient Cycles: Microbes as components of the environment – nutrient cycles carbon, nitrogen (Symbiotic and non-symbiotic nitrogen fixation), sulpur and phosphorus cycles, chemolithorophs. Metabolism of autotrophs; Biosynthesis of Fatty acids; Biosynthesis of Phospholipids, Degradation of Lipids, Bacterial Quorum sensing,

Unit II 14 hrs

Metabolism and Bioprocess technology: Metabolism of aromatic compounds, Fermentation pathways in specific group of microorganisms: Lactic acid, propionic acid, butyric acid producing fermentation; Characteristics and Degradation of industrial wastes, petroleum hydrocarbons, pestcidies, biofouling and corrosion. Fermentation - alcohol, propionic acid, butyric acid fermentation.

Unit III 14 hrs

Microbial Genetics: Para sexual process in bacteria and its significance: Transformation, transfection, transduction and conjugation. Endospore formation (differentiation). Genetic analysis of bacteria: Importance and uses of mutation analysis. isolating mutants, selecting mutants, mutant enrichment. Reversions versus suppression. Complementation tests, recombination tests and gene replacements. Overexpression and tagging of recombinant proteins in E.coli, driven by lac, T7 and Tet-regulatable promoters. Overexpression systems in S.cerevisiae, P.pastoris. Baculovirus over expression system.

Course Outcome

- Student capable of explaining role of microbes in ecological balance.
- Use of microbes in synthesis of commercially important compounds and over expression of proteins

References

1. Albert G. Moat and John W. Foster, Microbial Physisology, Wiley-Liss, A John Wiley & Sons, Inc. Publications.
2. Roberts, K., Lewis J., Alberts B., Walter P., Johnson A., and Raff. M., Molecular Biology of the Cell, 5th Edition, Garland Publishing Inc., 2008.
3. Lodish, H., Berk A., Kaiser C. A., Krieger M., Scott M.P., Bretscher A., Ploegh H., and Matsudaira P., Molecular Cell Biology, 6th Edition, Freeman, W. H. and Co., 2008.
4. Molecular Genetics of Bacteria by Larry Snyder and Wendy Champness, 3rd edition; ASM press; 2007.
5. Fundamental Bacterial Genetics by Nancy Trun and Janine Trempy, 1st edition; Blackwell Science Publishers; 2004.
6. Stanbury PF, Hall SJ, Whitaker A (1999). Principles of Fermentation Technology, Butterworth Heinemann, 2nd edition.
7. Creuger and Creuger (2001). Biotechnology- A textbook of Industrial Microbiology, Sinauer Associates, Inc.

BCS 555: BIOINFORMATICS, BIOSTATISTICS & NANOBIOTECHNOLOGY: SOFTCORE

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

Course objectives:

- To learn the all the basic concepts of statistics.
- To understand the fundamental and necessary aspects of bioinformatics.
- To understand the basic concept of nanotechnology.
- To synthesize nanoparticles and know their applications.
- To study the applications of nanotechnology in various industries.

Unit I **18 hrs.**

Introduction to Bioinformatics: History, Scope and Importance ,Aims and tasks of Bioinformatics - applications of Bioinformatics - challenges and opportunities - introduction to NCBI data model - Various file formats for biological sequences. Databases -Tools and their uses Primary sequence databases - Composite sequence databases - Secondary databases - Nucleic acid sequence databases - Protein sequence data bases – Structural databases –- Protein structure visualization tools (RasMol, Swiss PDB Viewer).**Sequence Alignment Methods**:Sequence analysis of Biological data - Significance of Sequence alignment – Pairwise sequence alignment methods - Use of Scoring matrices and Gap penalties in sequence alignments - Multiple sequence alignment methods – Tools and application of multiple sequence alignment. **Proteomics and Genomics.** Genome projects: E.coli, D.melanogaster, A. thaliana and mouse. The human genome project: goals, mapping strategies, markers, sequencing technologies, potential benefits and risks, ethical, legal and social issues(ELSI).

UnitII **14 hrs.**

Introduction to Biostatistics: Measures of central value - Mean, mode and median; Statistics of Dispersion; Coefficient of variation**;** standard deviation, standarderror Concepts of moments, skewness and kurtosis; Simple correlation and regression; Concept of sampling and sampling methods. Probability and Probability distributions (binomial, poisson and normal); Tests of statistical significance (t –Test, Chi-square test); Analysis of variance.Representation of statistical data line graph, histogram, bar diagram, pie chart.

Unit III **10 hrs.**

Introduction to nanoscience: Definition, and Nanoscale, Classification of Nanomaterials: Quantum Dots, Wells and Wires. Carbon-based Nanomaterials - Nanotubes, Metal based Nanomaterials (Nanogold, Nanosilver and metal oxides). Properties of nanostructuredMaterials.Biological methods of Synthesis: Use of Plant extracts, bacteria, fungi, yeast and other biological particles.Applications of Nanotechnology in Biomedical and Pharmaceutical Industries-Bionanomagnetism,Biosensors,Nanomedicine.

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 bioinformatics 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.
- Student learns about biosensors, nanotechnology and its applications.
- Nanotechnology in Food packaging, agriculture, farming,
- Potential of nanofertilizers.

REFERENCES:

1. Bioinformatics - Concepts, Skills, and Applications"S.C. Rastogi & others 2003,"CBS Publishing
2. Discovering Genomics, Proteomics and Bioinformatics – Campell&Heyer, Benjamin / Cummings pub.
3. Bioinformatics for Dummies, Jean-Michel Claverie, Cedric Notredame (2003) John Wiley & Sons.
4. An Introduction to Biostatistics N .Gurumani (2011), MJP Publishers.
5. Statistics, Basic Concepts and Methodology for the Health Sciences Daniel WW, Pub Wiley, India.
6. Elementary Statistical Methods by S.P. Gupta, Sultan Chand & Sons

7. Nano: The Essentials Understanding Nanoscience and Nanotechnology,Pradeep.T (2007).I Edition, Tata McGraw – Hill Publishing Company Limited, New Delhi.
8. Nanotechnology Lakshman Desai, 2007. 1st Edition, Paragon International Publishers.
9. Chemistry of nanomaterials : Synthesis, properties and applications by CNR Rao et.al.
10. Nano bio-technology: Concepts, Applications and Perspectives, Christ of M. Niemeyer, Wiley, 2004.
11. K.K.Jain, Nano Biotechnology, Horizions Biosciences, 2006.

BCH 556: NANOTECHNOLOGY: SOFT CORE

Lecture hours: 42 **Total 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.
- To understand the importance of nano-fertilizers.

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.**

Biosynthesis of nanoparticles: 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.

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.

REFERENCES:

1. Nano: The Essentials Understanding Nanoscience and Nanotechnology,Pradeep.T (2007).I Edition, Tata McGraw – Hill Publishing Company Limited, New Delhi.
2. Nanotechnology LakshmanDesai, 2007. 1st Edition, Paragon International Publishers.
3. Chemistry of nanomaterials : Synthesis, properties and applications by CNR Rao et.al.
4. Nano bio-technology: Concepts, Applications and Perspectives, Christ of M. Niemeyer, Wiley, 2004.
5. K.K. Jain, Nano Biotechnology, Horizions Biosciences, 2006.
6. Introduction to Nanoscience, by Stuart Lindsay.
7. Introduction to Nanomaterials and nanotechnology by Vladimir Pokropivny, Rynno Lohmus, 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".

BCPR/D 557: PROJECT WORK/DISSERTATION: HARD CORE:

Project work: 08 hours / week **Total Credits: 04**

Course objectives

- To orient the students towards research work
- To develop creativity, analysis, skill in research

Project work will be allotted to the students on defined research work such as protein and peptide chemistry, enzymology, clinical biochemistry, nanotechnology, inflammopharmocology, Phytopharmocolgy, biomarkers, toxicology etc. The students have to present and defend their project work.

Course Outcome

- Students gain the knowledge of literature survey and data analysis
- Students learn the laboratory techniques.

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