DHANALAKSHMI SRINIVASAN
COLLEGE OF ARTS AND SCIENCE FOR WOMEN (AUTONOMOUS)
Affiliated to Bharathidasan University, Tiruchirappalli
(Nationally Re-Accredited with A++ Grade by NAAC)
Perambalur – 621212.
M.Sc BIOCHEMISTRY
Choice Based Credit System-Learning Outcomes Based Curriculum Framework (CBCS-LOCF)
(Applicable to the candidates admitted from the academic year 2024-25 onwards)

PG Science (BIOCHEMISTRY)

Programme Pattern

Sem	Course	Course Title	Course Code	Ins.Hrs	Credit	Exam Hours	Marks		Total
							Internal	External	
I	Core Course-I	Chemistry of Biomolecules	24PBC1C1	6	6	3	25	75	100
	Core Course-II	Analytical Techniques	24PBC1C2	5	5	3	25	75	100
	Core Course-III	Advanced Human Physiology	24PBC1C3	5	5	3	25	75	100
	CorePractical-I	Lab in Chemistry of Biomolecules, Analytical Techniques And Advanced Human Physiology	24PBC1C1P	6	3	6	40	60	100
	Core Elective-I	Advanced Microbiology	24PBC1E1A	5	3	3	25	75	100
		Advanced Human Genetics	24PBC1E1B						
	Value Added Course-1	Detection Methods of Food Adulteration	24PBC1VAC	3	2	3	25	75	100
				30	**24**		**-**	**-**	**600**
II	Core Course- IV	Enzymology	24PBC2C4	5	5	3	25	75	100
	Core Course-V	Metabolism And Regulation	24PBC2C5	5	5	3	25	75	100
	Core Course-VI	Molecular Biology	24PBC2C6	4	4	3	25	75	100
	Core Course-VII	Advanced Dietetics	24PBC2C7	4	4	3	25	75	100
	CorePractical-II	Lab In Enzymology,Metabolism and Regulation,Molecular Biology	24PBC2C2P	6	3	6	40	60	100
	Industrial Based Course	Biomedical Instrumentation	24PBC2I	3	3	3	25	75	100
	Non Major Elective - I	Ayurveda Medicine In Human Health	24PBC2N1A	3	2	3	25	75	100
		Food Science In Human Nutrition	24PBC2N1B						
	Self-Paced learning I-Online course			-	2*				
				30	**26**		**-**	**-**	**700**
III	Core Course-VIII	Advanced Immunology	24PBC3C8	6	6	3	25	75	100
	Core Course-IX	Clinical Biochemistry	24PBC3C9	5	5	3	25	75	100
	Core Course-X	Plant And Animal Biotechnology	24PBC3C10	5	5	3	25	75	100
	CorePractical-III	Lab in Immunology,Clinical Biochemistry, Plant and Animal Biotechnologyand Advanced Dietetics	24PBC3C3P	6	3	6	40	60	100

	Core Elective-II	Developmental Biology	24PBC3E2A	5	3	3	25	75	100
		Endocrinology	24PBC3E2B						
	Non Major Elective - II	Health Disorders In Adolescents	24PBC3N2A	3	2	3	25	75	100
		Indo- Allopathy	24PBC3N2B						
	Internship/Field Study/ Industrial Visit		24P3IV		1				100*
	Self-Paced learning II-Online course				2*				
				30	**25**		**-**	**-**	**600**
IV	Core Course-XI	Research Methodology	24PBC4C11	6	6	3	25	75	100
	Core Elective-III	Nanotoxicology and Biosafety	24PBC4E3A	6	3	3	25	75	100
		Genetic Engineering	24PBC4E3B						
	Project Work		24PBC4PW	18	6		40	60	100
				30	**15**		**-**	**-**	**300**
Total				**120**	**90**				**2200**
Extra Credit Course					**90(4*)**				**2200**

Semester	Course code	Title of the course	Hours	Credits
I	24PBC1C1	CC-I: CHEMISTRY OF BIOMOLECULES	6	6

Objectives: To understand the chemical structure and functions of various biomolecules found in the living systems.

Unit-I Water and Carbohydrate (20 Periods)

Water - Unique properties, biological roles and significance of water. Classification & properties of carbohydrates, Chemistry and biological roles of homo and heteropolysaccharides. Oligosaccharides – lectin interaction in biochemical processes. Structure and role of proteoglycans, glycoproteins and glycolipids (gangliosides and lipopolysaccharides)

Unit –II Amino acids and Proteins (18 Periods)

Amino acids–classification, structure and physicochemical properties. Chemical synthesis of peptides – solid phase peptide synthesis. Proteins – classification and purification of proteins. Structural organization (Primary, Secondary, Tertiary and Quaternary), amino acid sequence determination and methods for characterization of proteins. Conformation of proteins – Ramachandran plots. Denaturation of proteins.

Unit –III Lipids (20 Periods)

Classification of Lipids, Biological significance of lipids, Fatty acids and their physicochemical properties. Structure and properties of Prostaglandins. Storage lipids - triacyl glycerol. Structural lipids in membranes – glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols. Brief account on structure, distribution and role of membrane lipids. Role of Lipids as signal molecules, cofactors and pigments.

Unit-IV Nucleic acids (15 Periods)

Nucleotides- structure and properties, physicochemical properties of nucleic acids, cleavage of nucleic acids by enzymatic methods, non – enzymatic transformation of nucleotides and nucleic acids, methylation, Sequencing, chemical synthesis of DNA. Three-dimensional structure of DNA. A, B and Z DNA. Major classes of RNA, Structure &functions. Minor classes of RNA (brief account). Nucleotides as source of energy, component of coenzymes and their role as secondary messengers. Nucleic acid binding proteins.

Unit-V Vitamins and Minerals (17 Periods)

Fat soluble vitamins and water-soluble vitamins. Fat soluble vitamins: structure, sources and requirement, biological actions and clinical significance of vitamin A, D, E, K. Water soluble vitamins: structure, sources and requirement, biological actions and clinical significance of

thiamine, riboflavin, niacin, pyridoxine, pantothenic acid, biotin, folic acid and vitamin B12. Classification, structural properties and biological role of minerals (iron, calcium, magnesium, sodium, iodine, potassium) in biochemical process.

Unit- VI Glycosaminoglycans and Glycoconjugates

Glycosaminoglycans - structure, location and biological role of hyaluronic acid, chondroitin sulphate, keratin sulfate, heparin sulfate, dermatan sulfate and heparin. Sialic acid - structure and significance. Proteoglycans. Glycoproteins and their biological importance. Principal sugars in human glycoproteins. Lectins - structure, function, applications. Major classes of glycoproteins - O-linked, N-linked, GPI linked oligosaccharides. Carbohydrates as information molecules- the sugar code. Blood group antigens and bacterial cell wall polysaccharides.

TEXT BOOK(S)

1. Biochemistry Zubay 4th edition 1998 William C. Brown Publication.
2. Harper's Biochemistry 25th edition McGraw Hill.
3. Biochemistry Stryer 4th edition Freeman.
4. Principles of Biochemistry. Lehninger Nelson Cox Macmillan worth Publishers,2000.

REFERENCE BOOK(S)

1. Nelson and Cox. Lehninger Principles of Biochemistry. Freeman. 7th ed. 2017.
2. Voet and Voet. Fundamentals of Biochemistry. Wiley. 5th ed. 2018. Rodwell et al.
3. Harper's Illustrated Biochemistry. McGraw Hill. 31th ed. 2018.

Course Outcomes:

CO No.	CO-STATEMENTS On the Successful completion of the course the student would be able to	Cognitive Levels (K-Levels)
CO 1	Helps to understand about the polysaccharides and its types.	Kl & K2
CO 2	Gives a clear understanding about the lipids and its role.	Kl, K2 &K3
CO 3	A Clear Knowledge regarding amino acids and protein	K2, K3 &K4
CO 4	Provides the structure and properties of Nucleic acids	K2& K3
CO 5	Gives an idea about energy level and its synthesis.	KI, K2 & K5

Relationship matrix for Course outcomes, Programme outcomes/ Programme specific outcomes

Mapping with Programme Outcomes:

Semester	Course code		Title of the Course							Hours	Credits
I	24PBC1C1		CC-I: CHEMISTRY OF BIOMOLECULES							6	6
Couse outcomes	Programme outcomes(POs)					Programme Specific Outcomes(PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	2	3	2	2	2	2	3	2	3	2	2.3
CO-2	2	1	2	2	2	2	3	2	3	2	2.1
CO-3	2	2	1	2	3	2	3	2	3	2	2.2
CO-4	2	1	3	3	2	3	2	2	3	2	2.3
CO-5	3	2	2	2	1	3	2	2	3	2	2.2
Mean overall score											2.2 (High)

Semester	Course code	Title of the course	Hours	Credits
I	24PBC1C2	CC-II: ANALYTICAL TECHNIQUES	5	5

Objectives: To understand the working principles, instrumentation and applications of analytical tools of biochemistry.

Unit- I Electrochemical techniques & Centrifugation (14 Periods)

Electrochemical techniques& centrifugation electrochemical cells - pH, Henderson – Hassel Balch equation, buffer capacity, pH measurement, glass electrode. Ion-selective and gas sensing electrodes, oxygen electrode Centrifugation- basic principles - instrumentation - centrifugation units - types of centrifuges-rotors-accessories- colloids-centrifugation methods - sedimentation velocity-sedimentation equilibrium-cell fractionation methods. Principle, methods and application, Ultra centrifugation. Differential and Density gradient centrifugation.

Unit-II Chromatography (20 Periods)

Chromatography-Principle, Instrumentation and applications- Paper, Thin layer, gas, Ion Exchange, gel filtration, Affinity chromatography and HPLC, RF- HPLC, HPTLC, FPLC, LC, Chromatofocusing, capillary electro chromatography.

Unit-III Electrophoresis (20 Periods)

Electrophoresis - General principle and instrumentation and application., Electrophoresis of proteins native- PAGE, SDS-PAGE, 2D-PAGE, gradient gels, isoelectric focusing gels, detection, estimation & recovery of proteins in gels; electrophoresis of nucleic acids agarose gel electrophoresis, pulse field Electrophoresis, capillary electrophoresis; microchip electrophoresis, Cellulose acetate electrophoresis, Di electrophoresis, Zymography.

Unit- IV Spectroscopy (18 Periods)

Spectroscopy: Laws of absorption and absorption spectrum. Principles and applications of ESR, NMR, IR. Principle, instrumentation and applications of UV- visible spectrophotometry, and spectrofluorimetric. Basic principles of turbidimetry and nephelometry. Principle, instrumentation and applications of luminometry. Atomic spectroscopy – principle and applications of atomic flame and flameless spectrophotometry. Use of lasers for spectroscopy. MALDI TOF.

Unit-V Radioisotope techniques (18 Periods)

Radioisotope techniques - Measurement of radioactivity – solid and liquid scintillation counting, scintillation cocktails and sample preparation, Autoradiography, Fluorography, Phosphor- imaging - applications, Cerenkov counting, applications of radioisotopes in biology, radiation hazards and safe disposal of radioactivity waste.

Unit-VI Blotting Techniques

Blotting -history- basic principles - instrumentation – types of methods – Southern blotting, Northern blotting and Western blotting technique and applications.

TEXT BOOK(S)

1. Principles and Techniques of Practical Biochemistry, Keith Wilson & John Walker, Cambridge University Press, India. 2005.
2. Biophysical Chemistry (Principles and Techniques) 4th Edition, Avinash Upadhyay, KakoliUpadhyay and Nirmalendu Nath, Himalaya Publishing House, India, 2014.
3. Methods and Techniques, 2nd ed, C.R. Kothari, Research Methodology, New Age International Publishers. India, 2004.
4. Andreas Hofmann and Samuel Clokie. Wilson and Walker's Principles and techniques of Biochemistry and Molecular Biology. Cambridge University Press. 8th ed. 2018.
5. Upadhyay, Upadhyay and Nath. Biophysical Chemistry principles and Techniques. Himalaya Publ. 2010.

REFERENCE BOOK(S)

1. Textbook of Biochemistry, West, E.S. and Todd, W.R, MacMillan, Germany, 1985**.** Research Methodology, Methods and Techniques 2nd Edition, C.R.
2. Kothari, New Age International Publishers. New Delhi, 2004.
3. Fundamentals of Bio Analytical Techniques and Instrumentation, Ghosal Sabari and Srivastava A. K., PHI Learning Pvt. Ltd. India, 2009
4. Introduction to Spectroscopy. 3rd Edition. Pavia, Brooks/Cole Pub Co., New Delhi, India, 2000.

Course Outcomes:

CO No.	CO-STATEMENTS On the Successful completion of the course the student would be able to	Cognitive Levels (K-Levels)
CO1	To obtain the knowledge about the microscope handling and the basic difference between the ordinary microscope and electron microscope.	Kl
CO2	To learn the chromatographic techniques for the separation of the individual compound from the mixture of compound	K2 &K3
CO3	To study the interaction between matter and electromagnetic radiation and visible light dispersed according to its wavelength, by a prism.	K3 &K4
CO4	To understand the characterization of surfaces using radioisotopes generally involves	K2& K3
CO5	observing the manner in which the radioactive species interact with the surface	KI, K2 & K5

Relationship matrix for Course outcomes, Programme outcomes/ Programme specific outcomes

Mapping with Programme Outcomes:

Semester	Course code		Title of the Course							Hours	Credits
I	24PBC1C2		CC-II: ANALYTICAL TECHNIQUES							5	5
Couse outcomes	Programme outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	3	2	3	1	2	2	3	2	3	2	2.3
CO-2	1	3	2	3	1	2	3	2	3	2	2.2
CO-3	2	1	3	2	3	2	3	2	3	2	2.3
CO-4	3	2	1	3	3	3	2	2	3	2	2.4
CO-5	2	3	2	1	2	3	2	2	3	2	2.1
Mean overall score											2.3 (High)

Semester	Course code	Title of the course	Hours	Credits
I	24PBC1C3	CC-III: ADVANCED HUMAN PHYSIOLOGY	5	5

Objectives: To acquire sound knowledge in the physiology of mammalian systems.

Unit-I Blood (15 Periods)

Blood: Composition and functions of blood. Separation of plasma and serum. Plasmaproteins in health and disease. Red blood cells - formation and destruction. Important aspects of RBC metabolism. The RBC membrane – principal proteins (spectrin, ankyrin, glycophorins). Blood grouping, Composition and functions of WBCs. Blood coagulation – mechanism and regulation. Fibrinolysis. Anticoagulants. Platelets and thrombolysis, anemias and its types.

Unit-II Cardiovascular System (20 Periods)

Cardiovascular System: Anatomy of heart structure, Structure and properties of cardiac muscle. Junctional tissues of heart - Origin and spread of cardiac impulses. Cardiac cycle: Definition, mechanical events during different phases of systole and diastole. Heart Rate- Normal value, physiological variation. Regulation of heart rate. Cardiac output - Definition, normal values, physiological variation, factors affecting, cardiac index, cardiac reserve, regulation of cardiac output. Heart sounds- Causes, characteristics, significance, phonocardiogram, murmurs.

Unit-III Respiratory System (15 Periods)

Comparison of respiration in different species, anatomical considerations, transportof gases, exchange of gases, waste elimination, neural and chemical regulation ofrespiration. Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture. Muscle physiology

Unit- IV Body Fluids (13 Periods)

Body Fluids: Lymph – composition and functions. CSF – composition and clinical significance. Formation of urine – structure of nephron, glomerular filtration, tubular reabsorption of glucose, water and electrolytes. Countercurrent multiplication, tubular secretion. Composition, functions and regulation of saliva, gastric, pancreatic, intestinal and bile secretions.

Unit -V Neuromuscular System (12 Periods)

Neuromuscular System: Structure of neuron. Propagation of action potential: Voltage – gated

ion channels. Neurotransmitters - release and cycling of neurotransmitters. The neuromuscular junction – activation of gated ion channels. The acetylcholine receptor. Structure of skeletal muscle. Muscle proteins – myosin, actin, troponin and tropomyosin and other proteins. Sequence of events in contraction and relaxation of skeletal muscle.

Unit – VI Digestive and Excretory System

Composition, functions and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Digestion and absorption of carbohydrates, lipids, proteins and nucleic acids. Structure of nephron. Formation of urine- glomerular filtration, tubular reabsorption of glucose, water and electrolytes. Tubular secretion. Normal and abnormal constituents of urine.

TEXT BOOK(S)

1. Principles of Biochemistry- Smith et al. Mammalian Biochemistry.
2. Cell and Molecular Biology. De Robertis and De Robertis. Lea and Febiger 8thed 1987).
3. Molecular Biology of the Cell - Alberts, 4th ed. Garland Sci. 2002.
4. Nelson and Cox. Lehninger Principles of Biochemistry. Freeman. 7th ed. 2017.
5. Lodish et al. Molecular Cell Biology. Freeman. 8th ed. 2016

REFERENCE BOOK(S)

1. Molecular Cell Biology 5th ed., Lodish, WH Freeman (for unit 1, 2, 5) 2003.
2. Harper's Biochemistry 26th^{ed}- Murray, McGraw Hill.
3. McGraw Hill 7th ed. (for unit 3, unit 4) 1983.

Course Outcomes:

CO No.	CO-STATEMENTS On the Successful completion of the course the student would be able to	Cognitive Levels (K-Levels)
CO1	Gain foundational knowledge about blood composition, functions, and disorders.	K1 & K2
CO2	Understand the structure, function, and regulation of the cardiovascular system.	K1, K2 & K3
CO3	Explore the mechanisms of body fluid regulation, including digestive secretions and urine formation.	K2, K3 & K4
CO4	Understand respiratory processes and neural regulation, including neuron function and muscle physiology.	K2 & K3
CO5	Develop insights into the neuromuscular system, including muscle contraction and neurotransmitter function.	K1, K2 & K5

Relationship matrix for Course outcomes, Programme outcomes/ Programme specific outcomes

Mapping with Programme Outcomes:

Semester	Course code		Title of the Course							Hours	Credits
I	24PBC1C3		CC-III: ADVANCED HUMAN PHYSIOLOGY							5	5
Couse outcomes	Programme outcomes(POs)					Programme Specific Outcomes(PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	3	2	3	2	1	2	3	2	3	2	2.3
CO-2	1	2	2	2	2	3	2	2	3	2	2.3
CO-3	1	2	2	3	2	2	3	2	3	2	2.2
CO-4	2	2	2	1	3	3	2	2	3	2	2.2
CO-5	3	2	3	2	1	2	3	2	3	2	2.3
Mean overall score											2.3(High)

Semester	Course code	Title of the course	Hours	Credits
I	24PBC1C1P	CP-I: LAB IN CHEMISTRY OF BIOMOLECULES, ANALYTICAL TECHNIQUES & HUMAN PHYSIOLOGY	6	3

Objectives:

To understand the working principles, construction and applications of the instruments used in the studies related to various disciplines of biological sciences.

1. Estimation of Total Proteins by Lowry's method.
2. Estimation of Magnesium.
3. Estimation of Tryptophan.
4. Estimation of Glycogen.
5. Estimation of phospholipids.
6. Estimation of blood glucose by Ortho-Toluidine method.
7. Estimation of blood Urea by DAM method.
8. Estimation of serum Uric acid Caraway's method
9. Estimation of serum creatinine by alkaline picrate method.
10. Estimation of serum phosphorus by Fiske Subbarow method.
11. Separation of sugar and Amino acid by TLC.
12. Separation of Phytoconstituents by Column Chromatography.
13. Separation of Biomolecules by Tissue Homogenization

TEXT BOOK(S)

1. Laboratory manual for Analytical Biochemistry & separation Techniques, P. Palanivelu, MKU University, Madurai.2001.
2. Introductory practical Biochemistry – S.K.Sawhney, Randhir Singh, 2nd^{ed}, 2005.
3. Biochemical methods – S. Sadasivam, New Age International Pub, 2000.
4. Instrumental Methods of Chemical Analysis Bk. Sharma, Goel publications, Meerut, 2000
5. Enzyme Kinetics – A modern Approach. AG Marangani, John Wiley & Sons, 2003.

Course Outcomes:

CO No.	CO-STATEMENTS On the Successful completion of the course the student would be able to	Cognitive Levels (K-Levels)
CO1	Perform, analyze, and report on laboratory experiments related to protein and biomolecule estimation.	K1 & K2
CO2	Demonstrate correct sample preparation and characterization prior to analysis using appropriate techniques.	K1, K2 & K3
CO3	Understand the biochemical principles of digestive secretions and urine formation.	K2, K3 & K4
CO4	Explain the roles and regulation of hormones in physiological processes.	K2 & K3
CO5	Analyze and interpret results from biochemical assays and experiments in a laboratory setting.	K1, K2 & K5

Relationship matrix for Course outcomes, Programme outcomes/ Programme specific outcomes

Mapping with Programme Outcomes:

Semester	Course code	Title of the Course					Hours	Credits			
I	24PBC1C1P	CP-I: LAB IN CHEMISTRY OF BIOMOLECULES, ANALYTICAL TECHNIQUES & HUMAN PHYSIOLOGY					6	3			
Couse outcomes	Programme outcomes(POs)					Programme Specific Outcomes(PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	3	2	3	3	1	2	3	3	3	2	2.5
CO-2	3	3	2	1	3	3	3	3	3	3	2.8
CO-3	2	2	3	3	2	2	3	2	3	2	2.5
CO-4	2	3	2	2	2	3	3	2	3	2	2.5
CO-5	2	2	2	2	3	3	2	2	3	3	2.5
Mean overall score											2.5 (High)

Semester	Course code	Title of the course	Hours	Credits
I	24PBC1E1A	CEC-I: ADVANCED MICROBIOLOGY	5	3

Objectives: To learn the morphology and ultrastructure of microorganisms, microbial growth and metabolism and their role in vector borne and water borne diseases.

Unit -I **(15 Periods)**

Morphology and Ultra structure: Ultra structure of bacteria, fungi, algae and protozoa. Cell walls of eubacteria (peptidoglycan) and related molecules. Outer membrane of Gram-positive and Gram-negative bacteria. Cell wall and cell membrane synthesis, flagella and motility. Purple and green bacteria, cyanobacteria, Acetic acid bacteria, Budding and appendaged bacteria, spirilla, spirochaetes, Endospore forming rods and cocci, Mycobacteria.

Unit- II **(15 Periods)**

Microbial growth and metabolism: Microbial growth– definition. Mathematical expression of bacterial growth, growth curve, measurement of growth and growth yields, synchronous growth, continuous culture, factors affecting growth. Microbial metabolism– overview. Photosynthesis in microbes. Nitrate and sulfate reduction; methanogenesis and acetogenesis. Nitrogen metabolism, nitrogen fixation, hydrocarbon transformation.

Unit -III **(10 Periods)**

Microbiological Techniques: Current methods in microbial identification. Pure culture techniques. Theory and practice of sterilization. Principles of microbial nutrition, preparation of culture media, Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microbes.

Unit- IV **(10 Periods)**

Classification and structure of viruses. Viruses: bacteriophage. Lytic cycle and lysogeny. DNA viruses; positive and negative strand, Double stranded RNA viruses. Replication; Herpes pox, adenoviruses, Retroviruses. Viroids and prions.

Unit – V **(10 Periods)**

Medical Microbiology: Disease reservoirs; Epidemiological terminologies. Infectious disease transmissions. Respiratory infections caused by bacteria and viruses; Tuberculosis, sexually transmitted diseases including AIDS; Vector borne diseases, water borne diseases. Public health and water quality.

Unit VI

Antimicrobial agents, Antibiotics. Penicillin's and cephalosporins, Broad spectrum antibiotics. Antibiotics from Prokaryotes, Antifungal antibiotics– Mode ofaction, Resistance to antibiotics. L antibiotics.

TEXT BOOK(S)

1. Brock Biology of microorganisms- Madigan, 10th ed. Prentice Hall, 2002.
2. Microbiology 4th ed- Davis, Lippincott Williams and Wilkins, 1989.
3. Microbiology – Saras

REFERENCE BOOK(S)

1. Microbiology - Joklik, Zinsser's McGraw-Hill Professional, 1995.
2. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
3. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
4. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.

Course Outcomes:

CO No.	CO Statement On the Successful completion of the course the student would be able to	Cognitive Levels (K-Levels)
CO1	Use culture techniques for isolation of microbes from various sources and preserve the isolates.	Kl & K2
CO2	Obtain knowledge about different energy sources such as inorganic compounds, organic compounds and visible radiation for organisms.	Kl, K2 &K3
CO3	Obtain knowledge for the concepts to diagnose the microbes from food using chemical and Immunological methods.	K2, K3 &K4
CO4	Obtain knowledge for isolation of microbes from textiles and also to identify the organisms responsible for HAI (Hospital acquired infection)	K2& K3
CO5	Know the concepts of laboratory diagnosis of infectious disease, sample collections and examinations of the specimens	KI, K2 & K5

Relationship matrix for Course outcomes, Programme outcomes/ Programme specific outcomes

Mapping with Programme Outcomes:

Semester	Course code	Title of the Course								Hours	Credits
I	24PBC1E1A	CEC-I: ADVANCED MICROBIOLOGY								5	3
Couse outcomes	Programme outcomes(POs)					Programme Specific Outcomes(PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	3	3	3	2	2	3	3	2	3	3	2.7
CO-2	2	3	3	1	4	2	4	3	3	2	2.6
CO-3	2	2	3	3	3	2	3	3	3	2	2.5
CO-4	2	2	2	3	2	3	2	2	3	2	2.4
CO-5	2	3	2	2	3	3	3	2	3	2	2.5
Mean overall score											2.5 (High)

Semester	Course code	Title of the course	Hours	Credits
I	24PBC1E1B	CEC-I: ADVANCED HUMAN GENETICS	5	3

Objectives: It encompasses *genetic* and functional genomics studies on *human*, genetic basis recommended complex diseases and on the functional mechanism.

Unit- I (12 Periods)

Genetic mapping of Mendelian traits: (a) History of human genetics, Pedigree, Pattern of inheritance. (b) Identifying recombinants and non-recombinants in pedigrees (c) Somatic cell fusion, cell hybrids and Radiation hybrids, (d) Genetic and physical map distances, (e) wo point mapping - LOD score analysis (f) Multipoint mapping (g) Homozygosity mapping.

Unit-II (12 Periods)

Genetic mapping of complex traits: (a) Difficulties in mapping complex traits (b)Allele sharing methods- Affected sib pair analysis (c) Allelic association mapping (d) Linkage Disequilibrium mapping e) Transmission disequilibrium test (f) Whole genome scan and mapping (g) Integrationof Cytogenetic, genetic and physical maps.

Unit-III (12 Periods)

Genetic basis of syndromes and disorders: (a) Monogenic diseases (b) Inborn errors of metabolism (c)Neurogenetic disorders (d) Genetic disorders of Haemopoietic systems (e) Genetic disorders ofeye (f) Genetic disorders in skeleton and skin (g) congenital heart diseases. (h) Complex polygenic syndromes (Atherosclerosis, Diabetes mellitus and Rheumatoid Arthritis) (i) Learning disorders.

Unit-IV (12 Periods)

Diagnosis, Genetic counseling and ethics: a) Prenatal diagnosis: (i) Noninvasive methods X-Radiation, Ultrasonography and Fetal echocardiography (ii) Invasive methods- Maternal serum screening, Amniocentesis, Chorionic villus sampling and Fetoscopy

Unit-V (12 Periods)

Genetic counseling: Definition, Models of eugenics and human right, Psycho therapeutic counseling, Decision making, Risk assessment and counseling in Mendelian and multifactorial syndromes. (c) Human genetics and legal, social and ethical considerations.

Unit-VI

Infertility - genetic basis of male infertility, genetic basis of female infertility; recurrent pregnancy loss; Linkage and crossing over – types of crossing over; Genetic and Physical mapping; hereditыand environment (twin studies).

TEXT BOOK(S)

1. Cummings, M. R. 1994. Human Heredity: Principles and Issues. West Publishing Company.
2. Epstein, R. J. 2003. Human Molecular Biology. Cambridge Univ. Press, Cambridge
3. Jobling M. A., Hurles and Tyler-Smith. 2004.
4. Motulsky, V. 1977. Human Genetics. Springer &Verlag, Berlin.Strachan, T. and A. P. Reads, 2004. Human Molecular Genetics Garland Science, London.

REFERENCE BOOK(S)

1. Human Evolutionary Genetics – Origin, People & Disease. Garland & Science
2. Khoury, M. J., J. Little and W. Burke. 2004. Human Genome Epidemiology. Oxford Univ. Press, Oxford

Course Outcomes:

CO No.	CO-STATEMENTS On the Successful completion of the course the student would be able to	Cognitive Levels (K-Levels)
CO-1	Analyze pedigrees to identify patterns of inheritance and the genetic basis of Mendelian traits.	K1 & K2
CO-2	Apply genetic mapping techniques to study complex traits and evaluate the challenges associated with them.	K1, K2 & K3
CO-3	Evaluate the genetic basis of various syndromes and disorders, including monogenic and polygenic diseases.	K2, K3 & K4
CO-4	Assess the ethical implications of genetic testing and counseling in prenatal and postnatal contexts.	K2 & K3
CO-5	Develop skills in genetic counseling, including risk assessment and decision-making for families affected by genetic disorders.	K1, K2 & K5

Relationship matrix for Course outcomes, Programme outcomes/ Programme specific outcomes

Mapping with Programme Outcomes:

Semester	Course code	Title of the Course								Hours	Credits
I	24PBC1E1B	CEC-I: ADVANCED HUMAN GENETICS								5	3
Couse outcomes	Programme outcomes(POs)					Programme Specific Outcomes(PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	3	3	3	2	2	2	3	3	3	2	2.7
CO-2	2	3	3	2	3	3	3	3	2	2	2.8
CO-3	2	3	3	3	2	3	2	3	2	2	2.6
CO-4	2	2	3	3	3	3	2	2	3	2	2.5
CO-5	2	3	3	2	3	3	2	2	3	2	2.6
Mean overall score											2.6 (High)

Semester	Course code	Title of the course	Hours	Credits
I	24PBC1VAC	VAC-I: DETECTION METHODS OF FOOD ADULTERATION	3	2

Objective: To provide fundamental and applicable knowledge about food adulteration, additives, quality control and various acts related to food safety.

UNIT-I **(16 Periods)**

Adulteration-Definition; types-Intentional, incidental, metallic and packaging hazard. Causes and methods of food adulteration. General Impact on Human Health. Detection and Prevention of Food Adulteration. Mitigation measures for addressing food adulteration. Food additives-Definition, classification, role of additives in processed foods. Safe levels of additive uses and the institutions involved in the process.

UNIT-II **(16 Periods)**

Importance and application of food regulation in the Indian and Global context, responsibilities for maintaining and enforcing food safety FSSAI, CODEX ALIMENTARIUS, HACCP, ISO 22000 series, TQM and codes of GMP. Auditing and accreditation (BIS, QCI, AGMARK etc.).

UNIT-III **(7 Periods)**

Common Foods subjected to Adulteration - Adulteration – Definition – Types; Poisonous substances, foreign matter, Cheap substitutes, Spoiled parts. Adulteration through Food Additives – Intentional and incidental. General Impact on Human Health.

UNIT-IV **(7 Periods)**

Means of Adulteration Methods of Detection Adulterants in the following Foods; Milk, Oil, Grain, Sugar, Spices and condiments, Processed food, Fruits and vegetables. Additives and Sweetening agents (at least three methods of detection for each food item).

UNIT-V **(7 Periods)**

Highlights of Food Safety and Standards Act 2006 (FSSA) –Food Safety and Standards Authority of India–Rules and Procedures of Local Authorities. Role of voluntary agencies such as, Agmark, I.S.I. Quality control laboratories of companies, Private testing laboratories, Quality control laboratories of consumer co-operatives. Consumer education, Consumer's problems rights and responsibilities, COPRA 2019 - Offensesand Penalties – Procedures to Complain – Compensation to Victims.

UNIT VI

Quality control in food industry – methods of evaluation and control of the various aspects; quality of raw materials, manufacturing process and the testing of finished products.

TEXT BOOK(S)

1. A first course in Food Analysis–A.Y. Sathe, New Age International (P) Ltd.,1999
2. Food Safety, case studies–Ramesh. V. Bhat, NIN,1992
3. Food Science & Quality Control by SMT. B. Poornima - Centrum Press First edition2014.
4. Post-Harvest Management of Horticultural crops - S. Saraswathy, T.L. Preethi AGROBIOS (India) 2013.
5. A Handbook of Agn. Food processing and marketing by S.C. Gaur, Argo Bios (India)2012.
6. Food science and food bio technology- Sheetal Singh

REFERENCE BOOK(S)

1. Rapid detection of food adulterants and contaminants Theory and Practice, S. N. Jh,2016, Kindle Edition.
2. Domestic Tests for Food Adulterations, H. G. Christian, Forgotten books
3. A Laboratory Manual of Food Analysis, S. Sehgal, Wiley Publishers.
4. Food Safety and Standards Act, 2006. Bare ACT, November 2020, Commercial law publishers

Course Outcomes:

CO No.	CO-STATEMENTS On the Successful completion of the course the student would be able to	Cognitive Levels (K-Levels)
CO1	Describe about basics of food adulteration, food additives and theireffects in human health	Kl & K2
CO2	Helps to know the Importance and application of food regulation inthe Indian and Global context	Kl, K2 &K3
CO3	Help to know about commonly adulterated foods	K2, K3 &K4
CO4	Describe about various food safety and standard acts	K2& K3
CO5	Give the importance of quality control of foods	KI, K2 & K5

Relationship matrix for Course outcomes, Programme outcomes/ Programme specific outcomes

Mapping with Programme Outcomes:

Semester	Course code	Title of the Course					Hours	Credits			
I	24PBC1VAC	VAC-I: DETECTION METHODS OF FOOD ADULTERATION					3	2			
Couse outcomes	Programme outcomes(POs)					Programme Specific Outcomes(PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	3	3	3	2	2	2	3	3	3	2	2.7
CO-2	2	3	3	2	3	3	3	3	3	2	2.8
CO-3	2	2	3	3	2	3	2	3	3	2	2.5
CO-4	2	2	2	3	2	3	2	3	3	2	2.4
CO-5	2	2	2	1	3	3	2	2	3	2	2.3
Mean overall score											2.5 (High)

Semester	Course code	Title of the course	Hours	Credits
II	24PBC2C4	CC-IV: ENZYMOLOGY	5	5

Objectives: To provide deeper knowledge on the fundamentals of enzyme structure, kinetics, function and kinetics to soluble and immobilized enzymes.

Unit-I (18 Periods)

Historical aspects of enzymology. Factors affecting rate of reactions - activation energy & transition state theory and catalysis. IUB Classification and Nomenclature, Intracellular localization of enzymes. Enzyme Units, Enzyme Turn over Number and its Significance. Active site - Investigation of 3D structure of active site, Isolation, Extraction, Purification and characterization of enzymes: Source and extraction procedures and criteria of purity. Isoenzymes

Unit-II (18 Periods)

Enzyme Kinetics - Steady state theory, Michaelis Menten and Briggs and Haldane theory Equation, LB Plot, Eadie Hofstee Plot, Briggs -Hanes Plot, King-Altman procedure for deriving the rate equation. Arrhenius plot, determination of activation energy. Factors affecting Enzyme activity. Enzyme catalysis and Mechanism of Enzyme catalysis – Serine proteases (Chymotrypsin) and Lysozyme. Mechanism of Bi Substrate reaction. Metalloenzymes and Metal - activated Enzymes. Coenzymes – Structure and functions of TPP, NAD, NADP, FAD, FMN, Coenzyme A.

Unit-III (18 Periods)

Enzyme Regulation: Mechanism, forward stimulation, Feedback inhibition- Allosteric Enzymes, Sigmoidal Kinetics and their Significance, Hill's Equation, Scatchard Plot and their application. Reversible and irreversible inhibition- types, Kinetics, Determination of Inhibitor constant LB Plot.

Unit-IV (14 Periods)

Multi Enzyme complex -Structure and Mechanism of action and Regulation of Pyruvate Dehydrogenase complex. Enzyme Immobilization- Source and techniques of immobilization. Effect of immobilization on enzyme activity. Application of immobilized enzymes. Enzymes as Biosensors - Calorimetric, Amperometry, Optical and Immuno biosensors.

Unit-V (22 Periods)

Industrial application of enzymes, proteolytic enzyme, lignocellulose degrading enzyme, pectin and pectic enzyme. Applications of enzymes in food and allied industries: leather, textile, detergent, paper industries. Therapeutic application of enzymes. Biotechnological applications of Enzymes. Enzyme Engineering: Artificial enzymes. Future prospects of Enzyme engineering.

Unit- VI

Coenzymes-prosthetic group, classification - vitamin and nonvitamin coenzymes, thiamine pyrophosphate - mechanism of oxidative and nonoxidative decarboxylation, transketolase reaction, flavoprotein enzymes, mechanism of oxidation and reduction of: flavin enzymes.

TEXT BOOK(S)

1. Enzymes. Dixon, E.C Webb, CJR Thorne and K.F. Tipton, Longmans, London.
2. Fundamentals of Enzymology, Nicholas C. Price, Lewis Stevans. 2 ed., (1998), Oxford University Press.
3. Protein Biochemistry and Biotechnology, Gary Walsh ,2002. John Wiley and Sons.

REFERENCE BOOK(S)

1. Understanding Enzymes, Trevor Palmer, 1991. Third Edition Ellis Horwood Limited.
2. Protein Biotechnology. Gary Walsh and Denis Headon, 1994.John Wiley and Sons.

Course Outcomes:

CO No.	CO-STATEMENTS On the Successful completion of the course the student would be able to	Cognitive Levels (K-Levels)
CO1	Course material will help in understanding of nomenclature and classification of enzymes and also the fundamentals of enzyme assay.	Kl & K2
CO2	Students will thoroughly understand the Kinetics of enzyme essay and derivation of velocity equations.	Kl, K2 &K3
CO3	Course will advance the knowledge of students on mechanism of enzyme action.	K2, K3 &K4
CO4	Understanding of detailed mechanism in enzyme regulation with relevant examples	K2& K3
CO5	Students will gain knowledge in various immobilization techniques and industrial application of enzymes	KI, K2 & K5

Relationship matrix for Course outcomes, Programme outcomes/ Programme specific outcomes

Mapping with Programme Outcomes:

Semester	Course code	Title of the Course								Hours	Credits
II	24PBC2C4	CC-IV: ENZYMOLOGY								5	5
Couse outcomes	Programme outcomes(POs)					Programme Specific Outcomes(PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	3	3	3	2	1	2	3	2	3	2	2.6
CO-2	2	3	3	2	3	3	3	3	3	2	2.9
CO-3	2	3	3	3	2	3	2	3	3	2	2.7
CO-4	2	3	2	3	2	3	2	3	3	2	2.6
CO-5	2	2	2	1	3	3	2	2	3	2	2.4
Mean overall score											2.5 (High)

Semester	Course code	Title of the course	Hours	Credits
II	24PBC2C5	CC-V: METABOLISM AND REGULATION	5	5

Objectives: To learn the principles of energy production in the cells and to understand the metabolic reactions of biomolecules as well as integral relationship of various metabolic pathways.

Unit -I **(18 Periods)**

Introduction to metabolism; Anabolism, Catabolism, Types of metabolic reactions. Carbohydrate metabolism: Glycolysis and gluconeogenesis– pathway, key enzymes and co-ordinate regulation. Pyruvate dehydrogenase complex and the regulation of this enzyme through reversible covalent modification. The citric acid cycle and regulation. The pentose phosphate pathway. Metabolism of glycogen and regulation.

Unit-II **(18 Periods)**

Amino acid metabolism and regulation

Metabolism of amino acids, purines and pyrimidines: Overview of biosynthesis of nonessential amino acids. Catabolism of amino acid–transamination, deamination, ammonia formation, the urea cycle and regulation of ureagenesis. Importance of glutamate dehydrogenase. Overview of Catabolism of carbon skeletons of amino acids

Unit-III **(18 Periods)**

Lipid metabolism: Lipogenesis-Control of acetyl CoA carboxylase-Role of hormones-Effect of diet on fatty acid biosynthesis. Regulation of biosynthesis of triacylglycerol, phospholipids and cholesterol. Metabolism of triacylglycerol during stress. α, β,γ, Oxidation of fatty acids– Role of carnitine cycle in the regulation of β-oxidation. Ketogenesis and its control. Lipoprotein metabolism exogenous and endogenous pathways.

Unit-IV **(18 Periods)**

Metabolism of purines- denovo and salvage pathways for purine biosynthesis-Purine catabolic pathway. Metabolism of pyrimidines -biosynthesis and catabolism. Regulation of biosynthesis of nucleotides. Metabolic integration and hormonal regulation: Key junctions in metabolism– glucose-6- phosphate, pyruvate and acetyl CoA. Metabolic profiles of brain,

muscle, liver, kidney and adipose tissue. Metabolic interrelationships in various nutritional and hormonal states– obesity, aerobic, anaerobic endurance, exercise, pregnancy, lactation, IDDM, NIDDM and starvation**,** HbA1C and thyroid.

Unit-V **(18 Periods)**

Bioenergetics& Thermodynamics: Free energy enthalpy and entropy. Phosphoryl group transfers and ATP. Enzymes involved in redox reactions. The electron transport chain– organization and role in electron capture. Oxidative phosphorylation- F1/F0 ATPase- structure and mechanism of action. The chemiosmotic theory. Inhibitors of respiratory chain and Oxidative phosphorylation uncouplers, ionophores. Mitochondrial transport systems- ATP/ADP exchange, malate/glycerophosphate shuttle.

Unit-VI

Metabolism of Porphyrin - Biosynthesis and degradation of Porphyrin, Heme formation, Biosynthesis of Bilirubin, transport and excretion of bile pigment. Integration of Metabolism - Interrelationship of Carbohydrates, Protein and Fat metabolism.

TEXT BOOK(S)

1. Harper’s Biochemistry- Murray, 29th ed. Mc. Graw Hill, 2011.
2. Principles of Biochemistry. 7th ed, Nelson Cox. Lehninger’s McMillan Worth, 2013.
3. Biochemistry 4th ed- Campbell and Farrell, Brooks/Cole Pub Co. 2002. Metabolic Regulation-Keith N. Frayne, 2009.

REFERENCE BOOK(S)

1. Biochemistry- Stryer, Freeman. 5th ed, 2002.
2. Biochemistry- Donald Voet, J.G. Voet, John Wiley, J O H N WI VP &Publisher Kaye Pace
3. Biochemistry- 2nd ed- Kuchel and Ralston. Schaum’s Outlines McGraw Hill,1998.

Course Outcomes:

CO No.	CO Statement On the Successful completion of the course the student would be able to	Cognitive Levels (K-Levels)
CO-1	Explain the fundamental principles of metabolism, distinguishing between anabolism and catabolism, and describing key metabolic pathways including glycolysis, citric acid cycle, and gluconeogenesis.	K1 & K2
CO-2	Analyze the metabolic pathways of carbohydrates, amino acids, and lipids, detailing the enzymes involved and their regulatory mechanisms.	K2 & K3
CO-3	Describe the biosynthesis and catabolism of purines and pyrimidines, including their regulation and metabolic integration with other biomolecules.	K2 & K3
CO-4	Evaluate the bioenergetics of metabolism, including thermodynamics, ATP generation, and the electron transport chain, alongside the role of enzymes in redox reactions.	K2 & K4
CO-5	Integrate knowledge of carbohydrate, protein, and fat metabolism, illustrating their interrelationships and the impact of nutritional and hormonal states on metabolic processes.	K3 & K5

Relationship matrix for Course outcomes, Programme outcomes/ Programme specific outcomes

Mapping with Programme Outcomes:

Semester	Course code	Title of the Course					Hours	Credits			
II	24PBC2C5	CC-V: METABOLISM AND REGULATION					5	5			
Couse outcomes	Programme outcomes(POs)					Programme Specific Outcomes(PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	3	2	3	2	1	2	3	2	3	2	2.3
CO-2	2	3	2	1	3	2	3	2	3	2	2.2
CO-3	1	2	2	3	2	2	3	2	3	2	2.2
CO-4	1	2	2	2	2	3	2	2	3	2	2.3
CO-5	2	2	2	1	3	3	2	2	3	2	2.2
Mean overall score											2.2 (High)

Semester	Course code	Title of the course	Hours	Credits
II	24PBC2C6	CC-VI: MOLECULAR BIOLOGY	4	4

Objectives: To gain knowledge and understanding on cell structure and functions and to gain an insight into replication, transcription and translation.

Unit-I **(15 Periods)**

Central dogma of life, Genomics &'Post-Genomics.' DNA as the genetic material, supercoiling, hybridization. Hierarchy of Chromatin Organization, Central Dogma, Unique sequence DNA, Repetitive DNA – SINEs, LINEs, Satellite, Minisatellite and Microsatellite DNAs, C-Value Paradox. Structure of Protein-coding genes in prokaryotes and eukaryotes. structures of DNA/RNA components, the different forms of nucleic acids (A, B, Z). Structure and function of prokaryotic and eukaryotic cell. Cytoskeleton - Microtubule and Microfilaments. Cell - Cell adhesion molecules - Cadherins, Integrins, Selectins, Collagen and Lignins. Classes of Cell Junctions: Gap, anchoring and tight junctions, desmosomes.

Unit-II **(15 Periods)**

Replication: DNA replication in prokaryotes and eukaryotes. Eukaryotic DNA polymerases and their roles, origin of replication. Recombination: DNA recombination: Homologous, site specific and transposition, Holliday Model, Meselson - Radding Model. Site specific recombination: Lambda phage integration, and excision rearrangement. Transposition: Prokaryotic transposition, conservative and replicative transposition. Eukaryotic transposable elements.

Unit- III **(15 Periods)**

Transcription: Review of prokaryotic transcription, transcription in eukaryotes: Eukaryotic RNA polymerases and their subunit structure, Class I, II and III promoters, upstream elements, enhancers and silencers, General transcription factors, Class I, II, III genes and their functions, elongation factors, TBP structure and its role in transcription, mediators. Structure of transcription activators, zinc fingers, homeo domains, helix loop helix, bZIP, Beta barrels, Post transcriptional modification.

Unit – IV **(15 Periods)**

Translation: Ribosome, formation of initiation complex, aminoacylation of tRNA, tRNA-identity, initiation factors and their regulation, elongation and elongation factors, termination. Enzymes

involved in translation and post translational modification. Regulatory sequences in protein-coding genes. Wobble hypothesis. chaperones and protein targeting- translocation, heat shock proteins, glycosylation; SNAPs and SNAREs. Translational proof-reading, translational inhibitors. Export and import of proteins from cytoplasm. Genetic code-features of genetic code, Properties of Genetic code.

Unit – V **(15 Periods)**

Chromosomal changes and consequences: Changes in the chromosome number and chromosome structure and its related genetic disorders. Mutation: definition, chemical basis and types. Types of mutagens. Mutant types - lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis. DNA repair mechanism: thymine dimer, light activation, excision, recombinational, SOS and mismatch repair.

Unit – VI

DNA polymorphisms: the basis of DNA typing, Minisatellite analysis, Polymerase chain reaction-based analysis, Short tandem repeat analysis, Mitochondrial DNA analysis, Y chromosome analysis, Randomly Amplified Polymorphic DNA (RAPD) analysis.

TEXT BOOK(S)

1. The Cell- A Molecular Approach Geoffrey Cooper, Robert E Harsman, 3rd ed ASM Press 2004.
2. Molecular Cell Biology, Lodish et.al. 5th ed., WH Freeman & Company 2003.
3. Cell and Molecular Biology De Robertis and De Robertis. 8th ed WoltersKluwer India Pvt Ltd 2001.

REFERENCE BOOK(S)

1. Molecular Biology of the Cell Alberts et al 4th ed. Garland Science Inc. 2002.
2. David Frei Felder, 2008. Molecular Biology. (Ed: 2). Narosa Publications, New Delhi.
3. Cell and Molecular Biology, Gerald Karp, 4th ed John Wiley & Sons, Inc, New York2004.

Course Outcomes:

CO No.	CO Statement On the Successful completion of the course the student would be able to	Cognitive Levels (K-Levels)
	On the Successful completion of the course the student would be able to	
O-1	Students will explain the structure and functions of cells, including the components of prokaryotic and eukaryotic cells, and their roles in biological processes.	K1 & K2
CO-2	Students will analyze the events and regulatory mechanisms of the cell cycle, detailing key checkpoints and molecular interactions involved in cell division.	K1, K2 & K3
CO-3	Students will describe the DNA replication process, differentiating between mechanisms in prokaryotes and eukaryotes, including the roles of various enzymes.	K2, K3 & K4
CO-4	Students will illustrate the mechanism of transcription, including the roles of RNA polymerases, transcription factors, and the regulation of gene expression.	K2 & K3
CO-5	Students will evaluate the translation process, including the role of ribosomes, tRNA, and the mechanisms of post-translational modifications and protein targeting.	K1, K2 & K5

Relationship matrix for Course outcomes, Programme outcomes/ Programme specific outcomes

Mapping with Programme Outcomes:

Semester	Course code	Title of the Course								Hours	Credits
II	24PBC2C6	CC-VI: MOLECULAR BIOLOGY								4	4
Couse outcomes	Programme outcomes(POs)					Programme Specific Outcomes(PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	3	2	3	3	2	2	3	3	2	2	2.6
CO-2	2	3	3	2	3	2	3	2	3	2	2.5
CO-3	2	2	3	3	2	3	2	3	2	2	2.5
CO-4	1	2	3	2	2	3	3	2	3	3	2.6
CO-5	2	3	2	1	3	3	2	2	2	2	2.4
Mean overall score											2.5(High)

Semester	Course code	Title of the course	Hours	Credits
II	24PBC2C7	CC-VII: ADVANCED DIETETICS	4	4

Objectives: To provide in depth knowledge on diet therapy for various human illness.

Unit-I **(9 Periods)**

Concept of Diet therapy: growth and source of dietetics, purpose and principles of therapeutic Diets, modification of normal diet, classification of therapeutic diets. Role of Dietician: definition of nutritional care, interpersonal relationship with patient, planning and implementer dietary care, Team approach to nutritional care.

Unit-II **(9 Periods)**

Routine hospital diets: Preoperative and postoperative diets, study and review of hospital diet. Basic concepts and methods of - (a) Oral feeding (b) Tube feeding (c) Parental nutrition, Intravenous feeding. Diet in surgical conditions, burns and cancer. Obesity and leanness-causes, complication and health effects, dietary treatment and other recommendation.

Unit-III **(9 Periods)**

Diet for fever and infections- Types- metabolism in fever, general dietary consideration diet in influenza, typhoid fever, recurrent malaria and Tuberculosis. Diet in gastritis, peptic ulcer-symptoms, clinical findings, treatment, dietary modification, adequate nutrition, amount of food, and intervals of feeding, four stage diet (Liquid, soft, convalescent, liberalized diet).

Unit-IV **(9 Periods)**

Diet for disturbances of small intestine and colon. Diarrhea- (child and adult)- classification, Modification of diet, fiber, residue. Fluids& nutritional adequacy, Constipation- flatulence - dietary considerations, Ulcerative colitis (adults)- symptoms, dietary treatment. Spruce, coeliac disease- disaccharide intolerance, dietary treatment. Diet in allergy and skin disturbances: Definition, classification, manifestations, common food allergies and test and dietetic treatment.

Unit-V **(9 Periods)**

Diet for Diabetes mellitus: Diabetes mellitus and types- Metabolism in diabetes, Dietary treatment & meal management Hypo glycemic agent, insulin and its types. Diet in Renal diseases: Basic renal function, symptoms and dietary treatment in acute and chronic

glomerulonephritis. Urinary calculi-causes & treatment, acid and alkali producing and neutral foods and dietary treatment. Diet for Cardiovascular diseases: Role of nutrition in cardiac efficiency, Hypertension- causes and dietary treatment.

Unit-VI

Nutritional and dietary aspects in Special Conditions, Space Travel, High Altitudes, Low Temperature and Submarines. Nutrition Programmes in developing and developed countries – Role of various agencies – National, International and voluntary.

TEXT BOOK(S)

1. "Dietetics" by Srilakshmi. edn 2014
2. "Nutrition and Dietetics" by Shubhangini A Joshi. Jul 2017
3. "Clinical Dietetics and Nutrition" by Antia F Pul 2002

REFERENCE BOOK(S)

1 "Principles of Therapeutic Nutrition and Dietetics" by Sharma A2005

2 "Dietetics in Practice: A Handbook" by Malhotra S 2012

Course Outcomes:

CO No.	CO-STATEMENTS On the Successful completion of the course the student would be able to	Cognitive Levels (K-Levels)
CO1	Acquire skill on various methods of assessing nutritional status.	Kl & K2
CO2	Relate metabolism of macronutrients with health.	Kl, K2 &K3
CO3	Comprehend the functions of micronutrients with health	K2, K3 &K4
CO4	Associate knowledge of nutrients with their deficiencies.	K2& K3
CO5	Apply the knowledge in determining the nutritional requirements.	KI, K2 & K5

Relationship matrix for Course outcomes, Programme outcomes/ Programme specific outcomes

Mapping with Programme Outcomes:

Semester	Course code	Title of the Course							Hours	Credits
II	24PBC2C7	CC-VII: ADVANCED DIETETICS							4	4
Couse outcomes	Programme outcomes(POs)					Programme Specific Outcomes(PSOs)				Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	3	3	3	2	2	2	3	3	2	2	2.6
CO-2	2	3	3	2	3	2	3	3	2	3	2.5
CO-3	2	2	3	3	2	2	3	2	3	2	2.5
CO-4	1	2	2	2	2	3	2	2	3	2	2.4
CO-5	2	3	2	1	3	3	2	2	2	2	2.3
Mean overall score											2.5(High)

Semester	Course code	Title of the course	Hours	Credits
II	24PBC2C2P	CP-II: LAB IN ENZYMOLOGY, METABOLISM & REGULATION, MOLECULAR BIOLOGY	6	3

Objectives: To gain knowledge on practical in molecular techniques and enzyme analysis.

Techniques and Enzyme **(90 Periods)**

1. Isolation of plasmid DNA by Alkaline lysis method.
2. Estimation of DNA by diphenylamine method.
3. Estimation of RNA by orcinol method.
4. Separation of DNA by Agarose Gel Electrophoresis.
5. Separation of protein by SDS-PAGE.
6. Purification of enzyme by ammonium sulphate precipitation Microbial Techniques.
7. Enzyme Assay - Determination of specific activity, effect of pH, temperature and substrate concentration of a. Salivary Amylase b. Urease
8. Effect of inhibitor on activity of any one enzyme.
9. Effect of activator on activity of any one enzyme.
10. Electrophoretic separation of isoenzyme.
11. Determination of Aspartate transaminase activity.
12. Determination of Alanine transaminase activity.

TEXT BOOK(S)

1. Laboratory manual for Analytical Biochemistry & separation Techniques, P. Palanivelu, MKU University, Madurai.2001.
2. Introductory practical Biochemistry – S.K. Sawhney, Randhir Singh, 2nd^{ed}, 2005.
3. Biochemical methods – S. Sadasivam, New Age International Pub, 2000.
4. Instrumental Methods of Chemical Analysis Bk. Sharma, Goel publications, Meerut, 2000
5. Laboratory manual in Biochemistry T.N. Pattabiraman. All India publishers, 1998

REFERENCE BOOK(S)

1. Manuals in Biochemistry – Dr. J. Jayaraman, New Age International Pub, 2000.
2. Laboratory Manual in Bio Chemistry, Jayaraman, New Age International Pub,2000.

Course Outcomes:

CO.No	CO Statement On the Successful completion of the course the student would be able to	Cognitive Levels (K-Levels)
CO1	Perform the isolation of plasmid DNA using the alkaline lysis method and explain its significance in molecular biology.	K1 & K2
CO2	Estimate DNA and RNA concentrations using the diphenylamine and orcinol methods, interpreting the results accurately.	K1, K2 & K3
CO3	Conduct agarose gel electrophoresis to separate nucleic acids and analyze the results to determine fragment sizes.	K2 & K4
CO4	Execute enzyme assays to evaluate the effects of pH, temperature, and inhibitors on enzyme activity, understanding the principles of enzyme kinetics.	K2, K3 & K4
CO5	Demonstrate knowledge of enzyme immobilization techniques and their applications in industry, with hands-on experience in enzyme purification.	K1, K2 & K5

Relationship matrix for Course outcomes, Programme outcomes/ Programme specific outcomes

Mapping with Programme Outcomes:

Semester	Course code	Title of the Course					Hours	Credits			
II	24PBC2C2P	CP-II: LAB IN ENZYMOLOGY, METABOLISM & REGULATION, MOLECULAR BIOLOGY					6	3			
Couse outcomes	Programme outcomes(POs)					Programme Specific Outcomes(PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	2	3	2	1	2	3	2	3	2	3	2.4
CO-2	3	2	3	2	1	2	3	2	3	3	2.5
CO-3	2	1	3	2	2	2	3	3	2	3	2.4
CO-4	3	3	1	2	2	3	2	2	2	2	2.6
CO-5	1	2	2	3	2	2	3	2	3	2	2.2
Mean overall score											2.4(High)

Semester	Course code	Title of the course	Hours	Credits
II	**24PBC2I**	**IBC: BIOMEDICAL INSTRUMENTATION**	**3**	**3**

Objectives: To understand and acquire knowledge on various biomedical instruments, physiotherapy and electrotherapy instruments.

Unit-I **(12 Periods)**

Bioelectric electrodes: ECG, EEG, EMG, microelectrodes. Biomedical recorders: ECG, EEG, EMG, ECHO cardiac pacemaker, defibrillators. Blood flow meters: Electromagnetic, ultrasonic, C T NM R, laser doppler.

Unit- II **(12 Periods)**

Pulmonary function analyzers: Spirometry, respiratory gas analyzers, blood pH, blood pCO2, Blood pO2 analyzer. Microscopy in biology and medicine: Visualization of cells and sub cellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze- etch and freeze fracture methods for EM, image processing methods in microscopy phase-Contrast microscopy; fluorescence, ultraviolet microscope

Unit-III **(12 Periods)**

Ultrasonic imaging system PET, MRI, fMRI, CAT Biomedical telemetry: Wireless telemetry, single and multi-channel telemetry, transmission of physiological signal over telephone lines. Detection of radiation: Detection and measurement of different types of radioisotopes normally used in biology; ionization chamber, G.M. counter, proportional counter, liquid scintillation counter, molecular imaging of radioactive material, safety guideline.

Unit-IV **(12 Periods)**

Audiometers: Basic audiometer, Speech audiometers. Hemodialysis Machine: Dialyzers, artificial kidney Physiological transducers: Body temperature, Pulse sensors, Respiration sensors.

Unit- V **(12 Periods)**

Basic idea about physiotherapy and electrotherapy instruments: Brief description of generation, circuit diagrams and testing. Demonstration of electrotherapy instruments, principles of their functioning, usage, and safety implications for human beings.

Unit- VI **(12 Periods)**

Imaging modalities and analysis - Radio graphic and fluoroscopic techniques – Computer tomography – MRI – Ultrasonography – Endoscopy – Thermography – Different types of biotelemetry systems - Retinal Imaging - Imaging application in Biometric systems.

TEXT BOOK(S)

1. Handbook of Biomedical Instrumentation" by Khandpur
2. "Biomedical Instrumentation and Measurements" by R Ananda Natarajan
3. "Biomedical Electronics and Instrumentation Made Easy" by G S Sawhney
4. Biomedical Instrumentation Systems" by Shakti Chatterjee.

REFERENCE BOOK(S)

1. "Biomedical Instrumentation and Measurements" by Cromwell
2. "Introduction to Biomedical Instrumentation" by Mandeep Singh

Course Outcomes:

CO No.	**CO-STATEMENTS** On the Successful completion of the course the student would be able to	**Cognitive Levels (K-Levels)**
CO1	Demonstrate an understanding of the principles and applications of various biomedical transducers in physiology.	K1, K2
CO2	Analyze and interpret data from human body parameter measurement setups, including physiological and biochemical parameters.	K1, K2, K3
CO3	Evaluate and apply basic forensic techniques in the context of biomedical instrumentation and analysis.	K2, K3, K4
CO4	Assess the role of multimedia evidence in crime investigations and its relevance to forensic science.	K2, K3
CO5	Investigate the application of electronics in both diagnostic and therapeutic contexts, emphasizing safety and efficacy.	K1, K2, K5

Relationship matrix for Course outcomes, Programme outcomes/ Programme specific outcomes

Mapping with Programme Outcomes:

Semester	Course code	Title of the Course								Hours	Credits
II	24PBC2I	IBC: BIOMEDICAL INSTRUMENTATION								3	3
Couse outcomes	Programme outcomes(POs)					Programme Specific Outcomes(PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	3	2	3	2	1	2	3	2	3	2	2.3
CO-2	2	3	2	1	3	2	3	2	3	2	2.2
CO-3	1	2	2	3	2	2	3	2	3	2	2.2
CO-4	1	2	2	2	2	3	2	2	3	2	2.3
CO-5	2	2	2	1	3	3	2	2	3	2	2.2
Mean overall score											2.2 (High)

Semester	Course code	Title of the course	Hours	Credits
II	24PBC2N1A	NME I: AYURVEDA MEDICINE IN HUMAN HEALTH	3	2

Objective: It aims to restore health by understanding the underlying causes of the diseases. It strives to attack the root causes and detoxifying, cleansing, strengthening body tissues (dhatus)and balancing bodily doshas, ensuring complete cure.

UNIT I **(9 Periods)**

Basic concepts of in Ayurveda (dosh, dhatu, mala, agni and bala). They're its explanation in science and modern medicine, Ritucharya, Dincharya, pathya-apdhya in achar, vihar and food (compatible and Non compatible Diet and Shad-kriya-Kal for health promotion. Basic principlesof Ayurveda and their significance, Philosophical background of fundamentals of Ayurveda.

UNIT II **(9 Periods)**

Ayurveda Nirupana: Lakshana of Ayu, composition of Ayu. Lakshana of Ayurveda. Lakshana and classification of Siddhanta. Derivation, definition and synonyms of Rasayana, importance of Rasayana and its benefits. Indications of Rasayana therapy. Classification of Rasayana. Kutipraveshika and Vatatapika Rasayana.

UNIT III **(9 Periods)**

Ayurveda Darshana Nirupana: Etymological derivation of the word "Darshana". General introduction to classification of schools of Indian Philosophy with an emphasis on: Nyaya, Vaisheshika, Sankhya and Yoga.

UNIT IV **(9 Periods)**

Introduction to Integrative medicine in context of principles of Astang Ayurveda, other AYUSH medicine (CAM), Conventional medicine, Sowa Rigpa, naturopathy, meditation, cognitive behaviour, nutrition, diet and Folklore medicine.

UNIT V **(9 Periods)**

Concept of Vyadhi-Kshmatwa, immunology, and psychosomatic control of physiology, Concept of Pragyaparad (Psychosomatic) and disease etiology, Introduction to Human genome project Prakrati assessment (Vata, pitta and Kapha) in Ayurveda.

UNIT VI

Concept of one health platform for human, animal and environment, Introduction to Human genome project Prakrati assessment (Vata, pitta and Kapha) in Ayurveda. Introduction to and activities of the following Organization Department of AYUSH, Central Council of Indian Medicine, Central Council for Research in Ayurvedic Sciences, Ayurvedic Pharmacopeia commission, National Medicinal Plants Board, Traditional Knowledge Digital Library.

TEXTBOOK(S)

1. Ayurvediya Padartha Vigyana Dr. Ayodhya Prasad Achal
2. Padartha Vigyana Dr. Vidyadhar Shukla
3. Padartha Vigyana Dr. Ravidutta Tripathi
4. AyurvediyaPadartha Darshan Pandit Shivhare

REFERENCE BOOK(S)

1. Scientific Exposition of Ayurveda Dr. Sudhir Kumar
2. History of Indian Medicine (1-3 part) Dr. Girindr Nath Mukhopadhyaya
3. A Short history of Aryan Medical Science Bhagwat Singh.

Course Outcomes:

CO No.	CO Statement On the Successful completion of the course the student would be able to	Cognitive Levels (K-Levels)
CO1	Helps to know the importance of ayurveda medicine	Kl & K2
CO2	Provide information on types of rasayanas	Kl, K2 &K3
CO3	Give the role of ayurveda in psychology	K2, K3 &K4
CO4	Give information about national health programmes on ayurveda	K2& K3
CO5	Importance of yoga in health	KI, K2 & K5

Relationship matrix for Course outcomes, Programme outcomes/ Programme specific outcomes

Mapping with Programme Outcomes:

Semester	Course code	Title of the Course							Hours	Credits
II	24PBC2N1A	NME I: AYURVEDA MEDICINE IN HUMAN HEALTH							3	2
Couse outcomes	Programme outcomes(POs)					Programme Specific Outcomes(PSOs)				Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	2	3	2	3	2	3	2	3	2	3	2.5
CO-2	3	2	3	2	3	3	2	3	2	3	2.6
CO-3	2	2	3	3	2	2	3	2	3	2	2.4
CO-4	2	3	2	2	3	3	2	3	2	3	2.5
CO-5	3	2	3	2	2	3	3	2	3	2	2.5
Mean overall score											2.5 (High)

Semester	Course code	Title of the course	Hours	Credits
II	24PBC2N1B	NME I: FOOD SCIENCE IN HUMAN NUTRITION	3	2

Objective: To promote health and reduce the risk of developing chronic diseases by encouraging people to consume healthful diets and to achieve and maintain healthy body weights.

UNIT I **(9 Periods)**

Properties of foods: Physical properties (solutions, vapor pressure, boiling point, freezing point, osmotic pressure, viscosity, surface and interfacial tensions, specific gravity), Dispersion systems in of foods-Sol, Gel, Foam, Emulsion; Food preparation: Objective and method of cooking, cooking media, changes during cooking, Food pigments and colors, Flavors and its types, Sensation- smell sensation, texture sensation, visual appearance and sensation of taste. Food additives: definition, need and classification of food additives, Preservatives- Natural and Artificial.

UNIT-II **(9 Periods)**

Food as a source of nutrients: classification of nutrients; functions, recommended dietary allowances, BMR, SDA. Vitamins: (A, B complex, C, D, E & K) & all major and minor mineral elements with their role in body, importance of Roughages in the diet. Water & electrolytes balance.

UNIT-III **(9 Periods)**

Nutritional Needs: Nutrition during infancy, childhood, adolescence and adult, nutrition during pregnancy& lactation, nutrition in later maturity period, nutrition and infection, nutrition and immunity, nutrition & stress.

UNIT-IV **(9 Periods)**

Nutritional Assessment: Assessment of nutritional status by direct & indirect methods, use of various methods for the assessment of nutritional status, anthropometric assessment, clinical examination, bio-physical or radiological measurement, functional assessment, laboratory &biochemical assessment, dietary assessment, vital health statistics.

UNIT-V **(9 Periods)**

Nutritional problems: food intake and its regulation, food pattern, population and food production, malnutrition, background problem of malnutrition in India ecology of malnutrition, effect of malnutrition on vulnerable society. National and International agencies in combating malnutrition.

UNIT-VI

Nutraceuticals and phytochemicals: definition, Classification. Dietary supplements, Functional foods- their legislation and health claims, Natural occurrence of certain photo- chemicals. Role of nutraceuticals against- skin health/ageing, bone health, eye health, mental health, cardiovascular health, cancer prevention etc. Safety, adverse effect and interactions of nutraceuticals.

TEXT BOOK(S)

1. Food Facts and Principles -N. Shakuntala Manay & M. Shadaksharaswamy, New Age International (P) Limited, New Delhi.
2. Branen AL, Davidson PM &Salminen S. 2001. Food Additives. 2nd Ed.Marcel Dekker..
3. Gerorge AB. 2004. Fenaroli's Handbook of Flavor Ingredients. 5th Ed.CRC Press.
4. Nakai S &Modler HW. 2000. Food Proteins. Processing Applications.Wiley VCH.

REFERENCE BOOK(S)

1. Essentials of Food and Nutrition – M. Swaminathan, vol. I & II, The Bangalore printing andPublishing Co. Ltd.
2. Human Nutrition and Dietetics – Davidson, Passmore, East wood, English Language Book Society (ELBS)

Course Outcomes:

CO No.	CO-STATEMENTS On the Successful completion of the course the student would be able to	Cognitive Levels (K-Levels)
CO1	To Give information on different types of food and food additives	Kl & K2
CO2	Provide information on nutrients and vitamins	Kl, K2 &K3
CO3	Give the role of nutrients on different stages of life	K2, K3 &K4
CO4	Help to know about different assessment methods of diet	K2& K3
CO5	Help to give deep knowledge regarding deficiencies of nutrients	KI, K2 & K5

Relationship matrix for Course outcomes, Programme outcomes/ Programme specific outcomes

Mapping with Programme Outcomes:

Semester	Course code	Title of the Course							Hours	Credits
II	24PBC2N1B	NME I: FOOD SCIENCE IN HUMAN NUTRITION							3	2
Couse outcomes	Programme outcomes(POs)					Programme Specific Outcomes(PSOs)				Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	2	2	3	2	3	2	2	3	2	2	2.3
CO-2	2	3	2	2	3	2	2	3	2	2	2.3
CO-3	3	2	3	2	2	2	3	2	3	2	2.4
CO-4	2	2	2	3	2	3	2	3	2	2	2.3
CO-5	3	2	3	2	2	2	2	2	3	2	2.3
Mean overall score											2.3(High)

Semester	Course code	Title of the course	Hours	Credits
III	24PBC3C8	CC VIII: ADVANCED IMMUNOLOGY	6	6

Objectives: To gain sound knowledge on cells of immune system, immuno protection and immune techniques.

Unit- I **(18 Periods)**

History of Immunology, Elements of Immunology. Types of immunity- innate and acquired. Humoral and cell mediated immunity. Central and peripheral lymphoid organs- Thymus, bone marrow, spleen, lymph nodes and other peripheral lymphoid tissues- GALT. Cells of the immune system- lymphocytes, mononuclear phagocytes- dendritic cells, granulocytes, NK cells and mast cells, cytokines. Antigens vs immunogens – types – determinants – Haptens – Factors influencing immunogenicity. Immunoglobulin's structure, classification and functions. Isotypes, allotypes and idiotypes.

Unit – II **(18 Periods)**

Complement activation and its biological consequences. Complement fixation test and assessment of immune complexes in tissues. Immune suppression and immune tolerance. Theories of Antibody formation. - Factors influencing antibody production – Genetic basis of antibody diversity. T-cell, B-cell receptors, Antigen recognition- processing and presentation to T-cells. Interaction of T and B cells. Immunological memory. Effector mechanisms-macrophage activation. Cell mediated cytotoxicity, immunotolerance, immunosuppression.

Unit -III **(18 Periods)**

Introduction and classification of MHC. MHC genes and products. Polymorphism of MHC genes, role of MHC antigens in immune response, MHC antigens in transplantation. Transplantation types. Immune responses to infectious diseases- Viral, bacterial and protozoal. Tumor antigens-immune response to tumor antigens- immunotherapy. AIDS and other immunodeficiency disorders. Autoimmunity - Autoimmune diseases – pathogenesis - treatment. Hypersensitivity - types & Mechanism.

Unit- IV **(18 Periods)**

Immunization practices- active and passive immunization. Vaccines- killed, attenuated-toxoids. Recombinant vector vaccines- DNA vaccines, synthetic peptide vaccines- anti idiotype vaccines. Hybridomas - production of polyclonal and monoclonal antibodies.

Principles, techniques and application. Genetically engineered antibodies. Fractionation of leucocytes by density gradient centrifugation. Identification of lymphocytes and their subsets in blood. Leukocyte migration inhibition technique. Delayed type hypersensitivity technique.

Unit- V **(18 Periods)**

Agglutination and precipitation: Techniques - Immuno-electrophoresis, RIA, immunoblotting assay, Avidin- biotin mediated immuno assay. Immunohistochemistry- immunofluorescence, immunoferritin technique. Cytokines assay: ELISA and ELISPOT, Abzymes. Experimental animal models: inbred strains, SCID mice, nude mice, knockout mice cell culture system: Primary lymphoid culture cloned lymphoid cell lines.

Unit- VI

Vaccine production- types of vaccines, principles of vaccine production, production of conventional and modern vaccines, new vaccine strategies and vaccines under development. Vaccination strategies, immunization schedules.

TEXT BOOK(S)

1. Immunology- Eli Benjamini AU, A short course. 4th ed. Wiley-Liss, 2000.
2. NMS Series in Immunology- 3rd ed, Lippincott Williams & Wilkins.
3. Fundamentals of immunology- Bier, Springer Verlag, 1986.
4. Cellular and Molecular Immunology: 7th Edition, Abul K, 2011.
5. Immunology. W. H. Freeman & Co. Fourth edition, 2005

REFERENCE BOOK(S)

1. Essential Immunology, 10th ed - Roitt's, Blackwell Sci, 2001.
2. Immunology, 4th ed- Kuby, Richard A, Goldsby et al. WH Freeman & Co. 2003.
3. Cellular and Molecular Immunology- Abbas, W.B. Saunders Company, 2000.
4. Immunobiology- 5th ed Janeway, C. (Ed), Paul Travers. Garland Publ. 2001.

Course Outcomes:

CO No.	CO Statement On the Successful completion of the course the student would be able to	Cognitive Levels (K-Levels)
CO1	To obtain the knowledge about the immune system, as a host defense system comprising many biological structures and processes within an organism that protects against disease	Kl & K2
CO2	To concentrate on the antigen and antibody reactions and immunological techniques.	Kl, K2 &K3
CO3	Understanding about the two branches of immune system such as humoral immunity and cellular immunity, cytokines and complement system.	K2, K3 &K4

CO4	Clear about the hypersensitivity reaction or intolerance with undesirable reactions produced by the normal immune system, including allergies and autoimmunity.	K2& K3
CO5	To obtain the knowledge about the hybridoma technology is to produce large numbers of identical antibodies (monoclonal antibodies) and a recombinant DNA technology that involves inserting the DNA encoding an antigen that stimulates an immune response	KI, K2 & K5

Relationship matrix for Course outcomes, Programme outcomes/ Programme specific outcomes

Mapping with Programme Outcomes:

Semester	**Course code**		**Title of the Course**							**Hours**	**Credits**
III	**24PBC3C8**		**CC VIII: ADVANCED IMMUNOLOGY**							**6**	**6**
Couse outcomes	**Programme outcomes(POs)**					**Programme Specific Outcomes(PSOs)**					**Mean scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO-1	3	2	3	2	3	2	2	3	2	3	2.5
CO-2	3	3	2	2	3	2	3	3	2	2	2.6
CO-3	3	2	3	3	2	2	3	2	3	2	2.5
CO-4	2	3	2	3	2	3	2	2	3	2	2.4
CO-5	3	2	3	2	2	2	3	2	3	2	2.5
Mean overall score											**2.5(High)**

Semester	Course code	Title of the course	Hours	Credits
III	24PBC3C9	CC IX: CLINICAL BIOCHEMISTRY	5	5

Objectives: To provide comprehensive knowledge on biochemical and molecular basis of diseases, diagnosis and therapy.

Unit- I **(18 Periods)**

Approaches to clinical biochemistry: Concepts of accuracy, precision, sensitivity and reproducibility. Automation in clinical biochemistry laboratory and factors in quality control. Specimen collection and processing: Blood collection methods, anticoagulants. Collection of urine - urine preservatives, Timed urine specimens. Tests and Clinical significance of urinary compounds with reference to sugars, proteins, ketone bodies, bilirubin and porphyrins. Stool – chemical examination and clinical significance. CSF – collection and composition, chemical examination and clinical significance. Amniotic fluid: Origin, collection, composition and analysis of amniotic fluid. Phlebotomy, Disposal of Biomedical Waste.

Unit -II **(18 Periods)**

Disorders of carbohydrate metabolism– glycogen storage diseases, galactosemia, fructose intolerance and fructosuria. Blood sugar homeostasis: Role of tissues and hormones in the maintenance of blood sugar. Hypoglycemia, hyperglycemia, glycosuria. Diabetes mellitus – classification, metabolic abnormalities, diagnosis and management.

Disorders of lipid metabolism– lipoproteinemia. Lipid storage diseases – Gaucher's, Tay Sach's Niemann Pick disease. Fatty liver. Atherosclerosis. Obesity -types, metabolic changes.

Unit- III **(18 Periods)**

Disorders of amino acid metabolism– Amino aciduria, Phenylketonuria, Hartnup disease, alkaptonuria, albinism, cystinuria, cystinosis, homocystinuria and maple syrup urine disease. Disorders of purine, pyrimidine metabolism: Hyperuricemia and gout. Hypouricemia. Orotic aciduria. Serology: C reactive protein test, Rheumatoid arthritis (RA) test.

Unit- IV **(20 Periods)**

Liver function test: clinical significance of AST, ALT, ALP, GGT, Alkaline phosphatases, amylase, LDH and CK. Jaundice – types and differential diagnosis. Hepatitis and cirrhosis. Gall stones.

Gastric function tests- Stimulation tests – insulin and pentagastrin. Peptic ulcer, gastritis and Zollinger Ellison syndrome

Renal function test - Biochemical findings in glomerulonephritis, renal failure and nephritic syndrome. Nephrolithiasis. Glomerular function tests – inulin, urea and creatinine clearance tests. Abnormal constituents of urine.

Unit- V **(16 Periods)**

Oncology: Cancer cell – morphology and growth characteristics. Biochemical changes in tumor cells. Differences between benign and malignant tumors. Tumor markers – AFP, CEA and HcG Agents causing cancer – radiation, viruses, chemicals. Multistep carcinogenesis – initiation, promotion, progression. oncogenes and proto- oncogenes – mechanisms of protooncogene activation. Tumor suppressor genes – p53.

Unit- VI

Disorders of Nucleotide and Heme Metabolism: Xanthinuria, erotic aciduria. Lesch- Nyhan syndrome.: Heme metabolism associated diseases- porphyria's, porphyrinurias, sickle cell anemia, thalassemia. Hemorrhagic disorders, disseminated intravascular coagulation, acquired prothrombin complex disorders.

TEXT BOOK(S)

1. Clinical Chemistry in diagnosis and treatment, Philip. D. Mayne & EdwardArnold,6th ed ELBS.1994.
2. Textbook of Clinical Chemistry, 3rd ed- Tietz, WB Saunders, Burtis & Ashwood,1999.
3. Principles of Internal Medicine. Harrison's Vol 1 & 2, 16th edition McGrawHill.2005.
4. Biochemistry and disease. Cohn and Roth, Williams and Wilkins, 1996.
5. Textbook of Biochemistry with Clinical Correlations, 7th Edition ISBN: 978-0-470-60976- 7 June 2010 Reference Books.

REFERENCE BOOK(S)

1. Clinical Biochemistry – Metabolic & Clinical Aspects, William Marshall, StephenK. Bansert, Churchill Livingstone, 1995.
2. Clinical Chemistry – Principles, procedures, correlations – Bishop, Lippincott.2000.
3. Textbook of Biochemistry with Clinical Correlation Thomas M Devlin 2nd edWiley

Course Outcomes:

CO No.	CO-STATEMENTS On the Successful completion of the course the student would be able to	Cognitive Levels (K-Levels)
CO1	Explain and apply key concepts of accuracy, precision, sensitivity, and reproducibility in clinical biochemistry.	Kl & K2
CO2	Demonstrate skills in the collection and analysis of biological specimens, recognizing the clinical significance of biochemical tests.	Kl, K2 &K3

CO3	Identify and differentiate metabolic disorders related to carbohydrates, lipids, amino acids, and nucleotides.	K2, K3 &K4
CO4	Interpret liver, gastric, and renal function tests, understanding their biochemical alterations and clinical implications.	K2& K3
CO5	Understand the biochemical principles of cancer, including tumor characteristics and mechanisms of carcinogenesis.	KI, K2 & K5

Relationship matrix for Course outcomes, Programme outcomes/ Programme specific outcomes

Mapping with Programme Outcomes:

Semester	**Course code**		**Title of the Course**							**Hours**	**Credits**
III	**24PBC3C9**		**CC IX: CLINICAL BIOCHEMISTRY**							**5**	**5**
Couse outcomes	**Programme outcomes(POs)**					**Programme Specific Outcomes(PSOs)**					**Mean scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO-1	3	3	3	2	3	2	2	3	2	3	2.6
CO-2	3	3	2	2	3	2	3	3	2	2	2.6
CO-3	3	3	3	3	2	2	3	2	3	2	2.7
CO-4	2	3	2	3	2	3	2	2	3	2	2.4
CO-5	3	2	3	2	2	2	3	2	3	2	2.5
Mean overall score											**2.6(High)**

Semester	Course code	Title of the course	Hours	Credits
III	24PBC3C10	CC X: PLANT AND ANIMAL BIOTECHNOLOGY	5	5

Objectives: To acquire comprehensive knowledge on plant and animal tissue culture and to acquire sound knowledge on methods of production of transgenic plants.

Unit-I **(18 Periods)**

Introduction of plant tissue culture, composition of media, Micropropagation, organogenesis, somatic embryogenesis, haploid and triploid production, protoplast isolation and fusion, hybrid and cybrid, synthetic seed production, secondary metabolic production.

Unit-II **(18 Periods)**

Plant Transformation Direct transformation by electro oration and particle gun bombardment. Agrobacterium, Ti plasmid vector. Theory and techniques for the development of new genetic traits, conferring resistance to biotic and abiotic. Plant engineering towards development of enriched food products, plant growth regulators.

Unit-III **(18 Periods)**

Disaggregation of tissue and primary culture; cell separation, Slide and coverslip cultures, flask culture, test tube culture techniques, cell synchronization, cryopreservation. Scaling up of animal cell culture, cell line and cloning micromanipulation and cloning, somatic cell cloning. Karyotyping; measuring parameters for growth, measurement of cell death, apoptosis and its determination, cytotoxicity assays.

Unit-IV **(18 Periods)**

Agrobacterium and crown gall tumors – Ti plasmid and Ri plasmid vectors. Mechanism of TDNA transfer to plants. Plant viral vectors, Direct transformation of plants by physical methods. Selectable markers and reporter genes used in plant vectors. Transgenic plants – plant resistance to bacteria, fungi, virus, pest and herbicides. Transgenic plants for improved nutrition, crop yieldand as bioreactors. GM foods.

Unit –V **(18 Periods)**

Nuclear magnetic resonance methods of monitoring cell metabolism culturing animal cells in fluidized bed reactors- GPI- Anchored fusion proteins- harvesting GPI- anchored proteins from CHO cells- Hematopoietic cells for cellular and gene therapy. Transgenic animals: Production and application; transgenic animals in livestock improvement, transgenic animals as model for human diseases.

Unit –VI

Animal health disease diagnosis, hybridoma technique, monoclonal antibodies, application of probes for disease diagnosis of existing and emerging animal diseases.Prophylaxis - Vaccines, Oral vaccines DNA Vaccines in animal disease. Cell culture: primary and established culture; organ culture; tissue culture.

TEXT BOOK(S)

1. Slater, 2008. Plant Biotechnology J.D.Watson, M.Gillman, J.Witknowski and M.Zoller.
2. Recombinant DNA. 3rdedition., W.H.Freeman.
3. K. Dass. 2005, Text book of Biotechnology, Second Edition, Wiley Dreamtech, India (P) Ltd.
4. H.Kreuzer & A. Massey. 2001. Recombinant DNA and Biotechnology: A guide for teachers Second Edition. ASM press, Washington.
5. Engineering Principles in Biotechnology, Wei-Shou Hu, 2018

REFERENCE BOOK(S)

1. Razdan.M.K., 2011. Plant tissue culture. Oxford and IBH publishing Company Pvt. Ltd, New delhi.
2. Chawla. H.S., 2010. Introduction to plant biotechnology. Oxford and IBHpublishing company pvt. Ltd, New delhi.
3. Ian Freshney, 2010. Culture of animal cells. 6th edition. Wiley-Blackwell publishers.

Course Outcomes:

CO No.	CO-STATEMENTS On the Successful completion of the course the student would be able to	Cognitive Levels (K-Levels)
CO1	Demonstrate a comprehensive understanding of plant tissue culture techniques, including micropropagation and somatic embryogenesis.	Kl & K2

CO2	Explain and apply various plant transformation methods, such as Agrobacterium-mediated transformation and direct physical techniques.	Kl, K2 &K3
CO3	Acquire proficiency in animal cell culture techniques, including tissue disaggregation, cell separation, and cloning methods.	K2, K3 &K4
CO4	Understand the principles of creating transgenic plants, including the use of selectable markers for disease and pest resistance.	K2& K3
CO5	Demonstrate knowledge of animal health diagnosis techniques and the applications of transgenic animals in disease modeling and livestock improvement.	KI, K2 & K5

Relationship matrix for Course outcomes, Programme outcomes/ Programme specific outcomes

Mapping with Programme Outcomes:

Semester	**Course code**	**Title of the Course**							**Hours**	**Credits**
III	**24PBC3C10**	**CC X: PLANT AND ANIMAL BIOTECHNOLOGY**							**5**	**5**
Couse outcomes	**Programme outcomes(POs)**					**Programme Specific Outcomes(PSOs)**				**Mean scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO-1	3	3	3	2	3	2	2	3	2	3	2.6
CO-2	3	3	2	2	3	2	3	3	2	2	2.6
CO-3	3	3	3	3	2	2	3	2	3	2	2.7
CO-4	2	3	2	3	2	3	2	2	3	2	2.4
CO-5	3	2	3	2	2	2	3	2	3	2	2.5
Mean overall score											**2.6(High)**

Semester	Course code	Title of the course	Hours	Credits
III	24PBC3C3P	CP III: LAB IN IMMUNOLOGY, CLINICAL BIOCHEMISTRY, PLANT & ANIMAL BIOTECHNOLOGY AND ADVANCED DIETETICS	6	3

OBJECTIVES: To acquire knowledge on the various assay methods for the blood and urine, biochemical parameters of diagnostic importance and to understand techniques of immunology and plant and animal biotechnology. (35 Periods)

1. Plant Tissue Culture 1. Media preparation and sterilization 2. Callus induction 3. Micropropagation
2. Isolation of genomic DNA.
3. Immobilization techniques for plant cells
4. Qualitative analysis of secondary phytochemicals in medicinal plants
5. Isolation of chloroplast and estimation of total chlorophyll, chlorophyll a and chlorophyll b pigments from leaves.
6. Estimation of chlorophyll in leaves.
7. Estimation of Cholesterol- Zak's method
8. Estimation of Creatine and Creatinine- Alkaline picrate method
9. Estimation of Urea DAM method
10. Assay of serum marker Enzymes- Determination of activity of SGOT and SGPT
11. Determination of tissue antioxidant enzyme activity – SOD/CAT
12. Determination of Bilirubin [Conjugated & Unconjugated]in serum.
13. Urine Analysis 1. Estimation of Urea, Uric acid, Creatine and Creatinine

TEXT BOOK(S)

1. Practical Clinical Biochemistry- Varley's by Alan H Gowanlock, published by CBS Publishers and distributors, India Sixth Edition ,1988.
2. Laboratory manual in Biochemistry, T.N. Pattabiraman. All India publishers, 1998.
3. Practical Biochemistry for Students, Varun Kumar Malhotra, Jaypee Bros, 1986.
4. Laboratory Manual in Bio Chemistry, Jayaraman, New Age International Pub, 2000.

REFERENCE BOOK(S)

1. Medical Lab Technology Vol I& II, Kanai L Mukerjee New Delhi: TataMcGraw-Hill Publishing Company, 1996.
2. Practical Biochemistry – Plummer, New Delhi: Tata McGraw Hill Publishing Company, 2000.
3. Introductory practical Biochemistry – S.K. Sawhney, Randhir Singh, 2nd ed, 2005.
4. Sadasivam, S, and Manickam, A., (2001), Biochemical Methods, 3rd edition, New Age International Publishers, New Delhi

Course Outcomes:

CO No.	CO-STATEMENTS On the Successful completion of the course the student would be able to	Cognitive Levels (K-Levels)
CO1	Demonstrate proficiency in the preparation and sterilization of culture media, as well as in inducing callus formation and micropropagation techniques.	Kl & K2
CO2	Isolate genomic DNA from plant tissues and apply immobilization techniques for plant cells to facilitate biotechnological applications.	Kl, K2 &K3
CO3	Conduct qualitative analyses of secondary phytochemicals in medicinal plants and accurately estimate chlorophyll content in plant leaves.	K2, K3 &K4
CO4	Perform biochemical assays for the estimation of cholesterol, creatine, creatinine, and urea, applying methods such as Zak's and alkaline picrate techniques.	K2& K3
CO5	Analyze serum marker enzymes and antioxidant enzyme activities, as well as determine bilirubin levels and perform comprehensive urine analysis for clinical assessments.	KI, K2 & K5

Relationship matrix for Course outcomes, Programme outcomes/ Programme specific outcomes

Mapping with Programme Outcomes:

Semester	Course code	Title of the Course							Hours	Credits
III	24PBC3C3P	CP III: LAB IN IMMUNOLOGY, CLINICAL BIOCHEMISTRY, PLANT & ANIMAL BIOTECHNOLOGY AND ADVANCED DIETETICS							6	3
Couse outcomes	Programme outcomes(POs)					Programme Specific Outcomes(PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	2	2	3	2	2	1	2	2	1	2	2.3
CO-2	2	2	2	1	2	2	2	2	1	2	2.1
CO-3	3	2	3	2	2	2	2	2	2	1	2.3
CO-4	2	2	2	2	1	2	2	1	2	2	2.1
CO-5	2	1	2	1	2	1	2	1	2	2	1.8
Mean overall score											2.5(High)

Semester	Course code	Title of the course	Hours	Credits
III	24PBC3E2A	CE II: DEVELOPMENTAL BIOLOGY	5	3

UNIT I **(15 Periods)**

Spermatogenesis – Definition – Process and significance - Structure of mammalian sperm. Oogenesis – Definition – Process and Significance – Types of Eggs and Egg membranes. Menstrual cycle, Monitoring of estrus cycle, Sperm Banking. Hormones involved in reproduction.

UNIT II **(15 Periods)**

Fertilization – Definition – Process and Significance. Entry of sperm – egg activation, Post fertilization changes – Theories of fertilization - Parthenogenesis: Definition and Significance –types of Parthenogenesis. Activation of sperm and egg– interaction of sperm and egg – Sequence of events in sperm entry – Egg surface changes. Post–fertilization changes. Embryo development.

UNIT III **(10 Periods)**

Cell cleavage – pattern of cleavage – Chemical changes- Distribution of cytoplasmic substances in the egg –Metamorphosis (Insects and amphibians) –Hormone control of metamorphosis. Planes and patterns of cleavage – Factors affecting cleavage – Cleavage in frog and Chick. Morula and Blastulation - Morphogenetic movements - Fate maps – Gastrulation in frog and
chick

UNIT IV **(10 Periods)**

Origin and development of organs – Development of brain, eye and heart. Development of foetal membranes in chick. Placenta in Mammal – Definition – Significance and types. Development of Microsporangium and Megasporangium, Pollination, Embryo -Embryo sac development and double fertilization in plants, seed formation and germination. Outline of experimental embryology.

UNIT V **(10 Periods)**

Metamorphosis – definition and significance. Regressive and Progressive Metamorphosis – hormonal control of metamorphosis in Amphibians– Regeneration –nuclear transplantation – induced ovulation – Artificial insemination – IVF – Embryo transfer. Organization of shoot and root apical meristem, and development. Leaf development and Phyllotaxy.

TEXT BOOK(S):

1. Gilbert, Scott's. 10 edition (2014). Developmental biology. Sinauer Association, Inc., Publishers.

2. Chattopadhyay.S. 2016. An Introduction to Developmental Biology, Books and Allied (P) Ltd, Kolkata. First Edition.

2. Bruce M Carlson, Patten's Foundation of Embryology,. Tata McGraw Hill Co.Th

3. Balinsky, B.I., 1981. 5 edition. An Introduction to Embryology, W. B. Saunders Co., Philadelphia

REFERENCE BOOK(S)

1. Verma , P.S., Agarwal, V.K., and Tyagi., 1995. Chordate embryology, S. Chand & Co., New Delhi.

2. Berril, N.T., Karp, G., 1988. Development. Tata McGraw Hill Co., New York

Course Outcomes:

CO No.	CO-STATEMENTS On the Successful completion of the course the student would be able to	Cognitive Levels (K-Levels)
CO1	Demonstrate an understanding of spermatogenesis and oogenesis, including the structure of mammalian sperm and the hormonal regulation of the menstrual cycle.	Kl & K2
CO2	Explain the fertilization process and its significance, including sperm entry, egg activation, and the theories of fertilization, as well as the concept of parthenogenesis.	Kl, K2 &K3
CO3	Analyze cell cleavage patterns and metamorphosis, including hormone control, factors affecting cleavage, and the stages of gastrulation in various organisms.	K2, K3 &K4
CO4	Describe the development of key organs such as the brain, eye, and heart, and explain the significance of fetal membranes and types of placenta in mammals.	K2& K3
CO5	valuate processes related to metamorphosis and regeneration, and assess reproductive technologies such as IVF, artificial insemination, and the organization of plant structures..	KI, K2 & K5

Relationship matrix for Course outcomes, Programme outcomes/ Programme specific outcomes

Mapping with Programme Outcomes:

Semester	Course code	Title of the Course							Hours	Credits
III	24PBC3E2A	CE II: DEVELOPMENTAL BIOLOGY							5	3
Couse outcomes	Programme outcomes (POs)					Programme Specific Outcomes(PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	2	3	3	2	2	1	2	2	1	2	2.4
CO-2	3	2	2	2	2	2	2	2	1	2	2.3
CO-3	3	3	3	2	2	2	2	2	2	2	2.6
CO-4	2	3	2	3	2	2	2	2	2	2	2.5
CO-5	3	2	2	1	2	2	1	2	2	2	2.3
Mean overall score											2.6(High)

Semester	Course code	Title of the course	Hours	Credits
III	24PBC3E2B	CE II: ENDOCRINOLOGY	5	3

UNIT I : **(15 Periods)**

Definition and scope of Endocrinology - Anatomical aspects of mammalian endocrine system. Definition of a hormone- chemical nature of mammalian hormones- types of hormone receptors- secondary messenger system general mechanism of peptide and non- peptide hormones action.

UNIT II **(15 Periods)**

Endocrine glands – Structure, secretions and functions of all Endocrine glands of Vertebrates. Antagonism and Synergism. Hormones: definition, classification, biosynthesis and degradation. Mechanism of hormone action, class I and II hormone receptors, steroids. Feedback regulation of hormones.

Hypothalamus and pituitary hormones: Hypothalamic releasing factors vasopressin, oxytocin; biosynthesis, secretion, transport, regulation and biological effects of growth hormones. FSH, LH, TSH, ACTH and prolactin.

UNIT III: **(10 Periods)**

Thyroid hormones: biosynthesis, secretion, transport, regulation and biological actions. Hypo and hyperthyroidism, antithyroid agents, role of parathyroid hormones, calcitriol, calcium and phosphorous homeostasis. Hypo and hyperparathyroidism. Pancreatic hormones: Islets of Langerhans, cell types. Insulin and glucagon: biosynthesis, mechanism of
action and biological effects. Hormonal action of somatostatin and pancreatic polypeptide.

UNIT IV: **(10 Periods)**

HORMONES OF FEMALE AND MALE REPRODUCTIVE SYSTEM: Hormones of female and male reproductive system: Ovarian steroid hormones chemistry- biosynthesis and transport; Synthesis, chemistry and metabolism of androgens - and metabolism mechanisms of action of sex steroid hormones. Testicular and ovarian determining genes – Mullerian-inhibiting substance genes- molecular basis of male and female contraception.

UNIT V **(10 Periods)**

ENDOCRINOPATHIES: Endocrinopathies: Hypo-physeal, Thyroid, parathyroid, adrenal and pancreas. Disorders of pituitary hormone axis- thyrotoxicosis- hypothyroidism- Hashimoto’s thyroiditis- metabolic bone diseases- Cushing syndrome- Addison’s diseases Diabetes mellitus, androgen deficiency syndromes, Testicular neoplasm: Klinefelter's syndrome and Turner’s syndrome.

TEXT BOOK(S):

1. Donald Voet , Judith G. Voet , Charlott W. Pratt. Fundamentals of Biochemistry, upgrade edition. John Willey & Sons. Inc,

2. Edward Staunton West, Wilbert R. Todd, Howard S. Mason, John T. Van Bruggen,1996.

3. Textbook of Biochemistry, 4 th edition , Oxford & IBH publising Co.Pvt.Ltd.,3. L. Jain, 2004. Fundamentals of Biochemistry, S. Chand publications.

4. David L. Nelson , Michael M.Cox, Lehninger Principles of Biochemistry, 4 edition, W.H. Freeman and company.

REFERENCE BOOK(S)

1. Lubert Stryer, 1995. Biochemistry, 4th edition, W.H. Freeman & Co,.
2. Concepts in Experimental Biochemistry , 1999, Brooks / Cole Publishing company.
3. White Handler Smith, Mammalian Biochemistry .
4. Francis Sreenspan, Gordon J. Strewler Prentice, 1997. Basic & Clinical Endocrinology – Hall International Inc. 5.th ed.

Course Outcomes:

CO No.	CO-STATEMENTS On the Successful completion of the course the student would be able to	Cognitive Levels (K-Levels)
CO1	Understand the definition, scope, and anatomical structure of the mammalian endocrine system, along with the chemical nature and mechanisms of hormone action.	Kl & K2
CO2	Explain the structure, functions, and secretions of vertebrate endocrine glands, including concepts of hormone antagonism, synergism, and feedback regulation.	Kl, K2 &K3
CO3	Analyze the biosynthesis, regulation, and effects of thyroid, parathyroid, and pancreatic hormones, focusing on their roles in calcium and glucose homeostasis.	K2, K3 &K4
CO4	Describe the biosynthesis and actions of sex steroid hormones in male and female reproductive systems and the molecular mechanisms of contraception.	K2& K3
CO5	Evaluate various endocrinopathies, including disorders of the pituitary, thyroid, parathyroid, adrenal glands, and pancreas, along with their clinical implications.	KI, K2 & K5

Relationship matrix for Course outcomes, Programme outcomes/ Programme specific outcomes

Mapping with Programme Outcomes:

Semester	Course code	Title of the Course							Hours	Credits
III	24PBC3E2B	CE II: ENDOCRINOLOGY							5	3
Couse outcomes	Programme outcomes (POs)					Programme Specific Outcomes(PSOs)				Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	2	3	3	2	2	1	2	2	1	2	2.4
CO-2	3	2	2	2	2	2	2	1	1	2	2.2
CO-3	3	3	3	2	1	2	2	2	2	2	2.4
CO-4	2	3	2	2	1	2	2	1	2	2	2.2
CO-5	3	2	2	1	2	1	1	2	2	2	2.0
Mean overall score											2.4(High)

Semester	Course code	Title of the course	Hours	Credits
III	24PBC3N2A	NME II: HEALTH DISORDERS IN ADOLESCENTS	3	2

Objective: To provide deep knowledge and understanding on health disorders during adolescents.

UNIT I: **(6 Periods)**

Concept of Women's Health - Status of women's health Adolescent health: adolescent sexual and reproductive health, adolescent mental health, adolescent pregnancy, adolescent nutritional requirements, - National Health Policy – National Health Programme – National Rural Health Mission (NRHM) – National Urban Health Mission

UNIT II: **(6 Periods)**

Eating disorders, obesity, underweight and adolescent anemia -basic need of nutrition for women.

UNIT III: **(6 Periods)**

MMR, health care delivery system, stages of pregnancy, physiological changes of pregnancy, nutritional requirements in pregnancy, nutritional deficiencies, complications of pregnancy: Anemia, under nutrition, Gestational Diabetes Mellitus (GDM), Pregnancy induced Hypertension(PIH).

UNIT IV: **(6 Periods)**

Understanding the Menstrual Cycle -Menstruation and Menstrual hygiene – menopause - Ailments related to pregnancy - Causes for Female Infanticide Premarital Sexuality – Abortion - issues and Gender Dimensions of Infertility - Contraception Prospects for improvement in reproductive health.

UNIT V **(4 Periods)**

Psychological disorders - Frustration, Anxiety disorder, eating disorders, sleeping disorders - meaning and management.

UNIT VI **(4 Periods)**

Self-Assessment and Health Behaviors, Understanding the Link between Nutrition and Education, Global Guidelines and Guidance for Improving Adolescent Nutrition.

TEXT BOOK(S)

1. International Handbook on Adolescent Health and Development Andrew L. Cherry, Valentina Baltag, Mary E. Dillon
2. Handbook of Adolescent Health Psychology William T. O'Donohue, Lorraine T.
3. Benuto, Lauren Woodward Tolle
4. Neinsteins Adolescent and Young Adult Health Care 6Th Edition by Neinstein, Wolters Kluwer | Lippincott Williams and Wilkins

REFERENCE BOOK(S)

1. Adolescenceand Health: Some InternationalPerspectives Joav Merrick,
2. Adolescent Health: Understanding and Preventing Risk Behaviors
3. Ralph J. DiClemente (Editor), John S. Santelli (Editor), Richard Crosby (Editor).

Course Outcomes:

CO No.	CO-STATEMENTS On the Successful completion of the course the student would be able to	Cognitive Levels (K-Levels)
CO1	Help to know more about stages of adolescents and women Health during adolescents	Kl & K2
CO2	Provide knowledge regarding different eating disorders and basic nutritional needs of women	Kl, K2 &K3
CO3	Describe about stages and physiological changes of pregnancy	K2, K3 &K4
CO4	Provide knowledge on menstrual cycle, abortion and other contraceptions	K2& K3
CO5	Describe about psychological disorders and self-assessment	KI, K2 & K5

Relationship matrix for Course outcomes, Programme outcomes/ Programme specific outcomes

Mapping with Programme Outcomes:

Semester	Course code	Title of the Course					Hours	Credits		
III	24PBC3N2A	NME II: HEALTH DISORDERS IN ADOLESCENTS					3	2		
Couse outcomes	Programme outcomes (POs)					Programme Specific Outcomes(PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	2	3	3	2	2	1	2	2	1	2	2.3
CO-2	3	2	2	2	2	2	2	1	1	2	2.2
CO-3	3	3	3	2	1	2	2	2	2	2	2.4
CO-4	2	3	2	2	1	2	1	1	2	2	2.1
CO-5	2	2	2	1	2	1	1	2	2	2	2.0
Mean overall score											2.3(High)

Semester	Course code	Title of the course	Hours	Credits
III	24PBC3N2B	NME II: INDO-ALLOPATHY	3	2

Objective: To provide knowledge on allopathy and various medicines related to various diseases.

UNIT I **(6 Periods)**

Indo allopathy meaning and introduction, History of allopathy, Benefits of allopathy, allopathy vs homeopathy overview. Treatment and preventive measures of allopathic medicines. Systemic Pharmacology – Drug oriented teaching, (Here a core information about drugs is to be given that should include pharmacological actions, mechanism of action, indications, contraindications, side effects, drug interactions, precautions etc.)

UNIT II **(6 Periods)**

Drugs Affecting Respiratory System -Antitussives, expectorants, mucolytics. Drug treatment of bronchial asthma, COPD (VIII). Drugs Affecting Gastro-intestinal System - Drugs for gastric acidity, peptic ulcer & GERD. Antiemetic and prokinetic agents - Drugs for constipation and Inflammatory Bowel Disease, Anti diarrheal agents

UNIT III **(6 Periods)**

Drugs Affecting Peripheral Nervous System (PNS) 27 Local anesthetics -Skeletal muscle relaxants (IV) Drugs Affecting Cardiovascular System (CVS) . Drugs Affecting Central Nervous system -Sedative hypnotic drugs -Antiepileptic drugs - Antipsychotic drugs - Antianxiety drugs Antidepressant and antimanic drugs

UNIT IV **(6 Periods)**

Drugs affecting vascular tone and volume of circulation, renin angiotensin system and other mechanisms affecting this system. Antihypertensive drugs. Drugs Affecting Kidney Function - Diuretics – Antidiuretics.

UNIT V **(8 Periods)**

Drugs Affecting Endocrine System and its Diseases -Thyroid hormones and antithyroid drugs - Estrogen, progesterone and inhibitors. Parathyroid hormones and drugs affecting calcium balance - Drugs acting on uterus.

UNIT VI

Allopathic medicine and their action for psychological disorders – anxiety, depression, eating disorders, obsessive compulsive disorder, paranoia, psychosis, schizophrenia.

COURSE OUTCOME

TEXT BOOK(S)

1. History Of Medicine in India: The Medical Encounters Chittabrata Palit & Achintya Dutta
2. Guide to Medicine by Dr. A. K Sharma
3. General Practice of Allopathy Dr.Atam Parkash Setia MBBS, MS

REFERENCE BOOK(S)

1. Practise of medicine. By Dr. Jahan Singh Chauhan
2. Hutchison's Clinical Methods: An Integrated Approach to Clinical Practice by Glynn
3. Davidson's Principles and Practice of Medicine, International Edition by Stuart Raltston

Course Outcomes:

CO No.	CO-STATEMENTS On the Successful completion of the course the student would be able to	Cognitive Levels (K-Levels)
CO1	Give knowledge about allopathy medicines	Kl & K2
CO2	Helps to know about the action of different drugs on respiratory system	Kl, K2 &K3
CO3	Provide information about central nervous system and the drugs affecting CNS	K2, K3 &K4
CO4	Give a deep view on drugs affecting different systems in the human body	K2& K3
CO5	Help to know more about the drugs and their action in psychological disorders	KI, K2 & K5

Relationship matrix for Course outcomes, Programme outcomes/ Programme specific outcomes

Mapping with Programme Outcomes:

Semester	Course code	Title of the Course							Hours	Credits
III	24PBC3N2B	NME II: INDO-ALLOPATHY							3	2
Couse outcomes	Programme outcomes (POs)					Programme Specific Outcomes(PSOs)				Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	2	3	3	2	2	1	2	2	1	2	2.4
CO-2	3	2	2	2	2	2	2	1	1	2	2.2
CO-3	3	3	3	2	1	2	2	2	2	2	2.5
CO-4	2	3	2	2	1	2	1	1	2	2	2.3
CO-5	2	2	2	1	2	1	1	2	2	2	2.1
Mean overall score											2.4(High)

Semester	Course code	Title of the course	Hours	Credits
IV	24PBC4C11	CC XI: RESEARCH METHODOLOGY	6	6

Objective: To improve the research and project handling skills in students.

Unit-1 **(15 Periods)**

Research Methodology Introduction: meaning of research; objectives of research; types of research; research approaches; significances of research; Components of a research, research methods; importance of knowing how research is done; Computer application in scientific research: Finding scientific articles. Research problem and Research Design.

Unit – II **(15 Periods)**

Data Collection Primary and secondary Data collection. Sampling: Sampling and Population, Technique's sampling selection, Characteristics of a good sample, Sampling errors and how to reduce them. Techniques of Data Collection: Data schedule, Observation, Opinionnaire, Questionnaire, Normal distribution and Multiple testing Methods ANOVA; Test of significance- t-test; F-test.

Unit – III **(15 Periods)**

Bioinformatics Origin and overview of bioinformatics. Applications of bioinformatics. Research in bioinformatics, Biological Databases: Literature databases, Sequence databases, Structure databases, Structural classification databases, Metabolic pathways database, Pattern and Motif searches: PROSITE, BLOCKS, PRINTS, PFAM. Sequence alignment: Pairwise sequence alignment - Local and Global alignments.

Unit IV **(15 Periods)**

Meaning and significance of research, characteristics and types of research, the research process, features of good research study. Research applications. Research report - Structure and components of scientific reports, types of report, writing and documentation of research report, developing successful research proposals,

Unit -V **(15 Periods)**

Report writing; Preparation of manuscript plan of the report, review of literature & its use in designing a research work, designing of methodology, interpretation of data & thesis layout. Scientific writing. Characteristic of scientific writing, essential features of an abstract, presentation of data, writing of results & discussions. Bibliography, oral presentation; precautions for writing research reports; conclusions.

Unit – VI

Dot plot -Dynamic programming methods. Scoring or Substitution matrices - Database searching-FASTA and BLAST searches - Multiple sequence alignment. Clustal W. T-Coffee. Tools for Drug discovery / drug design.

TEXT BOOK(S)

1. Research methodology- methods and techniques. Daniel 2006.
2. Research methods for biological science. Gurumani.N, 2007.MJP pub.
3. Research methods in biological science. Dr.S.Palanichamy, & M. Shanmugavelu,

REFERENCE BOOK(S)

1. Biochemical calculation and biostatistics. Dr. E.Padmini
2. Research Methodology-Methods and Techniques by C.R. Kothari

Course Outcomes:

CO No.	CO-STATEMENTS On the Successful completion of the course the student would be able to	Cognitive Levels (K-Levels)
CO1	Describe about fundamentals of scientific research	Kl & K2
CO2	Describe data collection and analysis	Kl, K2 &K3
CO3	Describe about bioinformatics and databases	K2, K3 &K4
CO4	Describe about research report	K2& K3
CO5	Describe about database searching	KI, K2 & K5

Relationship matrix for Course outcomes, Programme outcomes/ Programme specific outcomes

Mapping with Programme Outcomes:

Semester	Course code	Title of the Course							Hours	Credits
IV	24PBC4C11	CC XI: RESEARCH METHODOLOGY							6	6
Couse outcomes	Programme outcomes (POs)					Programme Specific Outcomes(PSOs)				Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	2	3	3	2	2	1	2	2	2	2	2.6
CO-2	3	2	2	2	2	2	2	1	1	2	2.3
CO-3	3	3	3	2	1	2	2	2	2	2	2.6
CO-4	2	3	2	2	1	2	1	1	2	2	2.3
CO-5	2	2	2	1	2	1	1	2	2	2	2.2
Mean overall score											2.6(High)

Semester	Course code	Title of the course	Hours	Credits
IV	24PBC4E3A	CEC III: NANOTOXICOLOGY AND BIOSAFETY	6	3

Objective: To provide knowledge about nanotoxicology and its applications and role in life and help to provide basic knowledge about biosafety

UNIT I **(12 Periods)**

Introduction, source of nanoparticles, epidemiological evidences, entry routes for nanoparticles in human body: lungs, intestinal tract and skin, Deposition and translocation in the body, Attributes contribute to nanomaterials toxicity.

UNIT II **(12 Periods)**

Classification of nanoparticles for biological applications, nanoparticles interaction with the biological membrane, uptake and toxicological effects of different nanoparticles.

UNIT III **(12 Periods)**

Mechanisms of nanomaterial toxicity: oxidative stress, ecotoxicity, genotoxicity, hemolytic toxicity, mutagenicity and immunotoxicity.

UNIT IV **(12 Periods)**

Assessment of nanomaterial toxicity: In vitro toxicity assessment-cell viability, lactate dehydrogenase release, reactive oxygen species generation, change in mitochondrial membrane potential and nuclear fragmentation. In vivo toxicity assessment: inflammatory response, acute toxicity studies, LD50 determination, histopathological studies.

UNIT V **(12 Periods)**

Need for safety in industries; Safety Programme – components and realization; Potential hazards – extreme operating conditions, toxic chemicals; safe handling, Implementation of safety procedures – periodic inspection and replacement; Accidents – identification and prevention; promotion of industrial safety EG: Government Regulator's Approach to Risk -Chernobyl and Bhopal Case Studies

UNIT VI

Collegiality and Loyalty – Respect for Authority – Collective Bargain in Confidentiality – Conflicts of Interest – Occupational Crime Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination, Multinational Corporations – Business Ethics - Environmental Ethics – Computer Ethics - Role in Technological Development –Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Honesty – Moral Leadership – Sample Code of Conduct.

TEXT BOOK(S)

1. Handbook of Nanotoxicology, Nanomedicine and Stem Cell Use in Toxicology. SauraC Sahu, Daniel A Casciano.
2. Nanotoxicology - Interactions of Nanomaterials with Biological Systems. Yuliang Zhao and Hari Singh Nalwa.
3. Bio interactions of Nanomaterials. Vijaykumar B. Sutariya, Yashwant Pathak

REFERENCE BOOK(S)

1. Fawatt, H.H. and Wood, W.S., "Safety and Accident Prevention in Chemical Operation", Wiley Interscience, 1965.
2. Charles E Harris, Michael S Pritchard and Michael J Rabins, "Engineering Ethics – Concepts and Cases", Thompson Learning, (2000).

Course Outcomes:

CO No.	CO-STATEMENTS On the Successful completion of the course the student would be able to	Cognitive Levels (K-Levels)
CO1	Describe about nanoparticles and its toxicity	Kl & K2
CO2	Describe about biological activity and interaction of nanoparticles	Kl, K2 &K3
CO3	Give knowledge about mechanisms of nanomaterial toxicity	K2, K3 &K4
CO4	Define biosafety and bioethics in the context of modern biotechnology	K2& K3
CO5	To be aware of the social and ethical issues related to plant/animal biotechnology and to understand the relevance of intellectual property rights	KI, K2 & K5

Relationship matrix for Course outcomes, Programme outcomes/ Programme specific outcomes

Mapping with Programme Outcomes:

Semester	Course code	Title of the Course							Hours	Credits
IV	24PBC4E3A	CEC III: NANOTOXICOLOGY AND BIOSAFETY							6	3
Couse outcomes	Programme outcomes (POs)					Programme Specific Outcomes(PSOs)				Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	2	3	3	2	2	1	2	2	2	2	2.4
CO-2	3	2	2	2	2	2	2	1	1	2	2.3
CO-3	3	3	3	2	1	2	2	2	2	2	2.6
CO-4	2	3	2	2	1	2	1	1	2	2	2.3
CO-5	2	2	2	1	2	1	1	2	2	2	2.2
Mean overall score											2.4(High)

Semester	Course code	Title of the course	Hours	Credits
IV	24PBC4E3B	CEC III: GENETIC ENGINEERING	6	3

Objectives: To gain sound knowledge on cloning strategies, gene expression analysis, and molecular techniques related to genetic engineering.

Unit-I **(12 periods)**

Gene cloning Genetic engineering tools Nucleic acid manipulating enzymes. Promoters, Selectable markers and reporters used in rDNA technology. Restriction digestion, Ligation, Transformation, Selection of Recombinants. Construction of gene libraries.

Unit-II **(12 Periods)**

E.Coli vectors - pBR322 and its derivatives; Cloning vectors for gram negative bacteria - ColE1, p15A, R1, IncPa, pSC101; Lambda bacteriophage vectors, filamentous phages, Cosmids, Phasmids, Phagemids. Cloning in gram-positive bacteria (Bacillus subtilis).

Unit-III **(12 Periods)**

Cloning in yeast Saccharomyces cerevisiae Life cycle and types of vectors; Eukaryotic vectors SV40 (molecular genetics and expression); Specialized cloning vector for cDNA; Synthesis of specific RNA in vitro; Vectors for cloning promoters and terminators; vectors with adjustable copy number**.**

Unit-IV **(12 Periods)**

Nucleic acid hybridization techniques; Molecular probes (Types of probes and its construction); probe labeling Nick translation, End labeling and Random primer labeling. Polymerase chain reaction and its variants; DNA fingerprinting; DNA sequencing first generation sequencing methods (Maxam and Gilbert sequencing, Sanger's Dideoxy sequencing, Pyrosequencing, PCR based sequencing and hybridization sequencing). Second generation sequencing methods.

Unit-V **(12 Periods)**

Site directed mutagenesis; DNA microarray; chromosome walking and jumping. Molecular techniques in prenatal diagnosis gene therapy, pharmaceutical products (Vaccine, Humulin, etc), Crop improvement pesticide resistance, herbicide resistance, transgenic animals and GMS foods.

Unit-VI

Genetic Engineering – Techniques of genomic sequencing - Recombinant DNA techniques. Applications of Recombinant DNA technology. Applied Genetics - Application of genetics in animal breeding. Application of genetics in Crime and Law - Genetic basis of intelligence. Studies on Twins.

TEXT BOOK(S)

1. T.A. Brown, 2010. Gene cloning and DNA analysis: An introduction, 6th edition, Wiley-Blackwell.
2. Sandy B. Primrose and Richard Twyman, 2006. Principles of Gene Manipulation and genomics, 7th edition, Wiley-Blackwell.
3. Lewin, 2009. Genes X, 10th edition, Jones & Barlett Publishers 4. Raymond Rodriguez and David T. Denhart 2003.Vectors A survey of molecular cloning vectors and their uses

REFERENCE BOOK(S)

1. Errst-L. Winnacker 1987.From genes to clones Introduction to Gene Technology, Ed. David V. Geoddel 2002.Gene Expression technologies. Methods in enzymology (Vol.185)
2. William Rezmikff, Lamy Gold 2002. 8. William Wu, Michael J.Welsh, Peter B. Kaufrmar, Helen H.Zhang 2001.Methods in Gene Biotechnology
3. Principles of Genetics 5th Edition by Gardner, M. J. Simmons 2006, D. P. Snustad John Wiley & Sons.

Course Outcomes:

CO No.	CO-STATEMENTS On the Successful completion of the course the student would be able to	Cognitive Levels (K-Levels)
CO1	The objectives of this course are to teach students with various approaches to conducting genetic engineering and their applications in biological research as well as in biotechnology industries.	Kl & K2

CO2	Genetic engineering is a technology that has been developed based on fundamental understanding of the principles of molecular biology and this is reflected in the contents of this course	Kl, K2 &K3
CO3	The objectives of this course are to teach students with various approaches to conducting genetic engineering and their applications in biological research as well as in biotechnology industries	K2, K3 &K4
CO4	Selectable markers and reporters used in rDNA technology	K2& K3
CO5	Synthesis of specific RNA in vitro; Vectors	KI, K2 & K5

Relationship matrix for Course outcomes, Programme outcomes/ Programme specific outcomes

Mapping with Programme Outcomes:

Semester	**Course code**		**Title of the Course**							**Hours**	**Credits**
IV	**24PBC4E3B**		**CEC III: GENETIC ENGINEERING**							**6**	**3**
Couse outcomes	**Programme outcomes (POs)**					**Programme Specific Outcomes(PSOs)**					**Mean scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO-1	2	3	3	2	2	1	2	2	2	2	2.5
CO-2	3	2	2	2	2	2	2	1	1	2	2.3
CO-3	3	3	3	2	1	2	2	2	2	2	2.6
CO-4	2	3	2	2	1	2	1	1	2	2	2.3
CO-5	2	2	2	1	2	1	1	2	2	2	2.2
Mean overall score											**2.5(High)**