BHARATHIDASAN UNIVERSITY TIRUCHIRAPPALLI - 620 024.

M.Sc. BIOCHEMISTRY

CHOICE BASED CREDIT SYSTEM – LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (CBCS - LOCF)

(Applicable to the candidates admitted from the academic year 2022-23 onwards)

Sem.	Courses	Title	Ins. Hrs.	Credit	Exam. Hrs.	Marks		Total
						Int.	Ext.	
I	Core Course I (CC)	Chemistry of Biopolymers	6	5	3	25	75	100
	Core Course II (CC)	Biochemical Techniques	6	5	3	25	75	100
	Core Choice Course I (CCC)	1. Cell Biology (or) 2. Biotechnology and Genetic Engineering	6	5	3	25	75	100
	Core Practical I (CP)	Biochemical Techniques and Enzymology	6	3	3	40	60	100
	Elective Course I (EC)	1. Biostatistics (or) 2. Nanotechnology	6	4	3	25	75	100
	Value Added Course I (VAC)	Detection Methods of Food Adulteration	-	2*	3	25	75	100*
	Total		**30**	**22**	**-**	**-**	**-**	**500**
II	Core Course III (CC)	Biophysical Chemistry	6	5	3	25	75	100
	Core Course IV (CC)	Enzymology	5	5	3	25	75	100
	Core Choice Course II (CCC) (Any one choice)	1. Genetics (or) 2. Endocrinology	5	5	3	25	75	100
	Core Practical II (CP)	Molecular and Microbial Techniques	6	3	3	40	60	100
	Elective Course II (EC)	1. Bioinformatics (or) 2. Genomics and Proteomics	5	4	3	25	75	100
	Non-Major Elective Course I@	#Clinical Biochemistry	3	2	3	25	75	100
	Total		**30**	**24**	**-**	**-**	**-**	**600**
III	Core Course V (CC)	Metabolism and Regulation	6	5	3	25	75	100
	Core Course VI (CC)	Clinical Biochemistry	5	5	3	25	75	100
	Core Choice Course III (CCC)	1. Ecology and Environmental Biology (or) 2. Developmental Biology	5	5	3	25	75	100
	Core Practical III (CP)	Clinical Biochemistry	6	3	3	40	60	100
	Elective Course III (EC)	1. Bioethics and IPR (or) 2. Pharmaceutical Chemistry	5	4	3	25	75	100
	Non-Major Elective Course II	Biochemistry	3	2	3	25	75	100
	Total		**30**	**24**	**-**	**-**	**-**	**600**
IV	Core Course VII (CC)	Immunology	6	5	3	25	75	100
	Core Course VIII (CC)	Molecular Biology	6	5	3	25	75	100
	Entrepreneurship / Industry Based Course	Industrial Chemistry	6	5	3	25	75	100
	Project	Project Work	12	5	-	20	80	100
	Value Added Course II (VAC)	Value Addition In Food	-	2*	3	25	75	100*
	Total		**30**	**20**	**-**	**-**	**-**	**400**
Grand Total			**120**	**90**	**-**	**-**	**-**	**2100**

SUMMARY OF CURRICULUM STRUCTURE OF PG PROGRAMMES

Sl. No.	Types of the Courses	No. of Courses	No. of Credits	Marks
1	Core Courses	8	40	800
2	Core Choice Courses	3	15	300
3	Core Practicals	3	9	300
4	Elective Courses	3	12	300
5	Entrepreneurship/ Industry Based Course	1	5	100
6	Project	1	5	100
7	Non-Major Elective Courses	2	4	200
8	Total	21	90	2100
	Value Added Courses *	2*	4*	200*

***The value added courses credit will not be included in the total CGPA.**
These courses are extra-credit courses.
Instruction hours for these courses are 30 hours.

@ Biochemistry students have to choose non-major elective papers offered by other department.

offered as Non major elective paper by Biochemistry Department to students of other departments

PROGRAMME OBJECTIVE:

- PG Graduands are Professionally Competent with characteristic **Knowledge-bank, Skill-set, Mind-set** and **Pragmatic Wisdom** in their chosen fields.
- PG Graduands demonstrate the desired sense of being **seasoned** and exhibit unequivocal **Spiritedness** with excellent qualities of productive contribution to **society** and **nation** in the arena of Science and Technology.
- PG Graduands are mentored such that they exert **Leadership Latitude** in their chosen fields with **commitment to novelty** and **distinction**.
- PG Graduates are directed in understanding of ethical principles and responsibilities, moral and social values in day-to-day life thereby attaining **Cultural** and **Civilized** personality.
- PG Graduates are able to **Collate** information from different kinds of sources and gain a coherent understanding of the subject.

PROGRAM OUTCOME:

- The course aims at gaining an understanding of the processes of metabolic transformation at the molecular level and how these processes are studied.
- It is important to study enzymes, the rate limiting molecule of all the chemical reactions and understanding enzymes could pave research ideas.
- Students can make the Knowledge of the relationship between structure and function at organ and/or organism level, of important cell biological communication principles and processes, and how they are regulated.

- Students are able to Characterize certain functionalities of biomolecules by using spectroscopic technique
- Students will gain conceptual understanding of subject matter, scientific reasoning skills, laboratory manipulative skills.
- The course aims to give participants a basic knowledge of mechanisms of signal transduction and the significance of signal transduction in physiology and pathophysiology.
- Students can understand the capacity to evaluate and synthesize information from a wide range of sources in order to communicate ideas, concepts and construct arguments in both non-scientific and scientific language.
- Students will learn at the end of the course to conserve nature and will be able to develop new strategies to preserve the sources of life.

First Year **CORE COURSE I** **Semester I**

CHEMISTRY OF BIOPOLYMERS

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- To understand the structure and functions of important biological macromolecules.

UNIT – I HOMO AND HETEROGLYCANS:

Polysaccharides - occurrence, structure, properties and functions of homoglycans - starch, glycogen, cellulose, dextrin, inulin, and chitin. Occurrence, structure, properties and functions of heteroglycans - hyaluronic acid, keratan sulphate and chondroitin sulphate. Bacterial cell wall polysaccharides, Blood group substances, Sialic acid**,** Glycoproteins, Lectins - biological functions.

UNIT – II PROTEINS:

Classification, structure and properties of amino acids, Essential and non-essential amino acids. Non protein amino acids. Proteins - Classification based on solubility, shape, composition and function. Properties of proteins. Denaturation and renaturation of proteins. Structure of peptide bonds. Chemical synthesis of polypeptides. Protein structure - Primary, secondary, tertiary and quaternary structures of protein. Forces stabilizing the secondary, tertiary and quaternary structures of proteins. **Ramachandran Plot** Structure and biological functions of fibrous proteins (keratins, collagen and elastin), globular proteins (haemoglobin, myoglobin).

UNIT – III LIPIDS:

Definition and classification of lipids. Fatty acids - classification, nomenclature, structure and properties. Triacylglycerols. Classification, structure and function of prostaglandins. Chemical properties and functions of phospholipids and their structures - lecithins, cephalins, phosphatidylserine, phosphatidylinositol, plasmalogens. Glycolipids (cerebrosides and gangliosides), Isoprenoids and sterols (cholesterol), bile acids and bile salts. Types and functions of plasma lipoproteins.

UNIT – IV NUCLEIC ACIDS:

Structure of purines and pyrimidines. Components of nucleic acids - nucleosides, nucleotides, and polynucleotides. Isolation of nucleic acids. Properties of DNA: buoyant density, viscosity, hypochromicity, denaturation and renaturation– the cot curve. Chemical synthesis of oligonucleotides. DNA: structure of different types (A, B and Z DNA), biological role. Structure and role of different types of RNA.

UNIT – V VITAMINS AND PORPHYRINS:

Structure and biochemical properties of water soluble and fat soluble vitamins and their coenzyme activity. Macro minerals (Ca, P, Mg, Na, K, Cl) and micro minerals/trace elements (Co, I, Fe, Mn, Zn, and F) - their sources, daily requirements, functions and deficiency diseases symptoms. Porphyrins the porphyrin ring system, chlorophyll, haemoglobin, myoglobin and cytochrome.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Recent developments in the design of biomolecule based nanostructures in clinical research.

REFERENCES:

1. L. Stryer. 2002. Biochemistry, 5thedition. W.H.Freeman Company, New York
2. Horton, R., Moranm, LA., Scrimgeour, G, MarcPerry and David Rawn. 2006. Principles of Biochemistry, 4thedition.
3. A. L. Lehninger, Nelson &Cox. 2007. Principles of Biochemistry, 5thedition, CBS, India.
4. Murray R. K. et al. Harpers Illustrated Biochemistry, 2009, 28thedition. Lange Medical Books/McGraw-Hill.
5. Zubay, 2005. Principles of Biochemistry, 4thedition. Prentice hall.
6. Richard Harvey, Denise Ferrier. 2005. Lippincott. Outlines of Biochemistry, 5thedition.

COURSE OUTCOME:

- The students will be able to understand the source, chemical structure, properties, function and uses of various polysaccharides.
- The students will be able to understand amino acid structures, their physical and chemical properties, and primary, secondary, tertiary and quaternary structure of proteins.
- The students will understand the structure of nucleic acids and its chemical synthesis.
- The students will understand the biological importance of vitamins and minerals in the biological system.

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First Year	CORE COURSE II BIOCHEMICAL TECHNIQUES	Semester I
Code:	(Theory)	Credit: 5

COURSE OBJECTIVES:

- This course will introduce some of the experimental techniques used in biochemistry and molecular biology.
- Students are able to learn methods for purifying proteins, expressing recombinant proteins in bacterial cells, and analyzing biological molecules by electrophoresis, Western blotting, and enzyme activity assays.

UNIT – I UNITS OF MEASUREMENT OF SOLUTES IN SOLUTION:

Normality, Molarity, molality and milliosmol. Ionic strength.pH, pOH, Henderson – Hesselbalch equation, buffers, pH of body fluids. Measurement of pH by indicators, Zwitterions.pH dependent ionization of amino acids and proteins. Viscosity, surface tension and Donnan membrane equilibrium. Principles of electrochemical techniques – measurement of pH by glass electrode and hydrogen electrode. Oxygen electrode – principles, operation of a Clarke electrode and its applications.

UNIT – II CELL FRACTIONATION TECHNIQUES AND RADIO ISOTOPE TECHNIQUES:

Cell lysis, differential and density gradient centrifugation, Salting in, Salting out, Dialysis, Ultrafiltration. Ultra Centrifugation - preparative and analytical ultracentrifuge, Svedberg's constant, Sedimentation velocity and Sedimentation equilibrium, Schlieren optics. Radioisotope technique: Radioactive decay constant, half life of an isotope, Detection and measurement of radioactivity, Geiger Muller counters, scintillation counting, auto radiography and RIA, Application of isotopes in biological studies.

UNIT – III CHROMATOGRAPHIC TECHNIQUES:

Principles, Instrumentation and Applications of Paper, Column, TLC, Adsorption, Ion exchanges, Gel filtration, Affinity, GLC, Chromato focusing, HPLC, FPLC.

UNIT – IV ELECTROPHORETIC TECHNIQUES:

Polyacrylamide gel electrophoresis, SDS-PAGE, 2D – PAGE, Isoelectric focusing, Visualizing protein bands – CBB & Silver staining. Agarose gel Electrophoresis, pulse field electrophoresis, high voltage electrophoresis, Capillary Electrophoresis, RFLP, FISH. Blotting techniques and its applications – Western, Northern & Southern.

UNIT – V SPECTROSCOPIC TECHNIQUES:

Spectroscopic technique: Colorimetry, spectrophotometry – UV & visible, Principle – Beer Lambert's law, Extinction coefficient. Principle Instrumentation and application - AAS, Fluorimetry. Basic principle and application of mass

spectra, NMR, ESR, MS, MALDI-TOF, MRI, CTscans. Biochips (DNA chips, Protein chips and Sensor chips).Vibration Spectra – IR – Principles and Applications. X-ray crystallography – protein crystals, Bragg's law.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Application of analytical techniques in diagnostics. Ex: qRT-PCR and its application with specific context to identification of Covid-19 infection.

REFERENCES:

1. Wilson and Walker. A biologists guide to principles and techniques of practical biochemistry. 5th ed. Cambridge University Press 2000.
2. Boyer, R. Modern Experimental Biochemistry. 3rd ed. Addison Weslery Longman, 2000.
3. Upadhyay, Upadhyay and Nath. Biophysical Chemistry Principles and Techniques. Himalaya Publ. 1997.
4. Simpson CFA & Whittaker, M. Electrophoretic techniques.
5. Sambrook. Molecular Cloning. Cold Spring Harbor Laboratory, 2001.
6. Friefelder and Friefelder. Physical Biochemistry – Applications to Biochemistry and Molecular Biology. WH Freeman &Co. 1994.
7. Pavia et al. Introduction to Spectroscopy. 3rd ed. Brooks/Cole Pub Co., 2000.

COURSE OUTCOME:

- To be able to communicate and discuss General principles of biochemical investigation
- Familiarity with working principles, tools and techniques of analytical techniques
- Students can understand the knowledge for the separation of proteins/peptides by selecting appropriate separation techniques.
- Students are able to characterize certain functionalities of biomolecules by using spectroscopic techniques.

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First Year	CORE CHOICE COURSE I 1) CELL BIOLOGY	Semester I
Code:	(Theory)	Credit: 5

COURSE OBJECTIVES:

- The Cell Biology course will enable you to consider the most exciting current problems in the field. This course will give you a unique opportunity to study the mechanisms that define and regulate the function of cells and organisms.
- As this is a research-focused master's course, one will take an interactive approach to learning, rather than taking traditional lectures, through seminars, small group tutorials and research placements.

UNIT – I THE CELL:

Cell theory, Protoplasm and Organismal theory, Broad classification of cell types – Bacteria, Archaea (Prokaryotes) and Eukaryotes. *Cell Membranes:* Basic properties of Cell Membranes – The lipid Bilayer: Composition and Structural Organization, Membrane proteins: Structure and basic functions, Membrane transport of small molecules and the electrical properties of Membranes, Endocytosis and Exocytosis. Specialized structures - Cell Junctions – Occluding, Anchoring and Gap, Ion channels. The plant Cell wall.

UNIT – II CELL ORGANELLES:

Organelles bounded by Double membrane Envelopes [Nucleus and Mitochondria], Organelles bound by single membrane [Peroxisome, ER, GA, Lysosomes], Ribosomes, Dictyosomes, Microbodies, Peroxisome, Plastids- Chloroplast, Chromoplast and Leucoplast. Vacuoles and Centrosomes.

UNIT – III INTERNAL ORGANIZATION OF THE CELL:

The Cytoskeleton: Components of Cytoskeleton, Structure and basic functions of Microtubules, Microfilaments, Intermediate filaments. *Cell Communication:* Cell-Cell Junctions, Tight Junction, Gap Junction, Cell – Matrix Anchoring junctions: Desmosomes, Adhering Junctions. Cell-Cell Adhesion proteins: Cadherins, Catenins, Integrins, Selectins. Plasmodesmata in Plants. The extracellular Matrix of Animals, Collagens, Elastins, Fibronectin, Laminin.

UNIT – IV CELL CYCLE:

Overview of Cell cycle: Mitosis and Meiosis, Stages of Mitosis and Meiosis, Crossing over and Linkage. Model organisms and methods to study the cell cycle. Regulation of CDK activity and role of checkpoints. Apoptosis and Cancer.

UNIT – V STEM CELLS:

Overview/ Concepts: Introduction to Concepts in Stem Cell Biology-Potency, Plasticity, Self Renewal and Expansion, Properties, Stem Cells. Classification and Sources. Embryonic Stem cells, Stem cell Morphology Differentiation, Origin and Types of Stem cells. Stem cells and Tissue Renewal.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Applications and methods in cell biology

Microscopy: Light microscopy, fluorescent microscopy, confocal microscopy, Phase contrast microscopy, electron microscopy. SEM, TEM. Freeze fracture technique, FACS, Tunel assay, comet assay, clonogenic assay and cell toxicity assays.

REFERENCES:

1. Stephen R. Bolsover, Elizabeth A. Shepherd, Hugh A. White, Jeremy S. Hyams. Cell Biology – A Short Course. Third Edition, Wiley-Blackwell Publication, 2011
2. George Plopper, David Sharp, Eric Sikorski. Lewin's Cells – THIRD Edition, Johnes & Bartlett Student Edition, 2015.
3. Lodish, Harvey et al., "Molecular Cell Biology", 7th Edition, W.H.Freeman, 2005
4. Cooper, G.M. and R.E. Hansman "The Cell: A Molecular Approach", VIIth Edition, ASM Press, 2007
5. Sadava, D.E. "Cell Biology: Organelle Structure and Function", Panima Publishing, 2004
6. Stem Cells- Scientific Facts and Fiction (Elsevier) By Christine Mummery, Sir Ian Wilmut,
7. Anja van de Stople, Bernard A J Roelen. 2011.
8. Alberts, Bruce et al., "Essential Cell Biology", IVth Edition, Garland Press (Taylor & Francis), 2004.
9. Bruce Alberts et al., Molecular Biology of the Cell. Sixth Edition, 2015
10. Becker, W.M. et al., "The World of the Cell", 9th Edition, Pearson Education, 2003

COURSE OUTCOME:

- Students will demonstrate their mastery of cell biology concepts**.**

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First Year **CORE CHOICE COURSE I** **Semester I**

2) BIOTECHNOLOGY AND GENETIC ENGINEERING

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- This course is to discipline to students knowledge of main engines of implementation and transmission of a genetic material at molecular and cellular levels
- The methods of change of a genetic material and construction of transgenic organisms with the given properties.
- Students can understand the natural function of restriction endonucleases and how a normal bacterial cell protects its DNA from their activity. Understand the value of and the processes involved with the polymerase chain reaction (PCR).
- To understand the function of creative use of modern tools and techniques for manipulation and analysis of genomic sequences.

UNIT – I INTRODUCTION TO GENE CLONING:

Restriction and modification enzymes. Cloning vectors: Characteristics, Natural & artificial plasmids as vectors) pBR322, pUC, shuttle vector and cosmids - advantages and disadvantages. Vectors used for cloning in E.coli., yeast, higher plants (Ti plasmid derivatives, caulimovirus) and animal cells (constructs of SV 40 and retroviruses). Expression vectors. Screening of recombinants. Construction of DNA libraries - genomic and cDNA libraries.

UNIT – II TRANSGENICS:

Transgenic animals - Gene transfer methods in animals. Totipotency, haploids, growth of animal cell lines. Competent cells preparation, electroporation, microinjection and particle bombardment method, and applications. Transgenic plants - Use of agrobacterium for genetic engineering in plants. Plant cell cultures for the production of important compounds. Plant tissue culture – Micropropagation, protoplast isolation, somatic hybrids. Identification of transformed cells into callus and regeneration of transgenic plants and applications.

UNIT – III MOLECULAR TECHNIQUES:

Polymerase chain reaction – principle, types and applications. Sanger's and Maxam-Gilbert's method for DNA sequencing. DNA Fingerprinting - RAPD, RACE (Rapid Amplification of cDNA Ends), RFLP and AFLP analysis and its application in forensic science. DNA footprinting. Chromosome walking, chromosome jumping. Mutagenicity test – Ames test. Markers linked to drug and disease resistant genes. Antisense technology and its application. Microarray technology: genomic and cDNA arrays.(*https://www.slideshare.net/drmalathi13/molecular-techniques*)

UNIT – IV GENE THERAPY:

Ex-vivo, Invivo, Insitu gene therapy Strategies of gene therapy: Gene augmentation – ADA deficiency, CFTR, Antisense therapy, Ribozymes, Protein Aptamers, Intrabodies. Stem cell therapy - Embryonic and adult Stem Cells, Totipotent, Pluripotent and Multipotent Cells. Testing and generation of embryonic stem cells, Testing for adult stem cells and differentiation, Potential use of stem cells – Cell based therapies.

UNIT – V GENOME PROJECT AND BIOETHICS:

Human genome projects, gene bank. Genetically modified organisms (GMOs) in developed and developing countries. Genetically modified foods – benefits and risks. Bioethics: Laws and regulations in biotechnology, patent laws, and Intellectual property rights (IPR). Biosafety, types of biosafety, advantages and disadvantages. Ethics in cloning and stem cell research.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Therapeutic application of genetic engineering tools:

Discuss on recent techniques in genetic engineering that help understand diseases and treating the same

REFERENCES:

1. Molecular Cloning: A Laboratory manual, J. Sambrook, E.Frisch and T. Maniatis, Old Spring Harbor Laboratory Press New York, 2000
2. DNA Cloning : a Practical Approach, DM Glover and BD Hames, IRL Press
3. Molecular and Cellular methods in Biology and Medicine. PB Kaufman,W.Wu.D Kim and LJ Cseke, CRC
4. DNA Science. A first Course in Recombinant Technology, DA Mickloss and GA Freyer, Cold Spring Harbour Laboratory Press, New York 1990
5. Molecular Biotechnology (2nd Edn) SB Primrose, Blackwell Scientific Pub. Oxford, 1994
6. Milestones in Biotechnology. Classic papers on Genetic Engineering. JA Davies and WS Reznikoff, Butterworth-Heinemann, Boston, 1992
7. Route Maps in Gene Technology, MR Walker and R Rapley, Blackwell Science Ltd, Oxford 1997
8. Molecular Biotechnology. Glick Principles of Gene Manipulation by Old and Primrose, Blackwell publication

COURSE OUTCOME:

- The course covers the fundamentals of genome, gene cloning and gene transfer techniques.
- Students will understand the general plant tissues culture technique along gene therapy strategies.
- Students will understand the basic molecular techniques and techniques involved in the field of forensics.
- The course also covers the human genome project and biosafety levels which enables the students to acquire good laboratory practices.

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First Year **CORE PRACTICAL I** **Semester I**

BIOCHEMICAL TECHNIQUES AND ENZYMOLOGY

Code: **(Practical)** **Credit: 3**

COURSE OBJECTIVES:

- To assay the activity of enzymes from different sources.
- To stimulate their interest in learning the structure, function and kinetics of enzymes and their role as catalyst and regulator of cell metabolism and to serve as foundation for more advanced enzymology courses.

EXPERIMENTS:

1. Estimation of proteins by Lowry / Brad ford method
2. Estimation of phospholipids by phosphorus assay
3. Demonstration of - Estimation of sodium and potassium by Flame photometry
4. Effect of pH, temperature and substrate concentration for amylase and urease and determination of Vmax & Km
5. Effect of inhibitor on activity of any one enzyme
6. Effect of activator on activity of any one enzyme
7. Desalting of proteins by dialysis
8. Separation of polar and non polar lipids by TLC
9. Rf value calculation of various amino acids using TLC and PC
10. Separation of proteins by SDS PAGE

REFERENCES:

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.
6. Laboratory Manual in Biochemistry, Jayaraman, New Age International Pub, 2000.

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First Year **ELECTIVE COURSE I** **Semester I**

1) BIOSTATISTICS

Code: **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

- The course emphasizes various statistical methods and its significance.
- The students are expected to understand the concepts and solve relevant problems pertaining to each topic.
- To provide sufficient background to be able to interpret statistical results in research.

UNIT – I STATISTICAL SURVEY:

Organizing, planning and executing the survey. Source of data - Primary and secondary data, collection, observation, interview, enquiry forms, questionnaire schedule and checklist. Classification and tabulation of data. Diagrammatic and graphical presentation of data.

UNIT – II MEASURES OF CENTRAL TENDENCY:

Arithmetic mean, median, mode, quartiles, deciles and percentiles. Measures of variation - range, quartile deviation, mean deviation, standard deviation, Coefficient of variation. Correlation analysis - Scatter diagram, Karl's Pearson's coefficient of correlation and Spearman's rank method. Regression analysis.

UNIT – III PROBABILITY:

Definition, concepts, theorems (proof of the theorems not necessary) and calculations of probability - Simple problems. Theoretical distributions – Binomial, Poisson and normal distribution - Simple problems (proof of the theorems not necessary).

UNIT – IV SAMPLING DISTRIBUTION AND TEST OF SIGNIFICANCE:

Concepts of sampling, Testing of hypothesis, errors in hypothesis testing, standard error and sampling distribution, sampling of variables (large samples and small samples.). Student's "t"distribution and its applications. Chi-square test and goodness of fit. Analysis of variance - one way and two way classification. Duncan's Multiple Range test. Student’s t test, ANOVA: Comparison of means in one or two groups (student’s t-test). Comparison of means in three or more groups (ANOVA), F- test.

UNIT – V DATA REPRESENTATION & ANALYSIS:

Design of experiment- Completely randomized block design, Randomized block design. Histogram, Stem-&-Leaf Plot, Line Diagram, Frequency Polygon, Frequency Curve, Pie Diagram, Bar Diagrams, Scatter Diagram, Box-&-Whisker Plot, Bubble Plot, Growth chart, Dendrogram, Nomogram, Partogram, Pedigree Chart, Cartogram.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Practice problems: Describing Data, The Normal Distribution, Sampling Distributions, Confidence Intervals, Hypothesis Testing, Proportions, Linear Regression, Survival Analysis.

REFERENCES:

1. Statistical Methods, 4thEdition- Gupta, S.P, Sultan Chand &Son Publishers. 2012.
2. Biostatistical Analysis, 5thEdition- Zar, J.H, Pearson Education, 2010.
3. Biostatistics - Daniel, W.W. A Foundation for Analysis in Health Sciences, 10thEdition, John Wiley and Sons, Inc., 1999.

COURSE OUTCOME:

- Students will able to describe various application area of biostatistics
- Will able to distinguish different types of data and sampling techniques
- To calculate and interpret measures of central tendency and variability in statistical data
- Will able to compute and interpret the result of correlation and regression analysis
- To compare different population sample using ANOVA.

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First Year	ELECTIVE COURSE I 2) NANOTECHNOLOGY	Semester I
Code:	(Theory)	Credit: 4

COURSE OBJECTIVES:

- Understand the principles of drug delivery systems and control of varied parameters for effective drug delivery.
- Gain knowledge on the mode of action of nanoparticle activity inside the cellular structure.
- Inculcate the concepts of advances in Nano therapeutics.

UNIT – I PRINCIPLES OF DRUG DELIVERY SYSTEMS:

Modes of drug delivery, Absorption distribution metabolism excretion characteristics of drugs, Controlled drug delivery - site specific drugs, Barriers for drug targeting - passive and active targeting, Strategies for site specific drug delivery.

UNIT – II TOXICITY ASSAYS AND THEIR PRINCIPLES:

Cell viability, LDH release, ROS production, Morphological observation, Membrane potential, Live/Dead assay, Comet Assay, Cell cycle analysis and Apoptosis detection by flow cytometer

UNIT – III NANOPARTICLES AND CANCER THERAPY:

Cancer and its types: Mechanisms of progression in Cancer: Cellular trafficking, Cancer invasion, Migration, Angiogenesis and Metastasis. Chemotherapy, Immunotherapy, Photodynamic Therapy (PDT), Photothermal Therapy (PTT), Magnetic Hyperthermia (MHT), High Intensity Focused Ultrasound (HIFU).

UNIT – IV TARGETED DRUG DELIVERY:

Classification of targeted drug delivery systems, Bioconjugation, Nanoparticles surface modification - PEGylation, Gold nanoparticles for drug delivery, Magnetic nanoparticles as drug
carriers.

UNIT – V 3D BIO -PRINTING (THREE DIMENSIONAL BIOPRINTING):

Introduction - History, principle and its components, Classification of 3D bioprinting techniques - Extrusion-based bioprinting, Droplet-based bioprinting, Laser-based bioprinting, Design Requirements for 3D Bioprinting- Magnetic Resonance Imaging, Computed Tomography, Computer-Aided Design Based Systems, 3D modeling softwares, Bio inks for 3D bioprinting - Applications of 3D Bioprinting and future trends.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Everyday Materials and Processes. Electronics and IT Applications · Medical and Healthcare Applications · Energy Applications.

REFERENCES:

1. Drug delivery: Principles & applications Wang, B., Hu, L, Siahaan, T.J, John Wiley& Sons, (2016).
2. 3D Bio-printing -Fundamentals, Principles and Applications, Ibrahim T. Ozbolat, Academic Press, (2016).
3. 3D Bio-printing in Regenerative Engineering, Principles and Applications, Ali Khademhosseini, Gulden Camci-Unal, 1st edition, CRC press, (2018).

COURSE OUTCOMES:

On the successful completion of the course, student will be able to:

1. Remember the elemental principles of drug delivery systems
2. Understand the mode of action of nanoparticles and it‘s in vitro toxicity assays
3. Recent developments and understanding the available therapy in cancer treatment
4. Understanding of most recent advances in Nanobiotechnology with novel Techniques.

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First Year | **VALUE ADDED COURSE I DETECTION METHODS OF FOOD ADULTERATION** | **Semester I**

Code: | **(Theory)** | **Credit: 2***

COURSE OBJECTIVES:

- To exemplify different food adulterants
- To elucidate the adulterants in food products

UNIT – I TESTING ADULTERATION OF MILK:

Test A: Adulteration of Milk Physical Tests: Detergent Test Filter Test Flow. Test B: Chemical Tests: Clot on boiling test. Test for starch in Milk Test for cane sugar in Milk Test for Buffaloes Milk in Cow's Milk Test for added colors in Milk Test for skim milk powder in milk Detects the presence of added carbonates and bicarbonates in milk Test for soda in milk. Test for glucose.

UNIT – II ADULTERATION OF GHEE:

Test for vegetable fat: Nitric acid test Soda ash test Valenta test Test for added alkali. Baudouin test. Analysis of butter:Test for Dalda in butter. Adulteration of Khoa: Test for starch in Khoa. Adulteration of Paneer: Presence of starch in paneer.

UNIT – III TESTING ADULTERATION OF OILS:

Test for sesame oil in other oils Halphen test for cottonseed oil Hexa bromide test for linseed oil Test for added mineral oil Test for added castor oil Detection of argemone oil in other oils Test for rancidity in oils Kries test for testing quality of oil.

UNIT – IV TESTING ADULTERATION OF SPICES:

Extraction of flavor. Coriander powder: Test for starch & horse dung power. Chili powder. Test for oil soluble dyes, powdered bran, saw dust and brick powder. Turmeric Powder: Test for metanil yellow and lead chromate polish. Cloves: Test for exhausted cloves. Curry powder: Test for metallic colors.

UNIT – V TESTING ADULTERATION IN SEEDS:

Poppy seeds: Test for Amaranthus seeds. Sajeera: Test for sand, stones and other seeds. Mustard seeds: Visual examination. Pepper: Test for papaya seeds. Saffron: Detection of maize cob tendrils. Cumin seeds; Cinnamon: plant bark.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Visit to the Food processing and analyzing lab. Food and adulteration awareness campaign – know your food quality

REFERENCES:

1. Rapid detection of food adulterants and contaminants Theory and practice. Shyam Narayan Jha. 2015

COURSE OUTCOMES:

After successful completion of the course, students will be able to:

- Understand the adulteration of common foods and their adverse impact on health
- Comprehend certain skills of detecting adulteration of common foods.
- Be able to extend their knowledge to other kinds of adulteration, detection and remedies.

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First Year **CORE COURSE III** **Semester II**

BIOPHYSICAL CHEMISTRY

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- This course will introduce physical techniques commonly used for macromolecular characterization. An emphasis will be placed on the physical principles that underlie each technique.

UNIT – I THERMODYNAMICS:

Thermodynamics - explanation of terms - types of systems - Zeroth law of thermodynamic - concept of heat and work - First law of thermodynamics - internal energy - enthalpy or heat content - Joule's Law - Joule - Thompson effect - inversion temperature and its significance - Second law of thermodynamics - need for the II law - Carnot's cycle - efficiency - carnot's theorem (statement only) - concept of entropy - entropy of an ideal gas - entropy changes in reversible and irreversible processes - Gibbs free energy - Helmholtz free energy - Gibbs & Helmholtz equations - Third Law of Thermodynamics - Nernst heat theorem - absolute entropy.

UNIT – II SOLUTIONS:

Solutions: ideal and non-ideal - Raoult’s law, Henry’s law - Nernst distribution law and its applications - Colligative properties - lowering of vapor pressure, elevation of boiling point, depression of freezing point and osmotic pressure - thermodynamics of ideal solutions.

UNIT – III ELECTROCHEMISTRY:

Electrochemical cells - cell e.m.f. - electrode potential - standard e.m.f. of the cell - Nernst equation - single electrode potentials and cell e.m.f. measurement of single electrode potential - types of electrodes - reference electrodes - standard electrode potential - electrochemical series - Types of electrochemical cells: Chemicals cells - liquid junction potential - salt bridge - Concentration cells - definition - types of concentration cells - examples - e.m.f. of electrolyte concentration cells - applications of e.m.f measurements.

UNIT – IV COLLOIDS:

Colloids: lyophobic and lyophilic colloids - Origin of charge and stability of lyophobic colloids - Coagulation and Schultz-Hardy rule - Zeta potential and Stern double layer 20 (qualitative idea) - Tyndall effect - Electro kinetic phenomenon (qualitative idea only) - Application of colloids Introduction, Self Assembly - Materials and molecules - Self Assembled Monolayers (SAM) - Nano materials:Techniques used in nanochemistry -Types of nanoparticles, Gold, Silver.

UNIT – V SPECTROSCOPY:

Spectroscopy – general introduction - electromagnetic radiation and different regions - absorption spectroscopy - molecular spectra - types of molecular spectra - Vibrational spectra - IR spectra of diatomic molecules - Hooke's law - simple harmonic oscillator force constant - - anharmonic oscillator - applications - force constant determination - vibrational spectra of H_2O and CO_2.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Study of molecules in crystals, in solution, in cells, and in organisms. Discuss on the electronic structure, size, shape, dynamics, polarity, and modes of interaction of biological molecules.

REFERENCES:

1. Physical Chemistry by Amrita Lal De and Abhranil De, Volume I.
2. Principles of Physical Chemistry by S.M. Maron and C.F.Brutton.
3. A text book of Physical Chemistry by P.L. Soni, Dharmarke and Sultan Chand.
4. Principles of Physical Chemistry by B.R. Puri, L.R. Sharma, M.S.Pathania, and Shobanlal Nagin Chand.
5. Essentials of Physical Chemistry by B.S. Bahl and G.D. Tuli, and S. Chand.
6. Physical Chemistry by R.A. Alberty and John-Wiley.
7. Physical Chemistry by Barrow.
8. Elements of Physical Chemistry by S. Glasstone, D.Lewis, and McMillan.
9. Fundamentals of Molecular Spectroscopy by Ban Welt and Taba.
10. Physical Chemistry by P.W. Atkins.
11. Physical Chemistry by G.W. Castellan.

COURSE OUTCOME:

- To know and understand how living organisms acquire and transform energy in order to perform biological work.
- To understand how enzyme catalysis increases reaction rates without altering the chemical equilibrium.
- To become familiar with Langmuir theory, BET theory and their uses, Zeta potential Electro kinetic phenomenon, Donnan equilibrium, Primary and Secondary salt effects.
- To know the latest techniques which are nowadays used in determining the fast reactions.

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First Year	CORE COURSE IV ENZYMOLOGY (Theory)	Semester II
Code:		Credit: 5

COURSE OBJECTIVES:

- Students will obtain basic knowledge about the relationship between properties and structure of the enzymes, their mechanism of action and kinetics of enzymatic reactions.
- Students can understand to compare and contrast the historical uses of enzyme technology with current applications in a diverse range of industries.

UNIT – I INTRODUCTION OF ENZYMES:

Definitions (catalytic power, specificity, reactivity, regulation, Holoenzyme, Apoenzyme, coenzymes and cofactors). Enzyme Nomenclature and IUB system of enzyme classification. Active site- Fisher and Koshland models. Formation of enzyme substrate complex evidence. Basic concepts of bioenergetics: The collision theory, activation energy and transition state theory. Measurement and expression of enzyme activity – enzyme assays, Enzyme units.

UNIT – II ENZYME KINETICS:

Pre-Steady state and Steady state kinetics,. Kinetics of single substrate enzyme catalyzed reaction - Michaelis-Menten (Briggs- Haldane) equation, Double-Reciprocal Plot, Lineweaver Burk plot, and Eadie-Hofstee plot. Determination of Vmax, Km, Kcat, Specificity constant (Kcat/Km) and their significance. Factors influencing enzymatic activity. Kinetics of enzyme reactions having two or more substrates. Single displacement and double displacement reactions**.**

UNIT – III MECHANISM OF ENZYME ACTION AND ENZYME INHIBITION:

Mechanism of enzyme action: Factors contributing to the catalytic efficiency - proximity and orientation, covalent catalysis, acid-base catalysis, metal ion catalysis, strain and distortion theory. Mechanism of action of Lysozyme, Carboxypeptidase, Chymotrypsin and Ribonuclease. Reversible and Irreversible inhibition - Competitive, Non-competitive and mixed inhibition. Substrate inhibition and Feedback inhibition. Therapeutic, diagnostic and industrial applications of enzyme inhibitors.

UNIT – IV INTRODUCTION OF CO-ENZYMES:

Structure and functions – Pyridine and flavin nucleotides, coenzyme A, Pyridoxal phosphate and thiamine pyrophosphate, tetrahydrofolate and B12 Coenzymes. Allosteric Interactions: Enzyme regulation, allosteric enzymes. Allosteric kinetics (MWC and KNF models), symmetry and sequential models. Hill's equation and Hill's coefficient. Isozymes.

UNIT – V MULTIENZYME SYSTEM:

Multifunctional enzymes. Multi-enzyme complexes (Pyruvate dehydrogenase complex, fatty acid synthase and Na - K ATPase), Metalloenzymes. Modern concepts of evolution of catalysts: Catalytic RNA (Ribozymes), abzymes. Immobilized enzymes and their industrial applications. Chemical modification and site-directed mutagenesis of enzymes. Industrial applications of enzymes - food and pharmaceutical enzymes. Biosensors**.**

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Recent advancement in enzyme technology and its applications. Influence of covid-19 infections on the level of enzymes.

REFERENCES:

1. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry, 2nd edition,2008 Trevor Palmer and Philip Bonner
2. Principles of Biochemistry, 1993. A.L. Lehninger, Nelson &Cox (CBS, India) and new edition.
3. Biochemistry, 2004, Donald Voet and Judith Voet, John Wiley and sons. ISBN - 047119350
4. Biochemistry, 5th edition, by Lubert Stryer, New York: W H Freeman; 2002, ISBN-10: 0-7167-3051-0.
5. TextBook of Biochemistry with clinical correlations, 4th edition – Thomas M. Devlin.
6. Text of Biochemistry, 1908 – West &Todd, MacMillian Publications
7. Principles of Biochemistry, by G. L. Zubay, 1995, Wm. C. Brown
8. Biochemistry 2nd edition Christopher K.Mathews and K.E.VanHoldge (1995) (Benjamin and cumming).
9. Enzymes. Dixon and Webb 3rd ed. Longmans, 1979.
10. Enzymes in Food Technology. CRC Press, 2001. Whitehurst RJ.
11. Industrial Enzymes and their applications. Uhlig H. John Wiley, 1998.
12. Fundamentals of enzymology 2nd edition,1989by Nicholas C. Price and Lewis Stevens.

COURSE OUTCOME:

- The student was able to analyze the structure/function relationships in bio catalyzed reactions.
- Students are able to research a contemporary application of enzyme technology or metabolic engineering and present the results in a well-structured oral presentation.
- At the end of the course students will be explored to understand the use of enzymes in medicine, food, organic synthesis, genetics and other areas that favor a wide reach for them.

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First Year **CORE CHOICE COURSE II** **Semester II**

1) GENETICS

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- Identify and describe the process and purposes of the cell cycle, meiosis, and mitosis, as well as predict the outcomes of these processes.
- Transmission genetics problems, make accurate predictions about inheritance of genetic traits, and map the locations of genes
- To identify the parts, structure, and dimensions of DNA molecules, RNA molecules, and chromosomes, and be able to categorize DNA as well as describe how DNA is stored
- To describe what causes and consequences of DNA sequence changes and how cells prevent these changes, as well as make predictions about the causes and effects of changes in DNA
- To describe applications and techniques of modern genetic technology, as well as select the correct techniques to solve practical genetic problems

UNIT – I INTRODUCTION TO GENETICS:

Brief history/basic concepts of genetics. Mendelian genetics/monohybrid, dihybrid cross. Mendelian genetics/trihybrid cross, probability. Modification of Mendelian ratios/incomplete and codominance. Modification of Mendelian ratios/incomplete and codominance. Structure of Gene - Interaction of Gene - Commentary Factors, Supplementary Factors, Inhibitory and Lethal Factors - Atavism. ***(https://www.slideshare.net/vanessaceline/intorduction-to-genetics)***

UNIT – II CHROMOSOME ABNORMALITIES:

Diploid chromosomes number- Sex differentiation and sex determination. The X chromosomes, Barr bodies, the Lyon hypothesis. Aneuploidy and polyploidy: Gene deletion, duplication, inversions and translocation. Sex Linkage in Drosopohila and Man, Sex Influenced and Sex Limited Genes - Non-Disjunction and Gynandromorphs - Cytoplasmic Inheritance - Maternal Effect On Limnaea (Shell Coiling), Male Sterility (Rode's Experiment).CO2 sensitivity In Drosophila, Kappa particles in Paramecium, Milk Factor in Mice**.**

UNIT – III BLOOD GROUPS AND CROSSING OVER:

Blood Groups and their Inheritance in Human - Linkage and Crossing Over:- Drosophila - Morgans' Experiments - Complete and Incomplete Linkage, Linkage Groups, Crossing Over types, Mechanisms - Cytological Evidence for Crossing Over, Mapping of Chromosomes - Interference and Coincidence.

UNIT – IV NATURE AND FUNCTION OF GENETIC MATERIAL:

Fine Structure of the Gene - Cistron, Recon, Muton - Mutation - Molecular Basis of Mutation, Types of Mutation, Mutagens, Mutable and Mutator Genes. Chromosomal Aberrations - Numerical and Structural Examples from Humans.

UNIT – V APPLIED GENETICS:

Animal Breeding - Heterosis, Inbreeding, OutBreeding, OutCrossing, Hybrid Vigor. Population Genetics, Evolutionary genetics, Hardy Weinberg Law - Gene Frequency, Factors Affecting Gene Frequency, Eugenics, Bioethics**.** ***(www.goldiesroom.org/...)***

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Practice problems: Genetic Principles and their application in medical practice; Case studies (Interacting with patients, learning family history and drawing pedigree chart); Syndromes and disorders: definition and their genetic basis - Cystic fibrosis and Tay Sachs Syndrome; Phenylketonuria and Galactosemia; Ethical issues with clinical genetics.

REFERENCES:

1. Genetics by Verma, P.S. and V. K.Aggarwal.
2. Genetics by Russell P.J.
3. Genetics analysis and principles by Brooker R.J and McGraw Hill.
4. Basic Genetics my Miglani G.S.
5. Genetics: Analysis of genes and genomes by Hartl D.L and Jones E.W.

COURSE OUTCOMES:

- Identify and describe the process and purposes of the cell cycle, meiosis, and mitosis, as well as predict the outcomes of these processes.
- Transmission genetics problems, make accurate predictions about inheritance of genetic traits, and map the locations of genes.
- To identify the parts, structure, and dimensions of DNA molecules, RNA molecules, and chromosomes, and be able to categorize DNA as well as describe how DNA is stored.
- To describe what causes and consequences of DNA sequence changes and how cells prevent these changes, as well as make predictions about the causes and effects of changes in DNA.
- To describe applications and techniques of modern genetic technology, as well as select the correct techniques to solve practical genetic problems.
- To carry out genetics laboratory and field research techniques.
- To describe experimental results in written format both informally and in formal manuscript format.
- To accurately diagram and describe the processes of replication, transcription, translation, as well as predict the outcomes of these processes.

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First Year **CORE CHOICE COURSE II** **Semester II**

2) ENDOCRINOLOGY

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- Study the molecular mechanisms of hormone and growth factors action.

UNIT – I BASICS OF ENDOCRINE SYSTEM:

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 ENDOCRINES OF HYPOTHALAMUS AND THYROID GLAND:

The Endocrines of Hypothalamus - Neurovascular hypothesis. Somatostatin. Pituitary gland hormones- chemistry and biochemical functions. Thyroid gland hormones- chemistry- biochemical functions- mechanism of action. Parathyroid glands- biochemical functions. Hormones involving in calcium metabolism- chemistry- mechanism of action.

UNIT – III HORMONES OF ADRENAL AND PANCREAS:

Adrenal gland: Hormones of adrenal gland- chemistry- mechanism of action biochemical functions. Pancreas- Insulin/glucagon: chemistry- biochemical functions- mechanism of action. Neuro-hormones- the brain-renin-angiotensin.

UNIT – IV 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 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.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Discussion on recent research in key human endocrine disorders

REFERENCES:

1. Lehninger's Principle of Biochemistry.: Nelson Cox. 3rd ed. MacMillian Worth Publ. 2000. 2. Endocrinology: Mac E. Hadely. 5th ed. Pearson Education, 2000.
2. Henry M. Kronenberg, Shlomo Melmed, Kenneth S. Polonsky, P. Reed Larsen. William Textbook of Endocrinology, 11th ed. Saunders Elsevier 2008 2. Bolander, F. F. Molecular Endocrinology, III ed. Academic Press, 2004.

COURSE OUTCOMES:

- Students will be able to identify the organs involved in endocrine function, will know the major hormones that are produced by these organs and will know the physiological effect of these hormones.
- Students will be able to understand key human endocrine disorders.

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First Year | **CORE PRACTICAL II MOLECULAR AND MICROBIAL TECHNIQUES** | **Semester II**

Code: | **(Practical)** | **Credit: 3**

COURSE OBJECTIVES:

- To introduce students to various practical aspects of Molecular biology.

EXPERIMENTS:

1. Isolation of plasmid & Genomic DNA
2. Estimation of DNA by diphenylamine method
3. Estimation of RNA by orcinol method
4. Separation of DNA by Agarose Gel Electrophoresis
5. Purification of enzyme by ammonium sulphate precipitation Microbial Techniques
6. Staining technique - Gram's staining
7. Determination of bacterial growth curve
8. Media preparation and Culture techniques - pour plate, spread plate and streak plate method
9. Antibiotic Resistance
10. Biochemical Characterization of Bacteria

1. Indole test
2. Methyl Red test
3. Triple Sugar Iron Agar test
4. Voges Proskauer test
5. Citrate Utilization test
6. Catalase test
7. Urease test
8. Oxidase test
9. Nitrate test

REFERENCES:

1. Manuals in Biochemistry – Dr. J. Jayaraman, New Age International Pub, 2000.
2. Instrumental Methods of Chemical Analysis Bk.Sharma, Goel publications, Meerut, 2000
3. Laboratory Manual in Bio Chemistry, Jayaraman, New Age International Pub, 2000.
4. Laboratory manual in Biochemistry T.N.Pattabiraman. All India publishers, 1998.
5. Lab Manual in General Microbiology - N Kannan, Palaniappa Brothers, 2000.
6. Lab Manual in Microbiology - Dr P Gunasekaran, New Age International Pub, 2000.

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First Year | **ELECTIVE COURSE II** | **Semester II**

1) BIOINFORMATICS

Code: | **(Theory)** | **Credit: 4**

COURSE OBJECTIVES:

- The purpose of studying this paper is to apply computational facilities in different fields of life sciences, physical and chemical sciences.
- After completion, students could learn drug designing through computer based modification programs using synthetic or natural sources.
- Most important application of Bioinformatics is in the field of drug discovery where it reduces more than 60% of the time, money and labor.

UNIT – I BIOINFORMATICS:

An overview, Definition & History; Bioinformatics databases & tools on the Internet- NCBI, EBI, PIR, Swiss-Prot, GenBank ; pattern and motif searches- BLOCKS, PRINTS, PFAM

UNIT – II PROTEINS AMINO ACIDS:

Levels of protein structure – Ramachandran Plot. Protein Secondary structure prediction - Chou-Fasman rules, Gamier-Osguthorpe-Robson (GOR) methods; Predicting 3D structure – homology modeling, threading - fold recognition and ab initio methods -- Rosetta – CASP.

UNIT – III BIOLOGICAL SEQUENCE ANALYSIS:

Pairwise sequence comparison – Sequence queries against biological databases – BLAST and FASTA - Multiple sequence alignments –Phylogenetic alignment.
Algorithms and Matrices: Scoring matrices- PAM and BLOSUM; dynamic programming Algorithms, Needleman and Wunsch, Smith-Waterman;

UNIT – IV PROTEIN STRUCTURE VISUALIZATION TOOLS:

Ras Mol, HEX, Argus Lab Swiss PDB Viewer - Structure –Classification, alignment and analysis – SCOP, CATH, FSSP, UNIX.

UNIT – V FUNCTIONAL GENOMICS (METABOLISM AND REGULATION) IN BIOCHEMISTRY:

Sequencing genomes– Genome databases on the web, Prokaryotic Genome Database with comparison with Human genome, HGP, GENE CLUSTER, DNA Microarray, SWISS-2DPAGE Database, TIGR, WIT, CYTOSCAPE and DRUG DISCOVERY.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Model Predictions: Using Bioinformatics tools to predict protein models in disease related pathways.

REFERENCE:

1. Bioinformatics-Sequence and Genome Analysis- David W.Mount, Cold Spring Harbor
2. Laboratory Press (2004).
3. Introduction to Bioinformatics, Attwood, T.K. and D.J. Parry-Smith, Pearson Education Ltd., New Delhi (2004).
4. Bioinformatics – Westhead, D.R., Paris J.H. And R.M. Twyman, Instant Notes: Viva Books Private Ltd, New Delhi (2003).
5. Introduction to Bioinformatics, Arthur M. Lesk, Oxford University Press, New Delhi (2003).
6. Bioinformatics- Sequence, structure and databanks, Higgins D. and W. Taylor (Eds), Oxford University Press, New Delhi (2000).
7. Bioinformatics; A practical Guide to the Analysis of Genes and Proteins, Wiley- Interscience, Baxevanis, A. and B.F. Ouellette , Hoboken, NJ (1998).
8. Introduction to computational Biology, Michael, S. Waterman, Chapman & Hall, (1)

COURSE OUTCOME:

- To get introduced to the basic concepts of Bioinformatics and its significance in Biological data analysis.
- Explain about the methods to characterize and manage the different types of Biological data.
- Introduction to the basics of sequence alignment and analysis.

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First Year **ELECTIVE COURSE II** **Semester II**

2) GENOMICS AND PROTEOMICS

Code: **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

- The objective of this course is to provide introductory knowledge concerning genomics, proteomics and their applications.

UNIT – I BASICS OF GENOMICS AND PROTEOMICS:

Brief overview of prokaryotic and eukaryotic genome organization; extra-chromosomal DNA: bacterial plasmids, mitochondria and chloroplast.

UNIT – II GENOME MAPPING:

Genetic and physical maps; markers for genetic mapping; methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques, FISH technique in gene mapping, somatic cell hybridization, radiation hybrid maps, *in situ* hybridization, comparative gene mapping.

UNIT – III GENOME SEQUENCING PROJECTS:

Human Genome Project, genome sequencing projects for microbes, plants and animals, accessing and retrieving genome project information from the web.

UNIT – IV COMPARATIVE GENOMICS:

Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing, SNPs; use of genomes to understand evolution of eukaryotes, track emerging diseases and design new drugs; determining gene location in genome sequence.

UNIT – V PROTEOMICS:

Aims, strategies and challenges in proteomics; proteomics technologies: 2D-PAGE, isoelectric focusing, mass spectrometry, MALDI-TOF, yeast 2-hybrid system, proteome databases.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Functional genomics and proteomics: Transcriptome analysis for identification and functional annotation of gene, Contig assembly, chromosome walking and characterization of chromosomes, mining functional genes in genome, gene function- forward and reverse genetics, gene ethics; protein-protein and protein-DNA interactions; protein chips and functional proteomics; clinical and biomedical applications of proteomics; introduction to metabolomics, lipidomics, metagenomics and systems biology.

REFERENCES:

1. Primrose, S. B., Twyman, R. M., Primrose, S. B., & Primrose, S. B. (2006).
2. *Principles of Gene Manipulation and Genomics*. Malden, MA: Blackwell Pub.
3. Liebler, D. C. (2002). *Introduction to Proteomics: Tools for the New Biology.* Totowa, NJ: Humana Press.
4. Campbell, A. M., &Heyer, L. J. (2003). *Discovering Genomics, Proteomics, and*
5. *Bioinformatics*. San Francisco: Benjamin Cummings.

COURSE OUTCOMES:

- Students should be able to acquire knowledge and understanding of fundamentals of genomics and proteomics, transcriptomics and metabolomics and their applications in various applied areas of biology.

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First Year **NON-MAJORE ELECTIVE COURSE I** **Semester II**

CLINICAL BIOCHEMISTRY

Code: **(Theory)** **Credit: 2**

COURSE OBJECTIVES:

- To impart thorough knowledge about the biochemical basis of various diseases and disorders.
- To study various diagnostic and therapeutic methodologies available for diseases and disorders.

UNIT – I BIOCHEMICAL LABORATORY - ROUTINE ANALYSIS IN URINE AND BLOOD:

Introduction to Biochemical laboratory: Roles of biochemical laboratory, Mechanization and automation in clinical biochemistry. Quality control in clinical laboratories - Total laboratory uncertainty, accuracy and precision. Selection and optimization of laboratory methods. Clinical evaluation of laboratory methods. Biochemical analysis in blood and urine. Analysis of proteins - Plasma protein spectrum during inflammation, paraproteins. Blood gasses. Electrolytes and acid – base balance. Regulation of electrolyte content of body fluids and maintenance of pH reabsorption of electrolytes. Acidosis & Alkaloids and their determination in the clinical laboratory.

UNIT – II DISORDERS OF CARBOHYDRATE AND PROTEIN METABOLISM:

Disorders of carbohydrate metabolism- Glucose level in normal blood, renal threshold, hyper and hypoglycemia and glycosuria - qualitative tests for sugars in urine - intravenous and other types of glucose tolerance tests - fructose levels in blood, lab diagnosis of early and latent diabetes mellitus - diabetic coma, secondary degenerative changes associated with diabetes mellitus. Glycogen storage disorders, Pentosuria, and galactosemia.

UNIT – III DISORDER OF PROTEIN METABOLISM:

Agammaglobulinemia, Alpha – fetoprotein, Amyloidosis. Cryoglobulinemia. Hypo and hyper immune gamma – globulinemia. Abnormalities in Nitrogen Metabolism – uremia and factors affecting nitrogen balance, porphyrias and porphyrinuria.

UNIT – IV DISORDERS OF LIPIDS AND INBORN ERRORS OF METABOLISM:

Disorders of lipids: Plasma lipoproteins, cholesterol, triglycerides & phospholipids in health and disease. Hyperlipidemia, hyperlipoproteinemia, ketone bodies, fatty liver. Major Cardiovascular diseases – Atherosclerosis – risk factors, pathogenesis. Laboratory diagnosis of acute myocardial infarction. Inborn error of metabolism: Phenylketonuria, alkaptonuria, albinism, tyrosinosis, maple syrup urine disease, Leish – Nyhan syndrome, Histidinemia, Gaucher's disease, Tay – sachs and Niemann – Pick disease.

UNIT – V DISORDERS OF LIVER AND KIDNEY:

Hepatobiliary system - Hepatobiliary function tests - lab findings and differential diagnosis of jaundice - metabolism of bilirubin - cirrhosis, hepatic coma, hepatitis, gallstones, cholecystitis and tumors. Diagnostic Enzymes – Enzymes in health and diseases. Excretory system - Renal function tests - Biochemical changes and laboratory findings in acute and chronic renal failure - clearance of tests - urinary calculi, renal hypertension - principles of peritoneal and hemodialysis. Blood and coagulation - disturbances of blood clotting mechanisms - systematic analysis of hemorrhagic disorders - coagulation and prothrombin time, determination - haemoglobin-anemia - abnormal hemoglobins and their identification.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Diagnosis: Laboratory diagnosis and investigations related to disorders of thyroid, pituitary, adrenal cortex, adrenal medulla, testes, ovaries - plasma and urinary assays of hormones related to various endocrine disorders.

REFERENCES:

1. Clinical Biochemistry, 5th Edition, Gaw , Murphy , Srivastava and Cowan , O'Reilly, 2013, ISBN: 9780702051791.
2. Rodney F. Boyer - (2010). Biochemistry Laboratory: Modern Theory and Techniques, 2thedition, Pearson Prentice Hall.
3. Undurti N. Das - (2011). Molecular Basis of Health and Disease, 1stedition, Springer.
4. Nanda Maheshwari – (2008). Clinical biochemistry, 1stedition, JAYPEE.
5. MN Chatterjea, Ranashinde – (2012). Textbook of Medical Biochemistry, 8thedition, JAYPEE.
6. By William J. Marshall, S. K. Bangert – (1995). Clinical Biochemistry: Metabolic and Clinical Aspects, 1stedition, Churchillivingstone.
7. Michael Lieberman, Allan D. Marks – (2009). Marks'Basic Medical Biochemistry: A Clinical Approach, 3rdedition,Lippincott Williams &Wilkins.

COURSE OUTCOMES:

- The students will understand the basic concepts and principles of various diseases, and on the various biological specimens including the process of collection, preservation and storage.
- The students will understand the etiology, types, clinical manifestations and treatment of various metabolic disorders of carbohydrate, protein and lipids.
- The students will understand the pathophysiological processes responsible for common inherited disorders.

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Second Year **CORE COURSE V** **Semester III**

METABOLISM AND REGULATION

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- To learn the metabolism and integration of biomolecules that takes place in the human system.
- Integrate the various aspects of metabolism & their regulatory pathways.
- Students can understand the fundamental energetic of biochemical processes.
- To elaborate the relation between biochemical defects and metabolic disorders.
- To follow the organization of signaling pathways.

UNIT – I INTRODUCTION:

Overview of major classes of biomolecules, forces stabilizing biomolecules. General scheme of metabolism, historical and experimental details in derivation of a metabolic pathway, catabolic, anabolic and amphibolic pathways. Oxidative phosphorylation. Electron transport chain. Standard free energy change of a chemical reaction, redox potentials, ATP and high energy phosphate compounds.

UNIT – II CARBOHYDRATES METABOLISM:

Glycolysis and gluconeogenesis – pathway, key enzymes and co-ordinate regulation. The citric acid cycle and its regulation. The pentose phosphate pathway. Metabolism of glycogen and regulation. Key junctions in metabolism– glucose-6-phosphate, pyruvate and acetyl CoA. Blood glucose homeostasis– role of tissues and hormones.

UNIT – III AMINO ACID METABOLISM:

Biosynthesis and degradation of amino acids and their regulation. Transamination and deamination, ammonia formation, the urea cycle and regulation of ureogenesis.

UNIT – IV LIPIDS METABOLISM:

Lipogenesis: biosynthesis of fatty acid, triglycerides, phospholipids, and cholesterol. Regulation of triacylglycerol, phospholipids and cholesterol biosynthesis. Oxidation of lipids. Role of carnitine cycle in the regulation of β - oxidation. Cholesterol Catabolism, Ketogenesis and its control. Lipoprotein metabolism - exogenous and endogenous pathways.

UNIT – V NUCLEIC ACID METABOLISM:

Biosynthesis and catabolism of purines and pyrimidines and their regulation. (https://www.slideshare.net/senchiy/nucleic-acids-and-nucleotide)

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Current aspects on metabolism: metabolic changes after covid-19 infections.

REFERENCES:

1. Biochemistry – L. Stryer.
2. Principles of Biochemistry – R. Horton et al.
3. Lehninger's Principles of Biochemistry - D. L. Nelson and M. M. Cox.
4. Harpers Biochemistry- R. K. Murray et al.
5. Principles of Biochemistry- G. L. Zubay.
6. Outlines of biochemistry- Lippincott.

COURSE OUTCOMES:

- To learn the metabolism and integration of biomolecules that takes place in human system.
- Integrate the various aspects of metabolism & their regulatory pathways
- Students can understand the fundamental energetics of biochemical processes
- To understand the relation between biochemical defects and metabolic disorders.
- To understand the organization of signaling pathways.
- To understand the role of membrane processes in metabolism
- Overall, gaining an understanding of the processes of metabolic transformation at the molecular level and how these processes are studied.
- Afford students opportunity to appreciate the relevance/applications of biochemistry in our daily activities.

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Second Year **CORE COURSE VI** **Semester III**

CLINICAL BIOCHEMISTRY

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- The course aims to provide an advanced understanding of the biochemical mechanisms and pathophysiological processes responsible for common biochemical disorders.
- The course provides an overview of normal and abnormal metabolic functions, the impact of disorders on metabolic processes, an overall picture about the molecular basis of diseases and novel strategies to prevent the diseases

UNIT – I BIOCHEMICAL LABORATORY - ROUTINE ANALYSIS IN URINE AND BLOOD:

Introduction to Biochemical laboratory: Roles of biochemical laboratory, Mechanization and automation in clinical biochemistry. Quality control in clinical laboratories - Total laboratory uncertainty, accuracy and precision. Selection and optimization of laboratory methods. Analysis of proteins - Plasma protein spectrum during inflammation, paraproteins. Blood gases. Acidosis & **Alkalosis** and their determination in clinical laboratory

UNIT – II DISORDERS OF CARBOHYDRATE METABOLISM:

Disorders of carbohydrate metabolism- Glucose level in normal blood, renal threshold, hyper and hypoglycemia and glycosuria - intravenous and other types of glucose tolerance tests - fructose levels in blood, Diabetes mellitus-types, causes and symptoms-lab diagnosis of early and latent diabetes mellitus - diabetic coma, secondary degenerative changes associated with diabetes mellitus. Glycogen storage disorders, Pentosuria, and galactosemia.

UNIT – III DISORDER OF PROTEIN AND LIPID METABOLISM:

Agammaglobulinemia, Alpha – fetoprotein, Amyloidosis. Cryoglobulinemia. Hypo and hyper immune gamma – globulinemia. Abnormalities in Nitrogen Metabolism – uremia and factors affecting nitrogen balance, porphyrias and porphyrinuria. Disorders of lipids: Plasma lipoproteins, cholesterol, triglycerides & phospholipids in health and disease. Hyperlipidemia, hyperlipoproteinemia, ketone bodies, fatty liver. Major Cardiovascular diseases – Atherosclerosis – risk factors, pathogenesis. Laboratory diagnosis of acute myocardial infarction. Inborn error of metabolism: Phenylketonuria, alkaptonuria, albinism, tyrosinosis, maple syrup urine disease, Lesch – Nyhan syndrome, Histidinemia, Gaucher's disease, Tay – sachs and Niemann – Pick disease.

UNIT – IV DISORDERS OF LIVER AND KIDNEY:

Hepatobiliary system - Hepatobiliary function tests - lab findings and differential diagnosis of jaundice - metabolism of bilirubin - cirrhosis, hepatic coma, hepatitis, gallstones, cholecystitis and tumors. Diagnostic Enzymes – Enzymes in health and diseases.

Excretory system - Renal function tests - Biochemical changes and laboratory findings in acute and chronic renal failure - clearance of tests - urinary calculi, renal hypertension - principles of peritoneal and hemodialysis.

UNIT – V DISORDERS OF ENDOCRINE SYSTEM:

Blood and coagulation - disturbances of blood clotting mechanisms -hemophilia, systematic analysis of hemorrhagic disorders - coagulation and prothrombin time, determination - haemoglobin-anaemia - abnormal hemoglobins - thalassemia and sickle cell anemia. Endocrine system: Laboratory diagnosis and investigations related to disorders of thyroid, pituitary, adrenal cortex, adrenal medulla, testes, ovaries - plasma assays of hormones related to various endocrine disorders.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Seminar talks on recent research topics in diabetes and cardiovascular diseases.

REFERENCES:

1. Rodney F. Boyer - (2010). Biochemistry Laboratory: Modern Theory and Techniques, 2th edition, Pearson Prentice Hall.
2. Undurti N. Das - (2011). Molecular Basis of Health and Disease, 1stedition, Springer.
3. Nanda Maheshwari – (2008). Clinical biochemistry, 1stedition, JAYPEE.
4. MN Chatterjea, Ranashinde – (2012). Textbook of Medical Biochemistry, 8thedition, JAYPEE.
5. By William J. Marshall, S. K. Bangert – (1995). Clinical Biochemistry: Metabolic and Clinical Aspects, 1stedition, Churchillivingstone.
6. Michael Lieberman, Allan D. Marks – (2009). Marks' Basic Medical Biochemistry: A Clinical Approach, 3rdedition, Lippincott Williams &Wilkins.

COURSE OUTCOMES:

- The students will understand the basic concepts and principles of Clinical Biochemistry, detail on the various biological specimens including the process of collection, preservation and storage.
- The students will understand the aetiology, types, clinical manifestations and treatment of various metabolic disorders of carbohydrate, protein and lipids.
- The students will understand the pathophysiological processes responsible for common inherited disorders

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Second Year **CORE CHOICE COURSE III** **Semester III**

1. ECOLOGY AND ENVIRONMENTAL BIOLOGY

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- To study the ecological factors, structure and function of the ecosystem.
- To study about biodiversity and natural resources in the Biosphere.
- To understand the causes, effects and control measures of pollution.

UNIT – I ECOLOGY:

Definition, principle, branches and scope of ecology. Ecological factor: Abiotic – Physical and chemical factors: Soil, air, water, temperature, pH, humidity, radiation, wind, pressure, precipitation. Biotic – Limiting factors – Species interaction: Commensalism, amensalism, mutualism, competition, parasitism, prey-predator relationship. Basic components of an ecosystem – structure and functional aspects of an ECOSystem, Trophic structure – Ecological Niche.

UNIT – II POPULATION:

Population: definition, characteristics, population density, natality, mortality, age distribution, growth patterns, population fluctuation, population equilibrium, biotic potentials, population dispersion and regulation of population. Ecological succession types, process, climax and significance of succession. Food chain – types of food chain with examples, food web, energy flow, ecological pyramid of biomass.

UNIT – III ECOSYSTEM:

Definition, concept, structure and function of an ecosystem: producers, consumers and decomposers. Primary and secondary productivity. Ecosystem types: Terrestrial – forest, mountain, deserts and grassland. Aquatic – Freshwater (lentic and lotic) and marine (Estuary, mangroves, corals, deep sea).

UNIT – IV BIODIVERSITY:

Definition, concept and types of biodiversity. Introduction to taxonomy. Biogeographical classification in India. Values of biodiversity. Status of biodiversity – Global, national and local status. Hot-spots of biodiversity. Endangered and threatened species. Strategies for biodiversity conservation – In-situ and Ex-situ conservation, Cryopreservation, Gene banks, Gene pool and species conservation. National parks and sanctuaries. Common flora and fauna in India. Bioprospecting.

UNIT – V ENVIRONMENTAL SCIENCE:

Definition, principle and scope of Environmental science. Earth, man and Environment interactions. Geographical classification and zones. Significance of Atmosphere, lithosphere and Hydrosphere. Biosphere – global distribution of

plant biomes, spatial distribution of animals – zoogeographic realms. Environmental pollution: definition types (Air, water and soil). Biogeochemical Cycles.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):
Seminar talks on recent research topics in Ecology, Biodiversity and Environmental issues.

REFERENCES:

1. Aguirre, A. Alonso. "Biodiversity and human health" EcoHealth 6.1, (2009): 153-156
2. Asthana, DK and Meera Asthana, (2014). A Textbook of Environmental Studies. S. Chand Publication, New Delhi
3. Begon M, Townsend CR & Harper JL, (2006). Ecology: from individuals to ecosystems
4. Daniel chiras, (2001). Environmental Science, 6th Edition. Jones and Bartket publishers
5. Jørgensen SE and Johnson I, (1981). Principles of Environmental Science and Technology. By Copenhagen, Denmark
6. Ranveer Kumar, BS Singh and MP Singh, (2012). Walter pollution and Environment. Enkay Publishing House
7. Sharma PD, (2003). Ecology and Environment. Rastogi Publication, Meerut 8. Shormila Mukherji, (2004). Fragile Environment, Manak publication Pvt. Ltd. New Delhi
8. Singh JS, Singh SP and SR Gupta, (2008). Ecology, Environmental and Resource conservation. Anamaya Publishers, India
9. Smith R and Smith RM, (2000). Ecology and Field Biology. (6th ed.). Prentice Hall
10. Subramanian V, (2002). A Text Book on Environmental Science. Narosa Publishing House. New Delhi
11. Suresh K. Dhameja, (2003). Environmental Science and Engineering, S.K.Kataria & Sons Publishers and Distributors, New Delhi

COURSE OUTCOMES:

- This course will provide an understanding of the major factors influencing the geographic distribution of species.
- Be able to understand the ecological context in which a particular species may have evolved, or a specific ecological process takes place.

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Second Year **CORE CHOICE COURSE III** **Semester III**

2. DEVELOPMENTAL BIOLOGY

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- Understand the molecular and cellular mechanisms of development and learn about basic embryology.

UNIT – I INTRODUCTION TO EVOLUTION:

Emergence of evolutionary thoughts: Lamarks; Darwin – concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; spontaneity of mutations; the evolutionary synthesis, Origin of cells and unicellular evolution; Origin of basic biological molecules; abiotic synthesis of organic monomers and polymers; concept of Oparin and Haldane; experiment of Miller (1953); the first cell; evolution of prokaryotes; origin of eukaryotic cells; evolution of unicellular eukaryotes; anaerobic metabolism, photosynthesis and aerobic metabolism.

UNIT – II CONCEPTS OF DEVELOPMENT:

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting.

UNIT – III FERTILIZATION IN ANIMALS AND PLANTS:

Gametogenesis, Fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination.

UNIT – IV DEVELOPMENT OF ANIMALS:

Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila, organogenesis – vulva formation in Caenorhabditiselagans; eye lense induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination.

UNIT – V DEVELOPMENT OF PLANTS:

Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; lead development and phyllotaxy; transition to flowering, floral development in Arabidopsis and Antirrhinum.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Recent advances in Developmental Biology. Short talk presenters and detailed discussion of original research articles in class.

REFERENCES:

1. Developmental Biology (Looseleaf), 10th Edition, Scott F. Gilbert, Sinauer Associates, Inc., 2013, ISBN: 978-1605351926.
2. Principles of Development. 3rdedition, by L. Wolpert, 2006, Oxford University press, incorporated; ISBN: 9780198709886.
3. Developmental Biology. 3rdedition, by Lewis Wolpert, 2006, Oxford University Press, USA; ISBN: 1405122161
4. Developmental Biology, 6th edition by Scott Gillbert, 2000, Sunderland (MA): Sinauer Associates; ISBN-10: 0-87893-243-7
5. Evolutionary developmental biology, 2ndedition by Brain K. Hall.1998, Springer; ISBN-10: 0412785803

COURSE OUTCOMES:

Upon completion of this course, the students will be able to

- To understand the basic concepts and theories related to developmental biology
- Understand reproductive organs, gametogenesis and fertilization
- Understand the concept of cell differentiation and gene action in development

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Second Year	CORE PRACTICAL III CLINICAL BIOCHEMISTRY	Semester III
Code:	(Practical)	Credit: 3

COURSE OBJECTIVES:

- To study the various diagnostic and therapeutic methodologies available for diseases and disorders.

EXPERIMENTS:

I - Hematological studies

1. Blood Grouping and Rh typing.
2. Estimation of hemoglobin content.
3. Total RBC count.
4. Total WBC count.
5. Determination of clotting time
6. Total platelet count.
7. Determination of Prothrombin time
8. Determination of ESR.

II - Biochemical analysis of urine & blood

Collection, preservation (blood and urine)

1. Estimation of blood glucose
2. Estimation of serum total proteins and A: G ratio
3. Estimation of serum cholesterol
4. Estimation of blood and urine urea
5. Estimation of serum and urine calcium
6. Estimation of serum and urine uric acid
7. Estimation of serum bilirubin.
8. Estimation of serum creatinine
9. Estimation of serum AST / ALT
10. Estimation of serum acid phosphatase / alkaline phosphatase

III - Urology

Urine- Qualitative tests of urine. Abnormal constituents - Reducing sugar-Benedict test, protein: -Heat and acetic acid test, and sulfosalicylic acid method, Ketone bodies-Rothera's test, Bile pigment (Fouchet method), bile salt (Hay's test), Urobilinogen-Ehrlich aldehyde test and Bence Jones protein test.

IV Paper electrophoresis of serum proteins

REFERENCES:

1. Practical Clinical Biochemistry- Varley's by Alan H Gowenlock, 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, VarunkumarMalhotra, Jaypee Bros, 1986.
4. Laboratory Manual in Biochemistry, Jayaraman, New Age International Pub, 2000.
5. Medical Lab Technology Vol I & II, Kanai L Mukerjee New Delhi: Tata Mcgraw Hill Publishing Company, 1996.
6. Practical Biochemistry – Plummer, New Delhi: Tata Mcgraw Hill Publishing Company, 2000.
7. Introductory practical Biochemistry – S.K. Sawhney, Randhir Singh, 2nd ed, 2005.

COURSE OUTCOMES:

- To learn about tests carried out for biochemical investigations.
- Understanding of principle of biochemical Clinical biochemistry tests.
- To learn normal ranges and abnormal ranges of biochemical components and hormones.
- To study diseases related to biochemical and hormone imbalance in the human body.

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Second Year **ELECTIVE COURSE III** **Semester III**

1. BIOETHICS AND IPR

Code: **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

- To discuss various aspects of biosafety regulations, IPR and bioethic concerns arising from the commercialization of biotech products.

UNIT – I BIOSAFETY AND RISK ASSESSMENT ISSUES:

Regulatory framework; National biosafety policies and law, The Cartagena protocol on biosafety, WTO and other international agreements related to biosafety, Cross border movement of germplasm; Risk management issues - containment.

UNIT – II GENERAL PRINCIPLES FOR THE LABORATORY AND ENVIRONMENTAL BIOSAFETY:

Health aspects; toxicology, allergenicity, antibiotic resistance, etc; Impact on environment: gene flow in natural and artificial ecologies; Sources of gene escape, tolerance of target organisms, creation of superweeds/superviruses, etc.

UNIT – III ECOLOGICAL ASPECTS OF GMOS AND IMPACT ON BIODIVERSITY:

Monitoring strategies and methods for detecting transgenics; Radiation safety and non isotopic procedure; Benefits of transgenics to human health, society and the environment.

UNIT – IV THE WTO AND OTHER INTERNATIONAL AGREEMENTS:

Intellectual properties, copyrights, trademarks, trade secrets, patents, geographical indications, etc; Protection of plant variety and farmers right act; Indian patent act and amendments.

UNIT – V PATENT FILING; CONVENTION ON BIOLOGICAL DIVERSITY:

Implications of intellectual property rights on the commercialization of biotechnology products.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Study the philosophical, social, and legal issues arising in medicine and the life sciences. Discuss on the rights given to persons over the creations of their minds.

REFERENCES:

1. Bioethics. 1. “Bioethics” by Nancy S Jecker. “Bioethics” Book Review: This book is designed for advanced undergraduate and postgraduate students.
2. IPR, Biosafety and Bioethics. 1. “IPR, Biosafety and Bioethics” by Goel and Parashar.

COURSE OUTCOMES:

- It will help to address important questions emerging in practice and research in healthcare and biological sciences as well as other allied fields.

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Second Year **ELECTIVE COURSE III** **Semester III**

2. PHARMACEUTICAL CHEMISTRY

Code: **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

To enable the students

- Study the general metabolism of drugs.
- Evaluate their clinical importance and effects by bioassays.

UNIT – I ABSORPTION, DISTRIBUTION AND METABOLISM OF DRUGS:

Sedatives, Analgesics, NSAIDS, Antidepressants, Anxiolytics, Anticonvulsants, Antihistamines, Local anesthetics, Cardiovascular drugs – Antianginal agents, Vasodilators, Adrenergic; cholinergic drugs, Cardiotonic agents, Diuretics, Antihypersensitive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents – Antibiotics, Antibacterials, Sulphadrugs. Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents.

UNIT – II BIOMEDICAL IMPORTANCE OF DRUGS:

Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids, Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction. Preparation and storage and uses of official Radiopharmaceuticals.

UNIT – III TOXICOLOGY:

Toxicology, drug interactions and pharmacology of drugs acting on the central nervous system, Cardiovascular system, Autonomic nervous system, Gastrointestinal system and Respiratory system. Hormones, Chemotherapeutic agents including anticancer drugs.

UNIT – IV BIOPHARMACEUTICALS:

Development, manufacturing standards, labeling, packing as per the pharmacopoeial requirements, storage of different dosage forms and new drug delivery systems. Biopharmaceuticals and Pharmacokinetics and their importance in formulation.

UNIT – V CHEMOTHERAPY OF MICROBIAL DISEASES:

Chemotherapy of microbial diseases: Urinary antiseptics, sulphonamides, penicillin, streptomycin, Tetracyclines and other antibiotics. Anti-tubercular agents, Antifungal agents, antiviral drugs, antiepileptic drugs. Chemotherapy of protozoal diseases, Anthelmintic drugs. Chemotherapy of cancer.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Seminar talks on recent research topics in Drug development and validation.

REFERENCES:

1. Devin., “Text Book of Biochemistry with clinical correlation”, 1992
2. Donald Voet., “Biochemistry”, 2004
3. Harper’s., “Illustrated Biochemistry”, 2006
4. Alfred Burger., “A guide to chemical basis of drugs design”, John Wiley & Sons.
5. Goodman and Gilman’s., “The Pharmacological Basis of Therapeutics”, 8 th edition Pergamon Press.
6. John Smith and Haywel Williams., “Introduction to the principles of drug design”, Wright PSG.
7. Manfred E Wolff., “Burgers Medicinal chemistry – The basis of Medicinal Chemistry” Part – I. John Wiley & Sons.

COURSE OUTCOMES:

- Students will be able to understand the basic concepts of bio-inorganic, bioorganic, physical chemistry, analytical chemistry, drug formulation, drug design and development, and green chemistry.
- Students will be able to demonstrate knowledge to develop Pharmaceutically important molecules, new drug delivery systems etc.
- Students will demonstrate an ability to analyze and interpret data of analytical experiments in production, quality control & assurance of pharmaceutical synthesis and formulation.
- Students will be able to apply analytical tools for determination of organic molecules.
- Students will be able to generate validation protocols for all pharmaceutical operations starting from drug research to development to formulation.
- Learn Role of drugs to inhibit the particular enzymes and treatment of disease.
- Learn Mode of action of different drugs.

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Second Year	NON MAJOR ELECTIVE II BIOCHEMISTRY	Semester III
Code:	(Theory)	Credit: 2

COURSE OBJECTIVES:

- To understand the structure and functions of important biological macromolecules.

UNIT – I CARBOHYDRATE:

Definition, classification, and biological significance of monosaccharide (glucose, fructose, ribose), Disaccharide (lactose, maltose & Sucrose), Polysaccharide – Homopolysaccharides (cellulose, starch and glycogen), Heteropolysacchrides (chondratin sulphate, Heparin and hyaluronate)**.**

UNIT – II AMINO ACIDS AND PROTEINS:

Classification, Physical properties. Peptide bond –Classification and biologically important peptides. Protein – Definition, classification. Biological functions and significance of proteins

UNIT – III NUCLEIC ACIDS:

Definition, Nucleoside; Nucleotide, functions of nucleotides Watson & ;Crick model of DNA structure, various forms and functions of DNA. Types, structure and functions of RNA (mRNA, tRNA, rRNA).

UNIT – IV LIPIDS AND PORPHYRINS:

Definition, Classification. Fatty acids - classification, Simple lipids –Triglycerides. Compound lipids: Structure and functions of phospholipids and glycolipids, Steroids – Structure and function of cholesterol. Structure of Porphyrins - Structure and function of Heme, Cytochromes and Chlorophyll.

UNIT – V VITAMINS AND MINERALS:

Definition, sources, functions, deficiency syndromes of Fat soluble vitamins (A, D, E and K) and Water soluble vitamins (B complex and C). Calcium, Phosphorus, Magnesium, Sodium, Potassium, Iron, Zinc, Iodine, Fluoride, Copper Selenium, Manganese and Chromium. Other trace elements: Molybdenum, boron, nickel, lithium, antimony, aluminium and lead.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Using the basic understanding of various biomolecules, identify its importance in drug development, immunology, pathology, pharmacy, vaccine development, etc.

REFERENCES:

1. Biochemistry – L. Stryer.

2. Principles of Biochemistry – R. Horton et al.
3. Lehninger's Principles of Biochemistry - D. L. Nelson and M. M. Cox.
4. Harpers Biochemistry- R. K. Murray et al.
5. Principles of Biochemistry- G. L. Zubay.
6. Outlines of biochemistry- Lippincott

COURSE OUTCOMES:

- Students can understand the fundamental energetics of biochemical processes
- To understand the relation between biochemical defects and metabolic disorders.
- To understand the organization of signaling pathways.
- To understand the role of membrane processes in metabolism
- Overall, gaining an understanding of the processes of metabolic transformation at the molecular level and how these processes are studied.

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Second Year	CORE COURSE VII IMMUNOLOGY	Semester IV
Code:	(Theory)	Credit: 5

COURSE OBJECTIVES:

- Describe the basic mechanisms, distinctions and functional interplay of innate and adaptive immunity
- Define the cellular/molecular pathways of humoral/cell-mediated adaptive responses
- Define the basic mechanisms that regulate immune responses and maintain tolerance
- To demonstrate the molecular basis of complex, cellular processes involved in inflammation and immunity, in states of health and disease.
- Describe basic and state-of-the-art experimental methods and technologies

UNIT – I INTRODUCTION TO IMMUNOLOGY:

Historical perspective: contribution by Metchnikoff, Edward Jenner, Louis Pasteur and Wu and Kabat. 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 – MALT, GALT and CALT. Cells of the immune system- lymphocytes, mononuclear phagocytes – dendritic cells, granulocytes, NK cells and mast cells. Immunoglobulins **–** structure, classification and functions. Idiotype network hypothesis. Antigen, types of antigen, antigen Vs immunogens, Haptens. Factors influencing immunogenicity. Isotypes, allotypes and idiotypes.

UNIT – II COMPLEMENT PATHWAYS:

Complement system: components of complement activation and its biological consequences – classical, alternative and lectin pathways. **Clonal selection theory.** Organization and expression of immunoglobulin genes, generation of antibody diversity. Class switching. **Overview of B cell &T cell**, types of immune response, T – cell, B- cell receptors, Antigen recognition – processing and presentation to T- cells. Interaction of T and B cells. Effector mechanisms – macrophage activation. Cell mediated cytotoxicity, Cytokines types.

UNIT – III MAJOR HISTOCOMPATIBILITY COMPLEX:

Major Histocompatibility complex (MHC): MHC genes and products. Polymorphism of MHC genes, role of MHC antigen in immune response, MHC antigens in transplantation. Transplantation types, allograft rejection mechanism, regulation of immune response : immune tolerance and immunosuppression. Immune response to infectious diseases – Viral, bacterial and protozoal. AIDS and other immunodeficiency disorders. Autoimmunity: Mechanism of induction of organ specific and systemic autoimmune diseases. **Hypersensitivity** – types. Immune response to cancer, immunotherapy.

UNIT – IV VACCINES:

Immunization practices – active and passive immunization. Vaccines – killed, attenuated – toxoids. Recombinant vector vaccines – DNA vaccines, synthetic peptide vaccines – anti idiotype vaccines. Humanized antibodies and plantibodies .Production of polyclonal and monoclonal antibodies. Principles, techniques and application. Genetically engineered antibodies. Abzymes.

UNIT – V IMMUNOTECHNIQUES:

Immunotechniques: Agglutination and precipitation technique. Immuno – electrophoresis, RIA, immunoblotting, Avidin – biotin mediated immunoassay. Immunohistochemistry – immunofluorescence, immunoferritin technique. Fluorescent immunoassay, fluorescence activated cell sorting (FACS). Cytokines assay: ELISA and ELISPOT. Lymphocytes transformation test (LTT); Lymphoblastoid cell lines. Experimental animal models: inbred strains, SCID mice, nude mice, knockout mice fully cloned animals.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Recent studies on Auto-immune disorders, Hypersensitivity. Dynamics of the immune response. The immune response in health and disease. Immunity against covid-19 infections

REFERENCES:

1. Janis Kuby - (1997), immunology, 3rd edition, W.H. Freedom &co (Sd).
2. Geoffrey Zubay - (1972), Immunology, 4th edition, W.M.C. Brown publishers.
3. Kenneth M. Murphy, Paul Travers, Mark Walport - (2007), Janeway's Immunobiology, 7th edition,Garland Science.
4. Peter Delves, Seamus Martin,B Dennis Burton, Ivan Roitt - (2006), Roitt's EssentialImmunology, 11thedition, Wiley-Blackwell.
5. Abul K. Abbas, Andrew H. Lichtman, Jordan S. Pober- (1994), Cellular and molecular immunology, 2nd edition, B. Saunders Company.
6. Onald Mackay Weir &Stewart John - (1997), Immunology, 8th edition, Churchill Livingston

COURSE OUTCOMES:

- Describe the basic mechanisms, distinctions and functional interplay of innate and adaptive immunity.
- Define the cellular/molecular pathways of humoral/cell-mediated adaptive responses.
- Define the basic mechanisms that regulate immune responses and maintain tolerance.
- Understand the molecular basis of complex, cellular processes involved in inflammation and immunity, in states of health and disease .
- Describe basic and state-of-the-art experimental methods and technologies .
- Integrate knowledge of each subsystem to see their contribution to the functioning of higher-level systems in health and disease.
- Apply understanding of basic and state-of-the-art experimental methods and technologies in the design of research plans to test specific hypotheses.

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Second Year	CORE COURSE VIII MOLECULAR BIOLOGY	Semester IV
Code:	(Theory)	Credit: 5

COURSE OBJECTIVES:

- This course is about genes - their structure and function - therefore, students will study the mechanics of replication, repair, transcription, and translation in bacteria, archaea and eukaryotes.
- A central goal is to understand gene regulation at all levels, and the structure-function relationships of nucleic acids and proteins.

UNIT – I CENTRAL DOGMA OF LIFE:

DNA as the genetic material, supercoiling, hybridization. Hierarchy of Chromatin Organisation, Central Dogma, Unique sequence DNA, Repetitive DNA – SINEs, LINEs, Satellite, Minisatellite and Microsatellite DNAs, C-Value Paradox. E.Coli Chromosome and plasmids, Mitochondrial and Chloroplast Genomes. Concept of genes. Structure of Protein-coding genes in prokaryotes and eukaryotes.

UNIT – II DNA REPLICATION, REPAIR AND MUTATION:

DNA in prokaryotes and eukaryotes. Mode of replication; experimental findings of Meselson &Stahl. Enzymes involved in replication, events on the replication fork and termination, mechanism of replication. Inhibitors of DNA replication and DNA repair mechanisms (Direct repair, excision repair, mismatch repair, recombination repair, SOS response, Eukaryotic repair system).Type of damages and mutation – point mutation and frameshift mutation. Suppressor Gene mutation and chromosomal aberration.

UNIT – II TRANSCRIPTION:

Organization of transcriptional units – prokaryotes and eukaryotes. RNA polymerases – structure and functions. Promoters, transcription factors, transcription complex assembly and mechanism of transcription- Transcriptional regulation –hormonal (steroid hormone receptors), phosphorylation (STAT proteins). Post-transcriptional processing. Alternative splicing. Catalytic RNA (ribozymes), antisense RNA. Inhibitors of transcription.

UNIT – IV TRANSLATION:

The genetic code – specificity, redundancy and wobble hypothesis. Mitochondrial and chloroplast genetic codons. Components of protein synthesis– mRNA, rRNA and tRNA. Mechanism of protein synthesis. Regulation of protein synthesis - constitutive and narrow domain regulation. Inhibition of protein synthesis. Co- and post-translational modifications. Protein targeting- the signal sequence hypothesis, targeting proteins to membranes, nucleus and intracellular organelles. Protein degradation - ubiquitin pathway. Protein folding - models, molecular chaperones.

UNIT – V GENE EXPRESSION AND REGULATION:

Levels of gene expression. Principles of gene regulation. Upregulation, downregulation, induction and repression. Operon models- Lac operon, Trp operon. Comparison of gene regulation strategies in prokaryotes and eukaryotes. Genetic and epigenetic gene regulation by DNA methylation. Methylation and gene regulation in mammals and plants. Epigenetic gene regulation by DNA methylation in mammals - role of imprinting and X-chromosome inactivation.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Role of antibiotics and other inhibitors of Prokaryotic and eukaryotic replication/transcription/translation.

REFERENCES:

1. Molecular Cell Biology, 5thedition, Harvey Lodish, Arnold Berk, Paul Matsudaira, chris A. Kaiser, Monty Krieger, Mathew P Scott, Lawrence Zipursky, James Darnell, W.H Freeman &Co. 2004, ISBN - 0716743663
2. Genes VIII, Benjamin Lewin, Pearson Prentice Hall, 2004, ISBN - 0131238264
3. Molecular Biology, David Friefelder, Jones &Bartlett Publishers ISBN 0867200693 (0-86720-069-3)
4. Molecular Biology of The Cell, 4thedition, Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter, Garland edition, ISBN-10: 0-8153-4072-9
5. Cell Biology and Histology, 6thedition, Gartner et al., Lippincott William and Wilkins Publishers, ISBN - 1608313212.
6. Cell Biology and Molecular Biology, 8thedition, EDP De Robertis and EMF De Robertis, Lippincott Williams and Wilkins, 2006, ISBN - 0781734932
7. Molecular Biology of the Gene, 6thedition, James D Watson, 2008, Cold Spring Harbor Laboratory, ISBN 978-080539592-1
8. Becker's World of The Cell, 8thedition, Jerrf Hardin, Gregory Bertoni, Lewis Kleinsmith, 2011, Pearson Publications, ISBN – 0321709780
9. Cell and Molecular Biology Concepts & Experiments, 5thedition, Gerald Karp, 2008, wiley Publications, ISBN - 978-0-470-04214-4

COURSE OUTCOMES:

- The course gives deep insight into the molecular mechanisms behind the existence of life.
- Students will understand the structure and organization of genomes and its functions in lower to higher forms of life.
- Students will learn about the regulation of gene expression.
- Course covers the fundamental molecular causes behind the several non-communicable and communicable diseases**.** Which enables the students to pursue careers in healthcare and clinical research.

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Second Year	**ENTREPRENEURSHIP / INDUSTRY BASED COURSE INDUSTRIAL CHEMISTRY**	**Semester IV**
Code	**(Theory)**	**Credit: 5**

COURSE OBJECTIVES:

- To teach students about concepts of entrepreneurship including identifying a winning business opportunity, gathering funding and launching a business, growing and nurturing the organization and harvesting the rewards.
- Illustrate the basics of bio-business in various emerging biological field
- Build critical thinking capability and design methodologies for entrepreneur
- Create the ability for planning, commencing, executing and managing business

UNIT – I Introduction to Bio business:

Introduction to Bio-business, Fundamentals of Biotech for bio-Business, Contemporary Vs antique Bio-business, Wealth Creation in Bio-business. Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make in India), strategic dimensions of patenting & commercialization strategies.

UNIT – II Biosciences in Business:

Healthcare, Biomedical sciences, Industrial Life Sciences, Biotechnology, Agriculture based business, Food Industry; Where Things Stand: A Quick Survey of Regional and Global Strengths and Capabilities. Business related to Environment Management, Bioremediation, Bioleaching and waste management.

UNIT – III Bio markets - business strategy and marketing:

Negotiating the road from lab to the market (strategies and processes of negotiation with financiers, government and regulatory authorities), Pricing strategy, Challenges in marketing in bio-business (market conditions & segments; developing distribution channels, the nature, analysis and management of customer needs), Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills.

UNIT - 1V Protecting the Intellectual Property:

Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; introduction to history of GATT, WTO, WIPO and TRIPS; plant variety protection and farmers rights act; concept of 'prior art': invention in context of "prior art"; patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation.

UNIT – V Patenting: Basics of patents:

Types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application; precautions before patenting-disclosure/non-disclosure - patent application- forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications: provisional and complete specifications; PCT and conventional patent applications; international patenting-requirement, procedures and costs; financial assistance for patenting-introduction to existing schemes; publication of patents-gazette of India, status in Europe and US; patent infringement- meaning, scope, litigation, case studies and examples; commercialization of patented innovations; licensing – outright sale, licensing, royalty; patenting by research students and scientists-university/organizational rules in India and abroad, collaborative research - backward and forward IP; benefit/credit sharing among parties/community, commercial (financial) and non-commercial incentives.

UNIT – VI Finance and accounting (For Continuous Internal Assessment Only):

Business plan preparation including statutory and legal requirements, Business feasibility study, and financial management issues of procurement of capital and management of costs, Collaborations & partnership, Information technology.

REFERENCES:

1. Adams, D. J., & Sparrow, J. C. (2008). Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences. Bloxham: Scion.
2. Jordan, J. F. (2014). Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press.
3. Ganguli, P. (2001). Intellectual Property Rights: Unleashing the Knowledge Economy. New Delhi: Tata McGraw-Hill Pub.
4. National IPR Policy, Department of Industrial Policy & Promotion, Ministry of Commerce, Government of India.

COURSE OUTCOMES:

- Students should be able to gain entrepreneurial skills, understand the various operations involved in venture creation, identify scope for entrepreneurship in biosciences and utilize the schemes promoted through knowledge centers and various agencies.
- The knowledge pertaining to management should also help students to be able to build up a strong network within the industry.
- Evaluate and develop critical thinking leading to innovative skills related to business.
- Develop the protocol to approach funding agencies both government and non-government

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Second Year **PROJECT** **Semester-IV**

Code: **Credit: 5**

Each candidate shall be required to take up a Project Work and submit it at the end of the final year. The Head of the Department shall assign the Guide who, in turn, will suggest the Project Work to the student in the beginning of the final year. A copy of the Project Report will be submitted to the University through the Head of the Department on or before the date fixed by the University.

The Project will be evaluated by an internal and an external examiner nominated by the University. The candidate concerned will have to defend his/her Project through a Viva-voce.

ASSESSMENT /EVALUATION /VIVA-VOCE:

1. PROJECT REPORT EVALUATION (Both Internal & External):

I. Plan of the Project - 20 marks

II. Execution of the Plan/collection of Data / Organisation of Materials / Hypothesis, Testing etc and presentation of the report. - 45 marks

III. Individual initiative - 15 marks

2. VIVA-VOCE / INTERNAL& EXTERNAL - 20 marks

TOTAL **- 100 marks**

PASSING MINIMUM:

	Vivo-Voce 20 Marks	**Dissertation 80 Marks**
Project	40% out of 20 Marks (i.e. 8 Marks)	40% out of 80 marks (i.e. 32 marks)

A candidate shall be declared to have passed in the Project work if he/she gets not less than 40% in each of the Project Report and Viva-voce but not less than 50% in the aggregate of both the marks for Project Report and Viva-voce.

A candidate who gets less than 40% in the Project must resubmit the Project Report. Such candidates need to defend the resubmitted Project at the Viva-voce within a month. A maximum of 2 chances will be given to the candidate.

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Second Year **VALUE ADDED COURSE II** **Semester IV**

VALUE ADDITION IN FOOD

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- To study the process of and provide a new perspective on value adding, with an emphasis towards 'authenticity' in food
- This course delivers new knowledge and provides future direction to small scale farming Producers and the wider food industry

UNIT – I FOOD SCIENCE AND TECHNOLOGY:

Methods of food preservation, Use of non-thermal technologies, alternate-thermal technologies, infrared biological technologies -antimicrobial enzymes and bacteriocins in food processing.

UNIT – II FRUITS AND VEGETABLES:

Value addition and storage of fruits and vegetables. Fruit juice, jam, jelly, marmalade, squash, candies, tomato sauce, ketchup, and puree, chips, pickles. Dehydrated fruits and vegetables. Fermented foods and beverages from fruit and vegetables.

UNIT – III FOOD GRAINS, SPICES AND PLANTATION CROPS:

Anti-nutritional factors in food grains and oilseeds. Value added food grain products like breads, biscuits, cakes, doughnuts, buns, pasta goods, extruded, Instant ready mixtures, puffed foods, confectionary products, breakfast cereals, snack foods, malted food products, legume based food products.

UNIT – IV DAIRY PRODUCTS:

Reconstituted and flavored milks**.** Technology of fermented milks. Milk products processing viz. cream, butter, ghee, cheese, condensed milk, evaporated milk, whole and skimmed milk powder, ice cream, khoa, channa, paneer and similar products. **Food Fortification:** Fortification of bread, pasta, noodles, biscuits, and breakfast cereals. Micronutrient fortification of snack products. Other special fortified products - salt, sugars, milk and oils. Safety limits

UNIT – V MEAT FISH AND POULTRY PRODUCTS:

Meat and poultry preservation like curing, smoking, freezing, canning and dehydration Value addition and byproducts utilizations. Factors influencing keeping quality of meat. Processing and preservation of fish and its products. Preservation canning, smoking and freezing of fresh and sea water fish and its products. Utilization of by-products from fish processing industries. Preservation methods of shell eggs and egg products freezing- pasteurization- desugarization . Technology of egg products viz. egg powder, albumen and flakes.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Examples of how to make value-added food products like making salsa out of your tomatoes, make jam or jelly out of your berries

REFERENCES:

1. Food Science by Potter
2. Fruit and Vegetable Preservation by Srivastava and Sanjeev Kumar
3. Principles of Food Science, Vol-I by Fennma Karrel
4. Preservation of Fruits & Vegetables by Girdhari Lal, Sidhapa and Tandon
5. Post Harvest Technology of cereal pulse and oil seeds by Chakraborty, AC
6. Food Science by Mudambi
7. Processed Meats; Pearson AM & Gillett TA; 1996, CBS Publishers.
8. Meat; Cole DJA & Lawrie RA; 1975, AVI Pub.
9. Egg and poultry meat processing; Stadelman WJ, Olson VM, Shemwell GA &Pasch S; 1988, Elliswood Ltd.
10. Developments in Meat Science – I &II, Lawrie R; Applied Science Pub. Ltd.
11. Egg Science & Technology; Stadelman WJ & Cotterill OJ; 1973, AVI Pub.
12. Fish as Food; Vol 1 &2; Bremner HA; 2002, CRC Press.
13. Fish & Fisheries of India; Jhingram VG; 1983, Hindustan Pub Corp
14. Fish as Food, Vol. I-IV; George Borgstrom, Academic Press
15. Fish Processing Technology, Rogestein & Rogestein.

COURSE OUTCOMES:

Upon completion the students will come to understand;

- The principles of preservation behind the methods of preservation.
- Acquire skills to formulate fruits based preserved products with value addition for nutritional benefits.
- Explore the principle of preservation in vegetables based products with nutritive value.
- Prepare cereals and pulses based on preserved products focusing on the principle of preservation.
- Develop new products with maximum retention of essential nutrients.

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