ACHARYA NAGARJUNA UNIVERSITY

A State Government University, Accredited with "A" Grade by NAAC

Nagarjuna Nagar - 522 510, Guntur, Andhra Pradesh, India.

M.Sc. BIOCHEMISTRY

SYLLABUS

2022 - 2023 onwards

UNIVERSITY COLLEGE OF SCIENCES

PROGRAM CODE:

ANUCS03


ACHARYA NAGARJUNA UNIVERSITY
సత్యం సర్వం ప్రతిష్ఠితమ్

ABOUT UNIVERSITY

ACHARYA NAGARJUNA UNIVERSITY (ANU)

- A Brief Profile

Acharya Nagarjuna University, a State University established in 1976, has been constantly striving towards achieving progress and expansion during its existence for over four decades, in terms of introducing new courses in the University Colleges, affiliated colleges and professional colleges. Spread over 300 acres of land on the National High Way (NH-16) between Vijayawada and Guntur of Andhra Pradesh, the University is one of the front ranking and fastest expanding Universities in the state of Andhra Pradesh. The University was inaugurated on 11th September, 1976 by the then President of India, Sri Fakruddin Ali Ahmed and celebrated its Silver Jubilee in 2001. The National Assessment and Accreditation Council (NAAC) awarded "A" grade to Acharya Nagarjuna University and also has achieved 108 International ranks, 39 National ranks UI Green Metrics rankings and many more It is named after Acharya Nagarjuna – one of the most brilliant preceptors and philosophers, whose depth of thought, clarity of perception and spiritual insight were such that even after centuries, he is a source of inspiration to a vast number of people in many countries. The University is fortunate to be situated on the very soil where he was born and lived, a soil made more sacred by the aspiration for light and a state of whole someness by generations of students. With campus student strength of over 5000, the University offers instruction for higher learning in 68 UG & PG programs and guidance for the award of M.Phil. and Ph.D. in 48 disciplines spread over six campus colleges and one PG campus at Ongole. It also offers 160 UG programs in 440 affiliated colleges in the regions of Guntur and Prakasam Districts. It has a Centre for Distance Education offering 87 UG & PG programs. Characterized by its heterogeneous students and faculty hailing from different parts of the state and the country, the University provides most hospitable environment for pursuing Higher Learning and Research. Its aim is to remain connected academically at the forefront of all higher educational institutions. The University provides an excellent infrastructure and on- Campus facilities such as University Library with over one lakh books & 350 journals; Computer Centre; University Scientific Instrumentation Centre; Central Research Laboratory with Ultra-modern Equipment; Well-equipped Departmental Laboratories; Career Guidance and Placement Cell; Health Centre; Sports Facilities with Indoor & Outdoor Stadiums and Multipurpose Gym; Sports Hostel; Separate hostels for Boys, Girls, Research Scholars and International Students; Pariksha Bhavan (Examinations Building); Computers to all faculty members; Wi-Fi connectivity to all Departments and Hostels; Canteen, Student Centre & Fast-food Centre; Faculty Club; Dr. H.H. Deichmann & Dr. S.John David Auditorium cum Seminar Hall; Post office; Telecom Centre; State Bank of India; Andhra Bank; Energy Park; Silver Jubilee Park; Fish ponds; internet center; xerox center; cooperative stores; Water harvesting structures.

VISION, MISSION & OBJECTIVES OF THE UNIVERSITY

ACHARYA NAGARJUNA UNIVERSITY

VISION

To generate sources of knowledge that dispels ignorance and establish truth through teaching, learning and research.

MISSION

To promote a bank of human talent in diversified faculties – Commerce & Management Studies, Education, Engineering & Technology, Humanities, Law, Natural Sciences, Pharmacy, Physical Education & Sports Sciences, Physical Sciences and Social Sciences that would become an investment for a prosperous society.

OBJECTIVES

- To inspire and encourage all who would seek knowledge through higher education and research.
- To provide quality instruction and research for the advancement of science and technology.
- To promote teaching and research studies in disciplines of societal relevance.
- To bridge the gap between theory and practice of the principles of higher education.
- To develop human talent necessary for the industry.
- To open up avenues of higher education and research through non-formal means.
- To invite and implement collaborations with other institutes of higher learning on a continuous basis for mutual academic progress.
- To motivate and orient each academic department/centre to strive for and to sustain advanced levels of teaching and research so that the university emerges as an ideal institute of higher learning.
- To focus specially on the studies involving rural economy, justifying its existence in the rural setting.

VISION

&

MISSION OF THE COLLEGE

ACHARYA NAGARJUNA UNIVERSITY

UNIVERSITY COLLEGE OF SCIENCES

VISION OF THE COLLEGE:

University College of Sciences envisages to be a good team of people with scientific temperament, research bent and a flair for Teaching & Learning for the betterment of the Community, Society, State and the Country at large.

MISSION OF THE COLLEGE:

The College intends to incubate and nurture the Leaders, Mentors, Educators and researchers who can transform the country and contribute to advances in science while addressing the challenges faced by the society for the betterment of human life.

VISION & MISSION OF THE DEPARTMENT

ACHARYA NAGARJUNA UNIVERSITY

UNIVERSITY COLLEGE OF SCIENCES

DEPARTMENT OF BIOCHEMISTRY

VISION OF THE DEPARTMENT:

- To impart basic and applied biochemical knowledge with a commitment teaching and research to excel the department as for the need for national and international society.
- To train the students as emerging entrepreneurs with potential innovative ideas to invent and disseminate the knowledge for the welfare of human society.

MISSION OF THE DEPARTMENT:

- To provide comprehensive biochemical skills and effective training to the students for the benefit of mankind.
- To train the students in identifying the environmental issues raised and in developing new strategies in solving the problem.
- To provide practical skills and enhance critical analysis and effective application of scientific methods.

ACHARYA NAGARJUNA UNIVERSITY

UNIVERSITY COLLEGE OF SCIENCES

DEPARTMENT OF BIOCHEMISTRY

PROGRAMME EDUCATIONAL OBJECTIVES (PEO's):

The graduated students of M.Sc. Biochemistry are expected to accomplish-

1. Ability to understand the structure, chemical properties and reactions of the biomolecules and their derivatives to predict chemical properties and reactivity.
2. Could gain the knowledge in understanding advanced and specialized courses evolve from time to time in future.
3. Can understand the advanced scientific methods through lectures, classes, seminars, debates and a problem-based learning exercise.
4. Information is provided to understand the theoretical concepts of analytics in performing the basic and critical reactions of biological importance, and instruments that are commonly used in most Biochemistry and its applied fields for excel them relevant fields.
5. The practical skills provided in the laboratory could help in analyzing the task in their respective Project work.
6. Critical thinking and scientific inquiry can be improved in designing the methodology, interpretation and documentation of laboratory experiments and gain the experience to the entry level position in Pharmaceutical/ Biochemical/ Biotech industries.
7. Able to participate in a team work for general investigations of problem-based assignments.
8. Suggest, evaluate and interpret biochemical investigation in a given clinical situation and apply knowledge to solve clinical problems.
9. Contribute their knowledge and experiences gained during the course to professional and/or public activities in developing the community.

PROGRAMME OUTCOMES (PO's):

Biochemistry, provides the knowledge about the chemistry of life to the students. The students on successful completion of M. Sc. Biochemistry programme should gain-

1. Ability to apply and acquire the knowledge in the core and applied fields of Biochemistry.
2. Ability to perform practicals competently in a laboratory setting, design and conduct experiments and simulations, operating and calibrating technical equipment as well as critical analysis.

3. Able to identify problems in specific areas of Biochemistry.
4. Capability to work effectively as individual and in group (team), and able to lead the team.
5. Maintains professional ethics and follows ethical principles.
6. Ability to engage in life-long learning
7. Discriminate knowledge effectively with the general society.
8. Strength to participate and succeed in State, National and International level competitive examinations.
9. Capability of linking interdisciplinary research areas.

Ability to create awareness on biochemical applications among the populations along with providing understanding on global environmental and societal contents.

PROGRAMME SPECIFIC OUTCOMES (PSO's):

Upon successful completion of M.Sc. Biochemistry program, the graduates are expected to

- Recognize, demonstrate and understand of structure, chemical properties and reactions of the biomolecules and their biopolymer structure to predict chemical properties and reactivity.
- Apply the knowledge of metabolism, detect various disorders, identify the defect in the metabolic pathways and evaluate solutions for metabolic disorders.
- Diagnose the pathogenic microbes in the laboratory by applying the knowledge of microbial culture techniques.
- Expertise on cell and molecular biology as well as on cell signaling that would help them to plan and carryout research program's in relevant aspects.
- Obtain the knowledge about the qualitative and quantitative analysis of different molecules using different types of microscopes, centrifuges, radio isotopes, chromatographic and electrophoresis techniques and spectroscopic techniques.

STRUCTURE

ACHARYA NAGARJUNA UNIVERSITY
UNIVERSITY COLLEGE OF SCIENCES
DEPARTMENT OF BIOCHEMISTRY
M.Sc. BIOCHEMISTRY

COURSE STRUCTURE

SEMESTER-I

S. No.	Componentsof Study	Course Code	Title of the Paper	No. of Credits	No. of hours/week	Practicals/Project	Internal Assessment	Semester end Examinations	Total Marks
1	**Mandatory Core**	**MBC 1.1 (22)**	Biomolecular Chemistry	04	04		30	70	100
2		**MBC 1.2 (22)**	Analytical Biochemistry	04	04		30	70	100
3	**Compulsory Foundation**	**MBC 1.3 (22)**	Advance Enzymology	04	04		30	70	100
4	**Elective Foundation (Choose one)**	**MBC 1.4 (22)**	A. Cell Biology and Physiology B. Human Physiology C. Fundamental Biochemistry	04	04		30	70	100
5			Tutorial/Seminar		08				
6	**Practical -I**			04		06	30	70	100
7	**Practical-II**			04		06	30	70	100
	SUB TOTAL			**24**	**24**	**12**	**180**	**420**	**600**

SEMESTER-II

S. No.	Componentsof Study	Course Code	Title of the Paper	No. of Credits	No. of hours/week	Practicals/Project	Internal Assessment	Semester end Examinations	Total Marks
1	**Mandatory Core**	**MBC 2.1 (22)**	Clinical Biochemistry	04	04		30	70	
2		**MBC 2.2 (22)**	Immunotechnology	04	04		30	70	
3	**Compulsory Foundation**	**MBC 2.3 (22)**	Microbial Biochemistry	04	04		30	70	
4	**Elective Foundation (Choose one)**	**MBC 2.4 (22)**	A) Nutritional Biochemistry & Analytical methods B) Nutrition & Clinical biochemistry C) Food Microbiology	04	04		30	70	
5	**Practical -I**		Tutorials / Seminars		02		00	00	
6	**Practical -I**				04		06	30	70
7	**Practical-II**								
8	**SKILL DEVELOPMENT COURSE**				04	06		00	00
SUB TOTAL				**28**	**24**	**12**	**180**	**420**	**600**

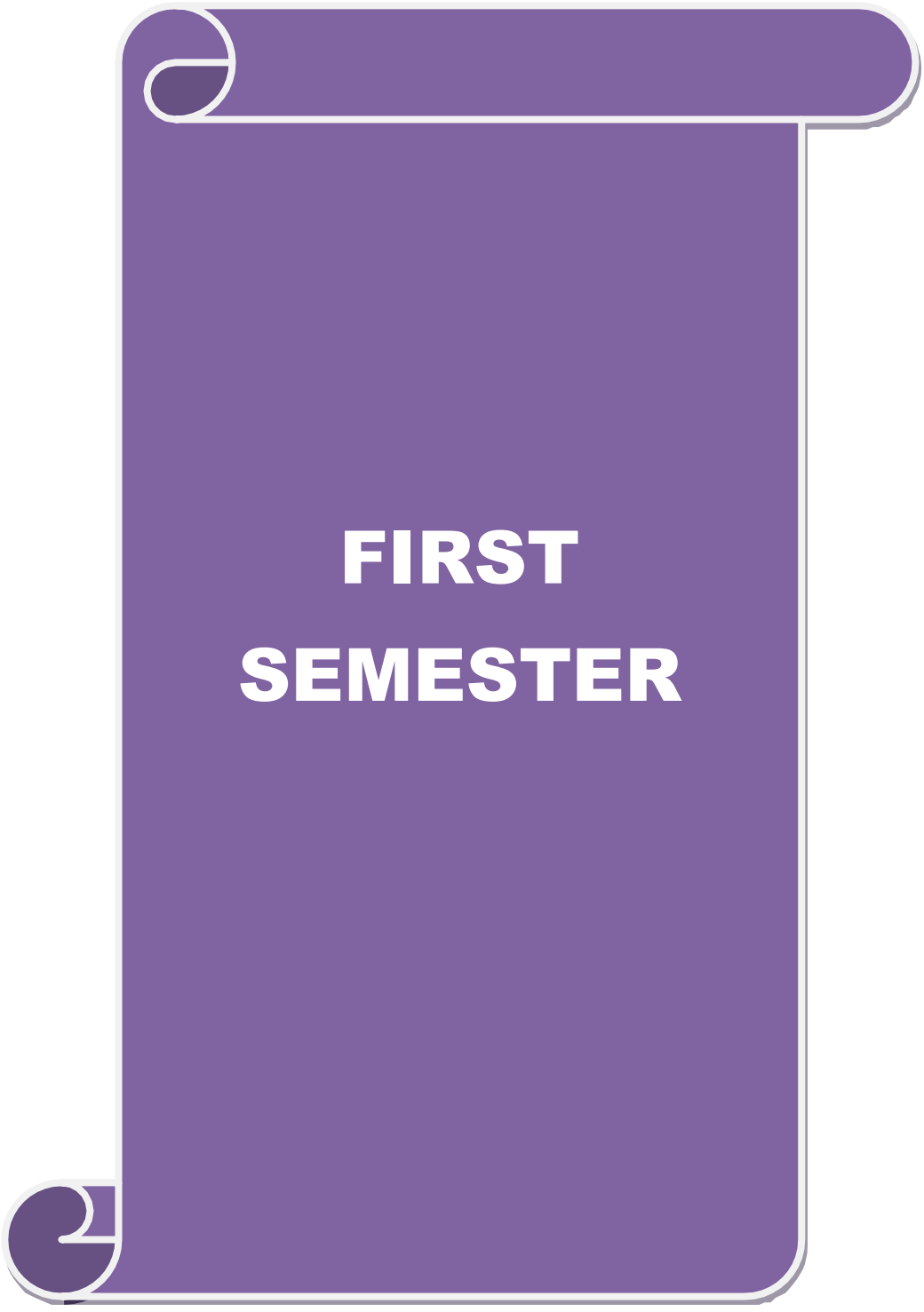
SEMESTER-III

S. No.	Componentsof Study	Course Code	Title of the Paper	No. of Credits	No. of hours/week	Practicals/Project	Internal Assessment	Semester end Examinations	Total Marks
1	**Mandatory Core**	**MBC 3.1 (22)**	Inheritance Biology	04	04		30	70	100
2		**MBC 3.2 (22)**	Molecular Biology -I	04	04		30	70	100
3	**Elective 1 (Choose one)**	**MBC 3.3 (22)**	A. Plant Biochemistry B. Food Technology C. Advanced Cell Biology	04	04		30	70	100
4	**Elective II (Choose one)**	**MBC 3.4 (22)**	A. Intermediary Metabolisms B. Genetics and Developmental Biology C. Medical Biochemistry	04	04		30	70	100
5			Tutorials / Seminars		02				
6	**Practical -I**			04		06	30	70	100
7	**Practical-II**			04		06	30	70	100
8	**Skill Enhanced Course (MOOCS)**			04	06		00	00	
SUB TOTAL				**28**	**24**	**12**	**180**	**420**	**600**

SEMESTER-IV

S.No.	Componentsof Study	Course Code	Title of the Paper	No. of Credits	No of Hours/ Week	Practical/Project	Internal Assessment Marks	Semester end Examinations Marks	Total Marks
1	**Mandatory Core**	**MBC 4.1 (22)**	Applied Biochemistry	04	04		30	70	100
2		**MBC 4.2 (22)**	Molecular Biology II & Bioinformatics	04	04		30	70	100
3	**Elective 1 (Choose one)**	**MBC 4.3 (22)**	A. Genetic Engineering & Biostatistics B. Advanced Genome Techniques C. Research Methodology	04	04		30	70	100
4	**Elective II (Choose one)**	**MBC 4.4 (22)**	A. Endocrinology B. Pharmacology & Toxicology C. Environmental Biochemistry	04	04		30	70	100
5	**Practical -I**			04		06	30	70	100
6	**Practical-II**			04		06	30	70	100
7	**Project**			04	08			100	
SUB TOTAL				**28**	**24**	**12**	**180**	**520**	**700**
GRAND TOTAL				**108**	**96**	**48**	**720**	**1780**	**2500**

- All core papers are mandatory
- Choose one from Elective Foundation in 1st & 2nd Semester
- Choose one from each sections of Elective 1 and Elective 2 in 3rd & 4th Semester
- Skill Development & Skill enhancement courses are Mandatory in 2nd & 3rd Semester
- Candidates should register for SWAYAM/MOOCS with the approval of DDC for the award of the grade in the respective course
- Project work is mandatory either from Subject orientation/multi-Disciplinary


FIRST
SEMESTER

ACHARYA NAGARJUNA UNIVERSITY
UNIVERSITY COLLEGE OF SCIENCES
DEPARTMENT OF BIOCHEMISTRY
M.Sc. BIOCHEMISTRY

SEMESTER-I

MANDATORY CORE:

MBC 1.1 (22): BIOMOLECULAR CHEMISTRY

COURSE OBJECTIVES:

- Understand the basic concepts of stereochemistry.
- Learn the structure, classification and importance of biomolecules such as carbohydrates, lipids, nucleic acids (DNA and RNA), aminoacids and proteins.

COURSE OUTCOMES:

CO1: By the end of the course, students will be able to understand the chemical structures and functions of biomolecules such as carbohydrates, lipids, proteins, and nucleic acids.

CO2: By the end of the course, students will be able to analyse the properties and characteristics of biomolecules, including how they interact with each other in biological systems.

CO3: By the end of the course, students will be able to investigate the biochemical pathways involved in metabolism and energy production.

CO4: By the end of the course, students will be able to evaluate the role of enzymes in catalysing biochemical reactions and the regulation of metabolic pathways.

CO5: By the end of the course, students will be able to explain the principles of molecular biology and genetic engineering, including DNA replication, transcription, and translation

UNIT-I

Stereochemistry: Relation between chirality and optical activity. Representation of chiral structure by Fishers projection, perspective, Newman and sawhorse formulas, molecular models. Classification of chiral compounds –DL, RS methods. Geometrical isomerism (E and Z nomenclature).

Porphyrins: Structure, properties and Identification. Structure of metalloporphyrins-heme, cytochromes and chlorophylls.

UNIT-II

Carbohydrates: Classification of carbohydrates, reactions of monosaccharides, structural elucidation of starch and glycogen. Structure and biological importance of aminosugars, Glycoproteins, proteoglycans, Bacterial cell wall polysaccharides, blood group substances and Lectins.

Lipids: classification, physicochemical properties of fats and oils. Characterization of natural fats and oils, structure and biological role of triacylglycerol, phospholipids, sphingolipids, gangliolipids. Prostaglandins, thromboxanes, leukotrienes – steroids – cholesterol, and bile acids.

UNIT-III

Amino acids and proteins: Classification of amino acids, acid base properties of amino acids, pKa of functional groups of amino acids, chemical reaction of amino acids, Nonprotein amino acids. Peptide bond – structure and conformation-Ramachandran plot. Merrifield solid phase peptide synthesis, naturally occurring peptides. Isolation and purification of proteins. Criteria of purity of proteins.

UNIT-IV

Structural organization of proteins, elucidation of primary structure, secondary structure helical, beta pleated sheet structure and triple helical structure. Tertiary structural features of myoglobin, lysozyme, ribonuclease, chymotrypsin, Quaternary structure – Hemoglobin – protein folding (Molecular chaperones) Denaturation and renaturation of proteins (RNase). Chemical modification of proteins.

UNIT-V

Nucleic acids: Structure of nucleic acids – purine and pyrimidine bases – nucleosides, nucleotides, polynucleotides – secondary and tertiary structure of DNA, different types of DNA, types of RNA – structures of RNAs. Isolation, fractionation and characterization of nucleic acids, properties of nucleic acids in solution denaturation and renaturation, hypo and hyperchromic effects, Tm, cot curves. Enzymatic hydrolysis of Nucleic acids.DNA sequencing methods: Maxam and Gilbert's method. Sanger's dideoxy chain termination method.

REFERENCE BOOKS:

1) Leininger's Principles of Biochemistry (2000) by Nelson, David L and Cox, M M, Macmillan/worth, NY.
2) Fundamentals of Biochemistry (1999) by Donald Voet, Judith G Voet and Charlotte W Pratt, John Wiley & Sons, NY.
3) Biochemistry III ed (1994) by Lubert Stryer, WH Freeman and Co., San Francisco.
4) Outlines of Biochemistry (1987) by Eric E Conn, P K Stumpf, G Bruening and Ray H Doi, John Wiley & Sons, NY.
5) Principles of Biochemistry General aspects 1983 Smith et al. (McGraw Hills)
6) Biochemistry (4 th edition) – Thomas M.Devlin.
7) Text book of Biochemistry (1908) west and Todd. (Mac Milan)
8) Text book of Biochemistry – Zubay.

CO-PO MAPPING TABLE:

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	3	2	2	3	2
CO2	3	3	2	3	2	3	3	3	3	3
CO3	3	2	3	3	3	2	2	2	2	2
CO4	3	2	3	2	3	3	3	3	3	3
CO5	3	2	3	3	3	3	3	3	3	3

MANDATORY CORE:

MBC 1.2 (22): ANALYTICAL CHEMISTRY

COURSE OBJECTIVES:

- Understand the Basic concepts of thermodynamics and applications
- Essential principles, methodology and applications related to techniques such as chromatography, electrophoresis and spectroscopy.

COURSE OUTCOMES:

CO1: By the end of the course, students will be able to understand the basic principles and concepts of analytical chemistry and its applications in solving analytical problems.

CO2: By the end of the course, students will be able to develop a strong foundation in analytical techniques such as titration, chromatography, spectroscopy, electrochemistry, and mass spectrometry.

CO3: By the end of the course, students will be able to perform quantitative and qualitative analysis of various types of samples and their components.

CO4: By the end of the course, students will be able to interpret and evaluate analytical data, and report them in a clear and concise manner.

CO5: By the end of the course, students will be able to develop critical thinking skills and problem-solving abilities for analyzing complex analytical problems.

UNIT-I

Thermodynamic aspects: Open, closed and isolated system; first law of thermodynamics, heat of formation and heat of reaction; second law of thermodynamics, molecular basis of entropy, Helmholtz and Gibbs free energy; third law of thermodynamics and its limitations. Application of the first and second law of thermodynamics in understanding energies in living cells, chemical potential, equilibrium constant. High energy compounds.

Electrode and Indicator dye Techniques: standard hydrogen electrode, reference electrodes, calomel electrode, silver-silver chloride electrode and oxygen electrode. Buffers: Physiological buffers and their importance in biological systems.

UNIT-II

Chromatographic techniques:

Methods based on Polarity: Classification of chromatography, Principle, methodology and applications of paper chromatography-circular, ascending, descending types, Rf values, Thin layer chromatography (TLC) and Gas Liquid chromatography (Instrumentation, principle, supporting media, columns, methodology, analysis of results and applications. Detectors of Gas Chromatography) HPLC: Principle, instrumentation, columns, materials, practical procedure and analysis of results. Applications of HPLC and HPTLC.

UNIT-III

Methods based on hydrophobic interaction: Principle, reverse phase media, methodology and applications.

Methods based on Biological affinity: Affinity chromatography: Principle, supporting media, ligands, linker arms, Methodology and applications.

Methods based on Charge: Ion exchange chromatography: Principle, types of changers, supporting media, Methodology, Automatic amino acid analyzer and its applications.

Methods based on Size: Gel permeation chromatography Principle, Gel matrices–sephadex, acrylamide, agarose gels, Methodology, Applications – molecular weight determination, desalting.

UNIT-IV

Electrophoresis: Ion movement in electric field, electrophoretic process, different tank systems, supporting media starch, paper, acrylamide, agarose, agarose-acrylamide. Polyacrylamide gel electrophoresis DISC and slab, SDS PAGE; Isoelectric focussing, two-dimensional gel electrophoresis, immunoelectrophoresis, high voltage electrophoresis, Denaturing gels for RNA separation, electroelution, detection of subunit composition and molecular weight. Pulse field electrophoresis and capillary electrophoresis.

UNIT-V

Blotting techniques: Southern blot, western blot, and northern blot – general methodology and applications.

Spectroscopic techniques: Principles of Spectroscopy; Beer-Lambert's Law. Instrumentation and biological applications- Spectrophotometry, Fluorimetry, Flame photometry, Atomic absorption Spectroscopy (AAS), I.R. Spectroscopy.

REFERENCE BOOKS:

1) The tools of Biochemistry – Terrace.E.Cooper (John Willey).
2) A Biologists guide to Principles and Techniques of Practical Biochemistry, Ed.Bryan, L.Willians & Keith Wilson (Edward Arnold).
3) Biochemical research techniques – A practical introduction. Ed. John M.Wriggelssorth.
4) Principles & Techniques of Practical Biochemistry – Wilson and Walker.
5) Analytical Biochemistry. David. J.Home & Hazelpeck. (Longman).
6) Practical Clinical Biochemistry, (5 th edition) – H.Varley, A.H.Cowenlock, M.Bell
7) A manual of Radiology. J.C.Steward & D.M. Hawcroft. (Sidgwick)
8) Instrumental methods of chemical analysis – B.K. Sharma publications)
9) Physical principles and Techniques of Protein chemistry – Leach. (Parts A, B, C)
10) 10.Text book of biochemistry – west and Todd
11) Physical Biochemistry (II ed 1983) by D Friefelder, WH Freeman & Co., USA
12) Biophysical chemistry – Upodhya and Nath (Himalaya publications)
13) Physical Biochemistry (II ed 1985) by vanHolde KE, Prentice Hall Inc., New Jersey.

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CO1	3	2	3	2	3	3	2	2	3	2
CO2	3	1	3	3	2	3	3	3	3	3
CO3	2	2	3	3	2	3	2	2	2	2
CO4	3	2	3	2	3	3	3	3	3	3
CO5	2	2	3	3	3	3	3	3	3	3

COMPULSORYFOUNDATION:

MBC 1.3 (22): ADVANCED ENZYMOLOGY

COURSE OBJECTIVES:

- Provide a deeper insight into the fundamentals of enzyme structure, function and kinetics of enzymes.
- Deals with current and future potential of enzyme technology in clinical and Industry applications.
- Learn the techniques of Enzyme purification and assays
- Catalytic properties key enzymes that revolutionized in the field of Biochemistry.

COURSE OUTCOMES

CO1: By the end of the course, students will be able to recite the mechanisms of enzyme catalysis and how to use this knowledge to design experiments to study enzyme function.

CO2: By the end of the course, students will be able to describe different methods used for enzyme purification and characterization.

CO3: By the end of the course, students will be able to classify the specific catalytic mechanisms of action for various enzymes and describe the regulation of enzymes in the biological system.

CO4: By the end of the course, students will be able to formulate different methods for enzyme purification and characterization.

CO5: By the end of the course, students will be able to identify and apply wide applications of the knowledge to use enzyme technology in medicine and industry and how to design enzyme-based assays for diagnostic and therapeutic purposes.

UNIT-I

Introduction to enzymes: structure, classification and enzyme units. Specificity of enzyme action: types of specificity, the active site; Fisher and Koshland hypothesis and transition-state stabilization. Holoenzyme, apoenzyme, coenzyme and cofactors; Enzyme purification techniques; Techniques of enzymatic analysis: continuous and discontinuous assays.

Isoenzymes, Multienzyme complexes (pyruvate dehydrogenase complex), Ribozymes, Abzymes and Zymogens.

UNIT-II

Enzyme kinetics to understand the mechanism of the effect of substrate on the initial velocity of a reaction; Transition state; Reaction kinetics (Pre steady state, steady state and post-steady state); Factors affecting enzyme catalysis – pH, Temperature and substrate on enzyme kinetics.

Kinetics of single substrate reactions: rapid equilibrium and steady-state approach, Derivation of Michaelis-Menton equation; significance of enzyme kinetics parameters (Km, Vmax, Kcat, Kcat/Km), determination of kinetics parameters using Linear transformations.

Kinetics of bisubstrate reactions: Pre-steady state kinetics; Sequential and Ping Pong reactions.

Sigmoidal Kinetics and allosteric enzymes: MWC and KNF models; Cooperativity – the Hill equation. Allosteric regulation of aspartate transcarbamoylase by CTP and ATP.

UNIT-III

Enzyme inhibition: Reversible inhibition (competitive, uncompetitive, and mixed inhibitions), Kinetics for determining inhibition mechanisms. Irreversible inhibition: Suicide inactivators (reaction of diisopropylfluorophosphate (DIFP) with chymotrypsin); Inhibition of ornithine decarboxylase by DFMO. Conversion of dUMP to dTMP by thymidylate synthase and dihydrofolate reductase.

UNIT-IV

Mechanism of enzyme catalysis: general acid-base catalysis (mechanism of action of Ribonuclease A), metal ion catalysis (mechanism of action of carbonic anhydrase), covalent and general acid-base catalysis (reaction catalyzed by chymotrypsin).

Role of coenzymes in enzyme catalyzed reactions: NADH and NADPH and Flavin Nucleotides

Mechanisms of enzyme catalysis: Chymotrypsin, Lysozyme, and Carboxypeptidase A.

UNIT-V

Enzyme Technology: Applications of Industry and medicine. Clinical Enzymology- serum enzymes in health and diseases. Immobilization of enzymes; Enzyme Engineering: Chemical Modification and Site- Directed Mutagenesis.

REFERENCE BOOKS:

1) Lehninger Principles of Biochemistry (2017 & 2005). Edited by David L. Nelson and Michael M. Cox (4th and 7th editions).
2) Enzymes (2007). Authored by Trevor Palmer and Philip Bonner (2nd edition).
3) Enzyme Kinetics: A Modern Approach (2012). Authored by by A.G. Marangoni (Wiley India).
4) Principles of Biochemistry (2012): Voet-Voet-Pratt (4th edition; Wiley).
5) Biochemistry (2015). Edited by Jeremy M. Berg, Lubert Stryer et al. (8th edition; WH freeman).

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CO1	3	1	3	2	3	-	2	3	2	2
CO2	3	3	3	3	3	-	2	3	2	2
CO3	3	3	3	3	3	-	3	3	3	3
CO4	2	3	3	3	3	-	2	3	1	2
CO5	3	1	3	3	2	3	2	3	3	2

ELECTIVE FOUNDATION

MBC 1.4. A (22): CELL BIOLOGY AND PHYSIOLOGY

COURSE OBJECTIVES:

- Learn the fundamentals of cell biology such as structure and functions of cell and subcellular organelles in both prokaryotes and eukaryote
- Understand the cell physiological aspects of cell membranes- function, transport of ions and communication
- Discuss the basic mechanism underlying digestive, nervous, muscular and excretory systems.

COURSE OUTCOMES

CO1: By the end of the course, students will be able to recite the basic structures and functions of cells, including the roles of organelles, cytoskeleton, and membrane transport.

CO2: By the end of the course, students will be able to describe the physiological functions of different cell types, including neurons, muscle cells, and epithelial cells.

CO3: By the end of the course, students will become familiar with the mechanisms of disease at the cellular level, including the roles of mutations, infections, and other factors.

CO4 By the end of the course, students will be able to develop critical thinking and problem-solving skills, including the ability to design experiments, analyze data, and interpret scientific literature related to cell biology and physiology.

CO5: By the end of the course, students will be able to identify and apply their knowledge, such as communication skills, and how to present scientific findings orally and in writing.

UNIT-I

Structural organization and comparison of prokaryotic and Eukaryotic cells, The ultra structure, composition and function of nucleus, mitochondria, endoplasmic reticulum, Golgi complex, peroxisomes, lysosomes. Cytoskeleton-microtubules and microfilaments.

UNIT-II

Biomembranes: Chemical composition of membranes – organization of lipids, Carbohydrates and proteins. The basement membrane-structural features and characteristics.

Molecular structure of membranes: Micelle, and liposome, asymmetry of the membrane; Membrane fluidity; Fluid mosaic model of biological membranes; Structure of RBC membrane;

Isolation of membrane and techniques used to study membrane structure, membrane biogenesis.

UNIT-III

Membrane Transport: Diffusion across cellular Membranes, Active, passive and mediated transport mechanisms. Energetics of transport system, passive transport anion exchange proteins, active transport. Active transport of Na^+ K^+ (Na^+ $K^{+\cdot}$ ATPase) Ca $^{2+}$ (Ca $^{2+}$ ATPase),

Na^+ dependent symport system (Sugars coupled to phosphorylation, group translocation. (gama-glutamyl cycle). Transport process in bacterial (systems) Membranes – proton motive force in bacterial transport processes. Ionophores, Gap junctions. Endocytosis, Exocytosis. Pinocytosis. Receptor mediated endocytosis.

UNIT-IV

Digestive system: Secretion, composition and functions of saliva, gastric, pancreatic, intestinal and bile juices in the digestion of ingested foods. Digestion and absorption of carbohydrates, proteins and lipids in gastrointestinal tract.

Nervous system:Outlines of organization of nervous system; blood brain barrier; nerve growth factor. Origin of membrane potential, mechanism of propagation nerve impulse of synaptic transmission. Myelin sheath – composition and function. Neurotransmitters Biogenic amines, aminoacids and peptides. Transmission at cholinergic, adrenergic nerve endings, Use of agonists and antagonists.

UNIT-V

Muscle: Types of muscles, structure of striated muscle fiber, molecular organization of contractile systems, molecular mechanism of contraction and relaxation of muscle. Differences and comparison among skeletal, cardiac & smooth muscles. Role of nitric oxide as vasodialator in smooth muscle.Regulation and energetics of contraction. Role of calcium.

Excretory system: Kidney structure and its functions, rennin-angiotensin system, mechanism of urine formation and urine composition, role of kidney in maintaining water, electrolyte and acid base balance.

REFERENCE BOOKS:

1) Cell biology – De Roberties and De Roberties.
2) Cell and Molecular biology – Shieler and Bianchi.
3) Biochemistry –West et al.\
4) Principles of Biochemistry. – A. L. Lehninger.
5) Text book of Biochemistry with clinical correlations (ed.) Thomas M.Devlin, (John Wiley).
6) Harper's review of Biochemistry – Martin et al (Longman)
7) Biochemistry L.Stryer. (Freeman) Dynamics of Biological Membranes – M.D.Houselay and K.K.Stainless (John wiley).
8) Introduction to Biological membranes (2nd edn 1988) M K Jain, John Wiley Sons, NY.
9) Comprehensive introduction to membrane biochemistry (1987) by D B Datta.
10) Biological membranes: Their structure and function (2^{nd} edn 1980) Harrison R.
11) Text Book of Medical Physiology (10^{th} edn 2001) by A G Guyton and Hall J E. Harcourt, Asia.
12) Review of Medical Physiology (12th ed, 1985) Ganong W F lange Medical Pub. Cell biology Karp et al.

CO-PO MAPPING TABLE: TABLE:

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	2	2	1	2	3	2
CO2	3	1	2	3	2	1	1	3	3	3
CO3	2	2	2	3	2	1	1	2	2	2
CO4	3	2	1	2	1	3	1	3	3	3
CO5	2	2	1	3	1	3	1	3	3	1

ELECTIVE FOUNDATION:

MBC 1.4. B (22): HUMAN PHYSIOLOGY

COURSE OBJECTIVES:

The main objectives of this course are to:

- This course presents an Introduction and provides a comprehensive, balanced introduction to this exciting, evolving and multi-disciplinary field.
- Learn or know the biological, physiological activities along with the mechanism of action of various organs.

COURSE OUTCOMES:

CO1: By the end of the course, students will be able to memorize the basic principles of human physiology, including the roles of different organ systems in maintaining homeostasis.

CO2: By the end of the course, students will be able to describe the molecular and cellular mechanisms underlying physiological processes, such as muscle contraction, neuronal signaling, and hormone secretion.

CO3: By the end of the course, students will be able to interpret scientific literature related to human physiology.

CO4 By the end of the course, students will be able to analyze research data, including the ability to design and carry out experiments, and communicate scientific findings both orally and in writing.

CO5: By the end of the course, students will be able to identify complex pathophysiology underlying disease conditions.

UNIT I

Composition, types and functions of blood and plasma. Blood volume, blood volume regulation, immunity, haemostasis, blood groups. Haemopoiesis.

Blood coagulation - mechanism, fibrinolysis, anticoagulants. Hemoglobin - structure, abnormal types, anemia, Blood corpuscles.

UNIT II

Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above.

Sense organs – Vision, hearing and tactile response.

UNIT III

Digestive secretions - composition, functions and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Digestions and absorption of carbohydrates, lipids, proteins and nucleic acids.

Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, electrolyte balance, acid-base balance.

UNIT IV

Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.

UNIT V

Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture.

Muscle physiology.

REFERENCE BOOKS:

1) Textbook of Medical Physiology, Guyton and Hall 15th Edition, Publisher: Saunders (2015)
2) Human Physiology by C. C. Chatterjee, CBS Publishers & Distributors; 13th revised edition, volume 2 (2020).
3) Review of Medical Physiology by William. F. Ganong. McGraw-Hill Medical; 22nd editions (2005).
4) Physiology and Mechanisms of Disease by Arthur C. Guyton, John E. Hall. Saunders, 6th Edition (1997).
5) V. Bhuvaneswari, T. Devi, Big Data Analytics, Scitech Publisher, 2018
6) Han Hu, Yonggang Wen, Tat- Seng, Chua, Xuelong Li „Toward Scalable Systems for Big Data Analytics: A Technology Tutorial", IEEE, 2014.

EXPECTED COURSE OUTCOMES:

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

1) Obtain a deep knowledge regarding blood
2) Gives an idea about heart and its regulation
3) Provides Knowledge about digestive secretion and urine formation
4) Obtain an insight about respiration and Neurons
5) Provides knowledge about Hormone and its regulation

ONLINE CONTENT:

1) Introductory Human Physiology Syllabus-revised Feb. 2022.doc
2) Animal Physiology https://nptel.ac.in/courses/102/104/102104042/#
3) NOC: Animal Physiology https://nptel.ac.in/courses/102/104/102104058/

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CO2	3	1	-	1	3	1	-	3	1	3
CO3	1	3	3	1	3	1	3	3	1	3
CO4	1	3	-	3	3	1	3	3	1	-
CO5	1	2	-	3	3	3	-	1	3	-

ELECTIVE FOUNDATION:

MBC 1.4. C (22): FUNDAMENTAL BIOCHEMISTRY

COURSE OBJECTIVES:

The main objectives of this course are to:

- This course emphasizes the basics of biomolecules and its significance.
- Enable the students to learn the basic functions, structures and biological importance of lifeless chemical compounds.
- On successful completion of the course the students of other disciplines should have understood the significance of the complex bio-molecules, polysaccharides, lipids, proteins, nucleic acids, vitamins and minerals.

COURSE OUTCOMES:

CO1: By the end of the course, students will be able to recite the fundamental concepts and principles of biochemistry, including the structure and function of biomolecules such as proteins, carbohydrates, lipids, and nucleic acids.

CO2: By the end of the course, students will be able to review, analyze and interpret experimental data and scientific literature.

CO3 By the end of the course, students will be able to illustrate biochemistry concepts to non-experts and present research findings both orally and in writing.

CO4 By the end of the course, students will be able to apply radiobiological techniques in research and development

CO5: By the end of the course, students will be able to relate the interdisciplinary nature of biochemistry and its applications in fields such as medicine, agriculture, and biotechnology

UNIT I

Biomolecules: Molecular logic of life, major constituents of cells. Classification, structure and functions of carbohydrates (glucose, fructose, lactose, Maltose, sucrose, glycogen, starch).

Lipids (fatty acids, phospholipids, triacylglycerol), proteins (hemoglobin, albumin, myoglobin, collagen and insulin) and nucleic acids (RNA and DNA).

UNIT II

Enzymes- Classification, compartmentation of enzymes, enzyme inhibition, use of enzymes, endocrine glands.

Hormones. Polypeptides and steroids. Immunoglobulins and immune action.

UNIT III

Metabolism: outline of metabolism, anabolism, catabolism, oxidation of glucose to CO_2 and H_2O, synthesis of glucose.

Protein synthesis, lipid biosynthesis. Inborn errors of metabolism.

UNIT IV

Biochemical techniques in biochemistry: safety and good lab practices.

Microscopy, centrifugation, chromatography, immunoassays (ELISA/RIA), UV-VIS spectroscopy.

UNIT V

Radiobiology,Detection and measurement of radio activity techniques - G.M. counters, proportional counter, scintillation counters and auto radiography Biological effects of radiation, Application of radioisotopes in biochemical sciences.

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CO1	3	2	-	1	3	1	-	3	1	3
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CO3	1	3	3	1	3	3	3	3	1	3
CO4	1	3	-	3	3	1	3	3	1	-
CO5	1	1	-	1	1	1	-	3	3	-

PRACTICAL-I: BIOCHEMICAL ANALYSIS

1) General reactions of carbohydrates. Specific reactions of different sugars: Ribose, Glucose,
2) Fructose, Galactose, Sucrose, Maltose, Lactose, Starch and Glycogen.
3) General reactions of proteins and Aminoacids.
4) General reactions of lipids and Cholesterol.
5) Isolation and estimation of cholesterol from brain.
6) .Isolation and estimation of glycogen/starch.
7) Estimation of Fructose in Fruit juice.
8) Estimation of proteins in biological samples: a.) Biuret method
9) Lin-lowry method c.)UV method, d.)Bradford dye binding method. Titration curve of aminoacids and calculation of pk and pi values.
10) Estimation of aminoacids by formal titration.
11) Estimation of amino acid by ninhydrin method.
12) Estimation of tyrosine by Millions method.
13) Estmation of praline by Colorimetric method.
14) Identification of N-Terminal group of proteins by Sanger's method.
15) Preparation of Casein from milk.

PRACTICAL-II: ANALYTICAL METHODS

1) Effect of solvent system on the Rf value of two solutes using paper and Thin layer Chromatography.
2) Separation of purines and pyrimidines by paper chromatography.
3) Separation of amino acids by paper chromatography.
4) Separation of sugars by TLC.
5) Separation of lipids by and TLC.
6) Separation of amino acids by Ion exchange chromatography (demonstration)
7) Separation of metalloenzymes by affinity chromatography.
8) Determination of Molecular weight of protein by gel permeation chromatography.
9) Precipitation of serum proteins and desalting by Dilaysis (or) Spin gel permeation chromatography – Lyophilization of desalted protein fractions.
10) Separation of Serum proteins by paper electrophoresis.
11) Determination of subunit composition of protein by SDSPAGE.
12) Absorption spectra of phenol red, Amino acids and Nucleic acids.
13) Verification of Beer's law and determination of molar extinction coefficient using Bromophenol blue (or) Para nitrophenol.
14) Isolation and spectrophotometric characterization of metalloporphyrins.
15) Measurement of specific rotation of sugars by polarimeter.

SECOND SEMESTER

M.Sc. BIOCHEMISTRY

SEMESTER-II

MANDATORYCORE I:

MBC 2.1 (22): CLINICAL BIOCHEMISTRY

COURSE OUTCOMES:

- Basics of laboratory practices in clinical biochemistry.
- Disorders of nitrogen, carbohydrate and lipid metabolism; dysfunction of gastro intestinal tract, liver, kidney and its clinical significance.
- Various diagnostic procedures related to clinical biochemistry.
- To understand the fate of drug.

COURSE OUTCOMES:

CO1: By the end of the course, students will be able to memorize the laboratory techniques used in clinical biochemistry, including the principles of instrumentation and assay development.

CO2: By the end of the course, students will be able to extend their knowledge to interpret and analyze laboratory results in clinical samples

CO3: By the end of the course, students will be able to demonstrate and appreciate quality control and quality assurance practices in the clinical laboratory, as well as laboratory regulations and accreditation standards.

CO4 By the end of the course, students will be able to acquire effective communication skills, including the ability to explain laboratory results to healthcare providers and patients.

CO5: By the end of the course, students will be able to apply and evaluate and evaluate clinical biochemistry in personalized medicine and the importance of interdisciplinary collaboration in healthcare

UNIT-I

Clinical Biochemistry: Introduction and maintenance of clinical laboratory, hazards in clinical biochemistry laboratory, units, normal range, reference values. Factors affecting reference values, quality control in laboratory – use of external and internal standards. Automation in clinical laboratory. Collection and preservation of specimens.

Disorders of gastrointestinal tract: Test of gastric function- fractional test meal. Pentagastrin test, insulin stimulation test. Hyperchlorohydria, achlorohydria, achylia gastrica, chloride shift, alkaline tide. Pancreatic exocrine secretion – composition. Duodenal contents – collection, examination following stimulation of pancreas; analysis; malaabsorption syndrome due to intestinal disease and pancreatic dysfunction; differential diagnosis. Disaccharidase deficiency.

UNIT-II

Disorders of nitrogen metabolism: Non-protein nitrogenous compounds in blood and urine, urea, creatine, creatinine, ammonia, aminoacids and their clinical significance. Aminoacidurias - overflow, renal, specific. Inbornerrors of aminoacid metabolism-phenylketonuria, alkaptonuria, hartnup's disease, maple-syrup urine disease, hyperuricemia-primary and secondary gout, Lesh- Nyhan syndrome, orotic aciduria, xanthinuria.

Prophyrin, haemoglobin and related compounds: Porphrias: classification, clinical and biochemical features. Hepatic and erythropoietic porphyrias. Porphyrinuria. Tests used in investigation of porphyrias and Porphyrinuria. Occurrence of haemoglobin and related pigments in cells, plasma and urine. Identification of pigments by spectroscopy. Haemoglobinopathies, Thalassemia, sickle cell anaemia.

UNIT - III

Disorders of carbohydrate metabolism: Diabetes mellitus-classification, aetiology, clinical and laboratory features, diagnosis of diabetes mellitus- glucose tolerance test, random, fasting and postpranodial glucose levels; glycosuria. Investigation of glycogen storage disease, galactosemia, hereditary fructosuria, lactose intolerance.

Lipid metabolism: Plasma lipids and lipoproteins and their functions. Hyperlipoproteinemias

classification-primary and secondary. Investigation of lipoproteinemias and lipedemias.

UNIT – IV

Biochemical aspects of liver disease: Liver function tests related to protein. Carbohydrate, lipid pigments metabolism, detoxification and excretion. Serum enzymes in liver disease. Jaundice

classification and differential diagnosis. Kernicterus.

Renal function: Tests for evaluation, concentration, dilution, excretion, clearance tests; Nephritis, nephrotic syndrome.

Infectious diseases at the outset of 21st century like AIDS, SARS, Dengue & corona.

UNIT - V

Clinical Enzymology: Plasma enzyme in diagnosis and prognosis-aminotransferases, creatine kinase, LDH, amylase, phosphatases, choline esterase, glucose 6-phosphate dehydrogenase, gama glutamyl transferase. Isozymes of LDH and alkaline phosphatase. Clinical application of plasma enzyme assays in myocardial infarction, liver disease, and muscle disease.

Introduction to Clinical Pharmacology; Principles and molecular mechanisms of drug action including pharmacokinetics and pharmacodynamics; Principles of Drug Therapy; Usage of drugs in specific clinical conditions; Drug monitoring; General Principles of the central nervous system and cardiovascular pharmacology; Drug evaluation in clinical trials.

REFERENCE BOOKS:

1) Biochemical aspects of human disease –R.S.Elkeles and A.S.Tavil. (Black well scientific Publications,1983)
2) Clinical chemistry in diagnosis and treatment –Joan F.Zilva and P.R.pannall Lloyd-Luke medical books limited 1979.
3) Varley's Practical Clinical biochemistry –Ed.Alan W.Gowen lock (heinmann medical books London, 1988)
4) Clinical diagnosis and management by laboratory methods (john Bernard Henry (W.B.Salunders company,1984)
5) Clinical Biochemistry-S.Ramakirshna and Rajiswami
6) Pharmacology (Sixth Edition): Lippincott's illustrated reviews. Authors: *Karen Whalen et al.*
7) Goodman Gillman's manual of pharmacology & therapeutics. Authors: *Randa Hilal-*
8) *Dandan & Laurence L Brunton*
9) Essentials of medical pharmacology. Author: *KD Tripathi*
10) Rang and Dale's Pharmacology (Editions 6 and 9)

CO-PO MAPPING TABLE:

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CO2	3	-	3	3	3	1	-	3	1	3
CO3	-	3	-	-	3	3	3	3	1	3
CO4	1	-	-	3	-	3	-	3	3	-
CO5	1	1	-	1	1	1	-	3	3	3

MANDATORY CORE II:

MBC 2.2 (22): IMMUNOTECHNOLOGY

COURSE OBJECTIVES:

- Fundamentals of Immunology including immune cells response, molecular mechanisms of antibody generation and antigen processing and presentation
- Immuno deficiency disorders and experimental models. Auto immune diseases, tolerance and Immuno suppressive therapy in clinical transplantation
- Principles of modern vaccines, monoclonal antibodies production, antibody engineering
- and principles of techniques relevant to Immuno diagnostics and therapeutics

COURSE OUTCOMES:

CO1: By the end of the course, students will be able to recall and outline the principles of the immune system and the mechanisms of immune responses against invading pathogens, autoimmune disorders and organ transplantation.

CO2: By the end of the course, students will be able to describe and extend their knowledge in demonstrating immunological assays, such as ELISA, flow cytometry and immunohistochemistry.

CO3: By the end of the course, students will be able to apply the knowledge of immunological techniques used in the development and production of biopharmaceuticals, such as monoclonal antibodies and vaccines.

CO4: By the end of the course, students will be able to develop independent research skills, including the ability to design and carry out experiments, analyze data, and communicate scientific findings both orally and in writing.

CO5: By the end of the course, students will be able to identify and comply with ethical considerations such as animal experiments, informed consent, and intellectual property rights. Further, students will be able to apply their knowledge in developing the new generation vaccines, monoclonal antibodies, etc., and to set up a start-up.

UNIT-I

The Immune system: cells, organs, and microenvironment; primary and secondary lymphoid organs and their role in immune cells development and immune response; Innate and adaptive immune systems. Immunogen, antigen, hapten, epitope, paratope, and adjuvant

T-cell and B cell receptor signaling: molecules participating in T-cell signal transduction pathways; Signal transduction in B cells; T-cell and B-cell activation, differentiation, and memory generation; the structure, classification, functions and enzymatic fragmentation of antibodies. Antibody purification techniques; **Generation of antibody diversity:** mechanism of V (D) J recombination, light chain, and heavy chain gene segment rearrangements and translation.

Signaling of cytokines and chemokines; cytokine-based therapies.

UNIT-II

The immune response: behaviour of immune cells during innate and adaptive immune response; primary and secondary immune responses.

Hypersensitivity and inflammation: hypersensitivity reactions of type I (allergy), type II (antibody mediated), type III (immune complex-mediated), and type IV (delayed-type); chronic inflammation.

The Major Histo Compatibility Complex (MHC) and antigen presentation: The structure and function of MHC-I and MHC-II; organization of MHC genes in mouse and humans; Antigen presenting cells (APCs); The role of MHC in antigen presentation: endogenous and exogenous pathways of antigen processing and presentation

UNIT-III

Immunological tolerance, autoimmunity and transplantation immunology: Central and peripheral tolerance to distinguish self vs. non-self antigens; classification of organ-specific and systemic autoimmune diseases and experimental animal models of autoimmune diseases; Immunological concepts of graft acceptance and rejection during transplantation; Strategies of immunosuppressive therapy in clinical transplantation.

Immunodeficiency disorders: Primary immune deficiencies resulting from congenital defects including replacement therapy; Nude (Athymic) mice, SCID mouse and RAG knockout mice; Secondary deficiencies: Acquired Immuno-Deficiency Syndrome (infection of target cells by HIV, activation of provirus and stage definition by $CD4^+$ T-cell count), HIV associated immunologic abnormalities and antiretroviral therapy.

The complement system: major pathways of complement system; functions of complement system; genetic deficiencies of the complement components; evasion strategy of complement by microorganisms

UNIT-IV

Production of monoclonal antibodies: Preparation of hybrid cell lines for B-cell hybridomas; fusing spleen (plasma) cells with myeloma cells; screening and selection of positive hybrid clones; purification and characterization of monoclonal antibodies; Production of humanized monoclonal antibodies; Diagnostic and therapeutic applications of monoclonal antibodies

UNIT - V

Concepts of vaccines: Active and passive immunization; Classification and preparation of vaccines for humans; DNA vaccines, mRNA vaccines

Immunological Techniques: Immunoprecipitation and western blotting; ELISA; ELISPOT; Radioimmunoassay; Immunohistochemistry; Immune cells isolation using Flow cytometry; Antibody engineering

REFERENCE BOOKS:

1) Kuby Immunology- 8th edition (2018) and 7th edition (2013) - *W. H. Freeman and Company (publisher).*
2) Roitt's Essential Immunology- 13th edition (2017)-*Wiley Blackwell (publisher).*
3) Janeway`s Immunobiology- 9th edition (2017); Authors: Kenneth M. Murphy and Casey Weaver- *W. W. Norton & Company (publisher).*
4) Lehninger Principles of Biochemistry (2017 & 2005). Edited by David L. Nelson and Michael M. Cox (4th and 7th editions).

RESEARCH OR REVIEW ARTICLES:

1) M-RNA vaccines - a new era in vaccinology (2018). Published in Nature Reviews Drug
2) Discovery doi: 10.1038/nrd.2017.243. Pub Med ID: 29326426; PMCID: PMC5906799.

CO-PO MAPPING TABLE:

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CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	2	3	3	2
CO5	3	1	3	3	1	3	3	3	3	3

COMPULSORY FOUNDATION:

MBC 2.3 (22): MICROBIAL BIOCHEMISTRY

COURSE OBJECTIVES:

- Learn the basic bacterial structure, isolation, physiology, isolation, characterization and microscopy.
- Understand the structure, replication of viruses and host -virus interactions.
- General characteristics of various animals and plant viruses.

COURSE OUTCOMES

CO1: Understanding the fundamental principles of microbial biochemistry, including microbial metabolism, energy generation, and nutrient uptake.

CO2: Ability to perform and interpret biochemical tests to identify microorganisms and diagnose infectious diseases.

CO3: Knowledge of the molecular mechanisms of microbial pathogenesis and host-microbe interactions.

CO4: Development of independent research skills, including the ability to design and carry out experiments, analyze data, and communicate scientific findings both orally and in writing.

CO5: Appreciation for the role of microbial biochemistry in biotechnology and industrial microbiology, including the use of microorganisms in food production, bioremediation, and biofuels

UNIT-I

Microbial biochemistry: Outlines of Bergey's manual of classification Gram positive and gram negative bacteria. General characteristics of actinomycetes, rickettsia, mycoplasms, spirochetes, fungi. Ultrastructure of bacterium, variant and invariant components of Bacterial cell wall, cell membrane, capsule, cyst, external appendages, cytoplasmic inclusions, nuclear material, ribosomes, Plasmids and endospore. Staining techniques-Endospore and Gram's staining.

UNIT-II

General methods of isolation and cultivation of bacteria. Sterilization methods. Bacterial growth.

Phases of growth and kinetics. Diauxic growth. Synchronous growth, chemostatic cultures.

Continuous cultivation of microbes.

Microscopy: Brightfield microscopy, Darkfield microscopy, fluorescence microscopy, phase contrast microscopy, transmission electron microscopy, scanning electron microscopy, Applications of Microscopy.

UNIT-III

Nutritional requirements in microorganisms: Modes of nutrition – phototrophy, chemotrophy, methylotrphy, organotrophy, mixotrophy, and saprophytic, symbiotic and parasitic mode of nutrition. Control of microorganisms: Fundamentals of control by physical agents control by chemical agents, antibiotics and other chemotherapeutic agents. Role of microorganisms in food spoilage, food borne infections, sewage (domestic and industrial) disposal.

UNIT-IV

Virology: Classification of viruses, Composition and structure of viruses, virusoids, prions, Virus-host interactions. General methods of virus isolation with examples of TMV and T phages; Assay of TMV; Plaque assay for Bacteriophage. Bacteriophage life cycles Qβ, M13 and x174.Llytic and Lysogenic cycle in lambda phage.

UNIT-V

Eukaryotic viruses: Animal viruses, General features and outlines of adenovirus, poliovirus, herpes virus, SV 40, Retrovirus and HIV/AIDS, Hepatitis. Plant viruses – TMV, CaMV, Peanut clump virus and Tomato yellow leaf curl virus. General features of SARS and Bird flu.

REFERENCE BOOKS:

1) Text book of Microbiology – William Burrows.
2) The Microbial world –R.Y.Stainer et al,
3) Microbiology – Peleczar, reid and Chan.
4) Biology of microorganisms – Sandes T.Lyles
5) Fundamentals of Microbiology – M.Frobisher,
6) Microbilogy – Pyalkin,
7) Principles of Microorganisms – Brocks.
8) Microbiology (5th ed 2000) M J Pelczar (jr) & R D Reid, Tata McGraw Hill.
9) Microbiology – Davis Bernard.
10) Fundamental Virology (1995) B. N. Fields, D. M. Knipe, P. M. Howley, R. M.
11) Chanock, J. L. Meenick, T. P. Monath, S. E. Strans, Lippin Cott Raven.

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CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
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CO3	3	3	3	-	-	-	-	-	-	-
CO4	1	3	-	3	3	-	-	1	-	-
CO5	3	1	-	-	1	-	-	3	3	3

ELECTIVE FOUNDATION:

MBC 2.4. A (22): NUTRITIONAL BIOCHEMISTRY & ANALYTICAL CHEMISTRY

COURSE OBJECTIVES:

- Introduce the importance of nutritional measurements in day today life.
- Biochemical significance of vitamins, minerals in various metabolic pathways and discuss the special aspects of nutrition.
- Introduce the methodology applied to study the intermediary metabolism.
- Describe the importance and different types of centrifugations in biochemistry.
- Importance, measurements, detection and applications of radioactivity in biochemistry.
- Familiarize the advanced spectrophotometry to understand the structural aspects of a bio molecule.

COURSE OUTCOMES:

CO1: Understanding the basic concepts of nutrition and the role of macronutrients and micronutrients in human health and disease.

CO2: Ability to perform and interpret analytical methods used in nutritional biochemistry, including chromatography and spectrophotometry.

CO3: Knowledge of nutritional biochemistry in relation to specific diseases and conditions, such as obesity, diabetes, and cardiovascular disease.

CO4: Development of independent research skills, including the ability to design and carry out experiments, analyze data, and communicate scientific findings both orally and in writing.

CO5: Appreciation for the ethical considerations in nutritional research and practice, including issues related to informed consent, confidentiality, and conflicts of interest.

UNIT-I

Nutritional Biochemistry: Calorific values of carbohydrates, fats and proteins, specific dynamic action. respiratory quotient and BMR. Factors effecting BMR. Essential and nonessential amino acids. Nitrogen balance, Determination of biological value of proteins, Kwashiorkor and Merasmus,

UNIT-II

Essential fatty acids and phospholipids in nutrition. Water soluble and fat soluble vitamins. Requirement, Sources and deficiency symptoms. Macro and trace elements in nutrition recommended allowances, sources, deficiency symptoms,

Special aspects of nutrition for the pregnant, lactating women, infants, children, Adults and old age. Obesity, Importance of nutrition under stress conditions.

UNIT-III

Experimental approaches to study of metabolism - Metabolic inhibition, growth studies and Biochemical genetics, isotopic biochemistry, isolated organs, cells and sub cellular organelles Organ perfusion. Use of experimental animals, tissue slices, homogenates and mutant organisms in the study of intermediary metabolism

UNIT-IV

Centrifugation Techniques: Basic principles of centrifugation, preparative centrifugation, differential, rate zonal, isopycnic and equilibrium iso density centrifugation, analysis of subcellular fractions, assessment of homogeneity. Analytical ultracentrifuge and its applications.

Spectroscopy techniques- NMR spectroscopy and Mass Spectrometry, X-ray Diffraction of protein crystallography.

UNIT-V

Radioactivity: Stable and radio isotopes, Nature of radioactivity-half life, decay constant and units of radioactivity. Detection and measurement of radio activity techniques-G.M. counters, proportional counter, scintillation counters and auto radiography. Radiation dose units, Roentgen, REP, REM, maximum permissible dose, lethal dose and tolerance doses. Evaluation of exposed doses-dosimetry and dosimeters. Biological effects of radiation, Application of radioisotopes in biochemical sciences.

REFERENCE BOOKS:

1) Nutrition: An integrated approach (3 rd edn. 1984) R L Pike and M L Brown, Wiley and Sons Inc. NY.
2) Text Book of Biochemistry and Human Biology G P Talwar, Prentice Hall.
3) Mechanism and Theory in Food Chemistry (1996) DWS Wong, CBS, New Delhi.
4) Text Book of Human Nutrition (1996) M S Bamji N Pralhad Rao and V Reddy, Oxford & IBH Publishers.
5) Nutritional Biochemistry and Metabolism Linten.
6) Principles of Food Science –I (Food Chemistry) Fennemona D R.
7) Human Nutrition and Dietetics (8 th Ed. 1982) by Davidson and Passmore ELBS.
8) Modern Nutrition in Health and Diseases (7 th ed 1988) by Maurice E Skills and VR Young K M Varghese Co. Bombay.
9) The tools of Biochemistry – Terrace.E.Cooper (John Willey).
10) A Biologists guide to Principles and Techniques of practical Biochemistry – Ed.Bryan, L.Willians & Keith Wilson. (Edward Arnold).
11) Biochemical research techniques – A practical introduction. Ed. John M.Wriggelssorth.
12) Principles & Techniques of Practical Biochemistry –Wilson & Walker
13) Analytical Biochemistry. David. J.Home & Hazelpeck. (Longman).
14) Practical Clinical Biochemistry, (5^{th} edition) – H.Varley, A.H.cowenlock & M.Bell
15) A manual of Radiology.J.C.Steward & D.M. Hawcroft. (Sidgwick &)
16) Biophysical chemistry – D.Freifelder
17) Biophysical chemistry – Upodhya and Nath (Himalaya publications)

CO-PO MAPPING TABLE:

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	1	1	1	1	1	1
CO2	3	3	3	3	-	-	-	1	-	-
CO3	3	3	3	-	-	-	-	-	-	-
CO4	3	3	-	3	3	-	-	1	-	-
CO5	3	1	-	-	1	-	-	3	3	3

ELECTIVE FOUNDATION:

MBC 2.4. B (22): NUTRITION AND CLINICAL BIOCHEMISTRY

COURSE OBJECTIVES:

The main objectives of this course are to:

- The main objective of this course is to introduce about Dietary requirements and energy content in foods needed for human body
- The course aims to give exposure to learn about malnutrition, starvation, protein metabolism in prolonged fasting and diseases that occur due to malnutrition.
- Provide knowledge about carbohydrate, lipid and nucleic acid metabolic disorders
- Offer knowledge about hemoglobin metabolism and associated diseases
- Give knowledge about functional tests of organs and clinical diagnosis of diseases by enzymatic assays
- Provide awareness about application of Artificial Intelligence in health and medicine.

COURSE OUTCOMES

CO1: Understanding the biochemical basis of human nutrition and the role of macronutrients and micronutrients in health and disease.

CO2: Ability to interpret laboratory data and diagnose nutritional deficiencies and metabolic disorders.

CO3: Knowledge of clinical biochemistry, including the use of biomarkers and other diagnostic tools to evaluate health and disease status.

CO4: Development of independent research skills, including the ability to design and carry out experiments, analyze data, and communicate scientific findings both orally and in writing.

CO5: Appreciation for the ethical considerations in nutrition and clinical research and practice, including issues related to informed consent, confidentiality, and conflicts of interest.

UNIT I

Diet, Balanced diet, calorific value of foods, nutritional requirements, RDA, BMR, biological value of proteins, energy value of fats, protein calorie deficiency (Kwashiorkor and Marasmus), malnutrition (under nutrition and over nutrition), Obesity, dietary guidelines for Indians.

UNIT II

Micronutrients: water soluble and fat-soluble vitamins- structure, sources, requirements, functions and deficiency symptoms.

UNIT III

Microminerals – calcium, phosphorus, magnesium, sodium, potassium, chloride.

Micro Minerals – Iron, zinc, copper, selenium.

UNIT IV

Use of clinical biochemistry in Medicine. Use of biochemical tests, specimen collection and sample analysis. Tests for diabetes, thyroid, jaundice, lipid profile, anemia and tumor markers.

UNIT V

Organ function tests – Liver function tests, kidney function tests.

Plasma enzymes in diagnosis and prognosis – Transaminases, CK, LDH, Alkaline phosphatase, α-amylase, molecular diagnostics.

CO-PO MAPPING TABLE:

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	1	-	1	1	-	1	-	-
CO2	-	3	3	3	-	-	1	1	-	-
CO3	-	3	3	-	-	-	-	-	-	-
CO4	1	3	-	3	3	-	-	1	-	-
CO5	3	1	-	-	1	-	-	3	3	3

ELECTIVE FOUNDATION

MBC 2.4. C (22): FOOD MICROBIOLOGY

COURSE OBJECTIVES:

- Food Microbiology is a comprehensive course designed for students to understand the microorganisms that cause disease and spoilage in foods and find ways of controllingthem.
- This course provides knowledge of food composition, protection, preservation and food processing methods.
- Students will also learn about food-borne diseases caused by various microorganisms and drug resistance.

UNIT I

History and development of Microbiology-Importance and significance of microorganisms in food science. Bacterial growth curves, Factors affecting the growth of micro organisms in food – Intrinsic and Extrinsic parameters

UNIT II

Determination of microorganisms and their products in food: Sampling, sample collection, transport and storage, sample preparation for analysis. Microscopic and culture dependent methods- Direct microscopic observation, culture, enumeration and isolation methods; Chemical and Physical methods-Chemical, immunological and nucleic acid based methods;

UNIT III

Protection and preservation of Foods:

Chemical, Modified atmosphere, Radiation in foods from the microbiological angle. Indicators of water and food safety and quality: Microbiological criteria of foods and their Significance.

UNIT IV

Food spoilage: characteristic features, dynamics and significance of spoilage of different groups of foods - Cereal and cereal products, vegetables and fruits, meat poultry and sea foods, milk and milk products, packed and canned foods.

UNIT V

Food borne diseases: *Bacterial borne diseases* (Staphylococcal intoxification, Botulism, Salmonellosis, Shigellosis, Enteropathogenic Escherichia Coli Diarrhoea, *Clostridium Perfringens* gastroenteritis, Bacillus cereus Gastroenteritis).*Mycotoxins:* Aflatoxicosis, Deoxynivalenol Mycotoxicosis, Ergotism. Drug resistance - phenomena and mechanism.

LEARNING OUTCOMES:

- Will be able to identify the pathogens and spoilage microorganisms in foods and the conditions under which they will grow.
- Understand the principles that make a food product safe for consumption.

- Will be able to identify the conditions such as sanitation practices and inactivation of pathogens that spoils foods.
- Will define a problem, identify potential causes and possible solutions, and work effectively in teams.

TEXT BOOKS AND REFERENCE MATERIALS:

1) Prescott LM Harley JP and Klein DA (2006). Microbiology (7th edition) McGraw Hill, Newyork.
2) Frazier, W.C. (1988) Food Microbiology, Mc Graw Hill Inc. 4th Edition.
3) Vijaya Ramesh,K. (2007) Food Microbiology. MJP publishers, 2007
4) Yasmine Motarjemi and Martin Adams. (2006) Emerging Food borne pathogen- Wood Head Publishing England.
5) Arun, K Bhunia. (2008) Food borne microbial pathogens: Mechanisms and pathogenesis. Springer.
6) Thomas J. Montville, Karl R. Matthews, Kalmia E. Kniel (2012). Food Microbiology: An Introduction, American Society for Microbiology.
7) Dubey, R.C. and Maheswari, D.K. (2008) Text book of Microbiology. S Chand Publishing.

CO-PO MAPPING TABLE:

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CO1	3	1	3	2	3	-	2	3	2	2
CO2	3	3	3	3	3	-	2	3	2	2
CO3	3	3	3	3	3	-	3	3	3	3
CO4	2	3	3	3	3	-	2	3	1	2
CO5	3	1	3	3	2	3	2	3	3	2

PRACTICAL-I: ENZYMOLOGY

1) Amylase from Saliva.
2) Urease from Horsegram
3) Acid phosphatase from potato.
4) Alkaline phosphatase from serum.
5) SDH from liver.
6) Trypsin.
7) invertase.
8) LDH from Serum (Isoenzymes).
9) Acetylcholine esterase activity.
10) Purification and study of enzyme kinetics with respect to substrate and enzyme
11) concentrations pH, temperature, activators and inhibitors and immobilization.

PRACTICAL-II: IMMUNOLOGY & CLINICAL BIOCHEMISTRY

A. IMMUNOLOGY

1) Total RBC and WBC count.
2) WBC differential count.
3) Erythrocyte sedimentation rate (ESR).
4) Packed cell volume (PCV)
5) Estimation of Haemoglobin (Hb).
6) Mean Cell Haemoglobin and Mean Cell RBC volume.
7) Estimation of serum antibodies by Biuret method.
8) Immunodiffusion.
9) Single radial Immuno diffusion.
10) Rocket Immuno-electrophoresis.
11) Crossover Immuno-electrophoresis.
12) Detection of HCG by Latex Agglutination inhibition test.
13) Detection of Rheumatoid arthritis (Auto immune disease) by slide agglutination tests.
14) Haem agglutination tests for identification of human blood groups.
15) Detection of viral fever by slide agglutination tests.

B. CLINICAL BIOCHEMISTRY

1) Estimation of blood glucose.
2) Estimation of blood urea.
3) Estimation of creatine in serum.
4) Estimation of uric acid in serum.
5) Estimation of serum total protein and albumin.
6) Estimation of serum cholesterol.
7) Estimation of serum bilirubin.
8) Estimation of serum SGOT, SGPT activity,
9) Estimation of serum alkaline phosphatase activity.
10) Estimation of serum calcium.
11) Estimation serum phosphate.
12) Agar gel electrophoresis of serum proteins and serum lipoproteins.
13) Test for abnormal constituents in urine.

THIRD SEMESTER

M.Sc. BIOCHEMISTRY

SEMESTER-III

MANDATORY CORE-I

MBC 3.1 (22): INHERITANCE BIOLOGY

COURSE OBJECTIVES:

- Refresh the fundamentals of Mendelian and advanced genetics.
- Understand the organization of genome and modern gene concepts.
- Information about the mechanism of gene transfer and gene mapping
- Significance of cellular signaling pathways leading to abnormal cell division and programmed cell death.

COURSE OUTCOMES:

CO1: By the end of the course, students will be able to memorize and outline the concepts of gene, genotype, phenotype and cell division

CO2: By the end of the course, students will be able to describe how programmed cell death regulates cell division turnover under normal and cancer conditions

CO3: By the end of the course, students will be able to evaluate the significance of gene transfer in the evolution of living organisms applicable to research

CO4: By the end of the course, students will be able to identify and discuss mechanisms of genetic mutations to translate into applied research

UNIT-I

Mendelian Inheritance: Law of Dominance, Law of Segregation and Law of Independence assortment and deviations of Mendelian inheritance. **Extra chromosomal inheritance**-inheritance of Mitochondrial and Chloroplast. Sex-linked inheritance. Polygenic inheritance. Identification of Nucleic acids as genetic material.

Genome Organization: in Viroids, Viruses, Prokaryotic and Eukaryotic chromosomes. Histones and non-Histones type DNA binding proteins. C-value paradox. Plasmids, Transposons.

UNIT-II

Concepts of Cistrons, Recons and Mutons. Single copy genes, unique sequences, repetitive sequences and tandem gene cluster-Histone genes, Immunoglobulin genes. Mutations-Different types of mutations and nature of mutagens. Detection and isolation of mutants. Mechanism of mutation. Benger's fine structure of rII locus. Ames test. Site directed mutagenesis. Eugenics and Euphonics.

UNIT-III

Cell growth and Cell division: Mitosis and Meiosis. Cells cycle parameters, specific events in the cell cycle, control of cell cycle, Internal and external mitotic inducers. Cell death – Apoptosis, Protooncogenes and Oncogenes.

UNIT-IV

Gene transfer mechanisms: Transformation, Conjugation, and Transduction - Generalized, abortive and specialized transduction. Mechanism of general recombination, cross over, Site specific recombination

UNIT-V

Elements of gene mapping: Gene linkage. Mapping by recombination analysis. Multiple crossover and interference. The circular chromosome and mapping by conjugation. Tetrad analysis and complementation analysis. Mapping by transformation and transduction. Map units and cytological maps of eukaryotic chromosomes. Somatic cell genetics.

REFERENCE BOOKS:

1) Genetics – Gardener,
2) Molecular Genetics of Bacteria 2nd edition 1995, Jeremy W.Dale.-John Wiley and sons.
3) Cell biology (1993)-David E.Sadva (Jones and Barrette).
4) Modern genetics (2nd edition,1984)-A.J.Ayala and W.Castra(Goom Helns,London)
5) Genetics by P.K Gupta.
6) Genetics by Verma and Agarwal.
7) Text Book of Molecular Biology –K.Sivaramasastry, *etal*, Macmillan India Ltd., 1994.
8) Genetics by m.W.Strickberger.
9) Enetics by Weaver.

CO-PO MAPPING TABLE:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	3	3	3	1	3	3	3	3
CO2	3	3	3	3	3	-	3	3	3	3
CO3	3	3	3	3	3	-	3	3	3	3
CO4	3	3	3	3	3	-	3	3	3	3

MANDATORY CORE-II

MBC 3.2 (22): MOLECULAR BIOLOGY- I

COURSE OBJECTIVES:

- Types of replication, Enzyme involved in DNA replication, DNA repair mechanisms.
- Discuss the mechanism of transcription and mRNA processing.

COURSE OBJECTIVES:

CO1: By the end of the course, students will be able to recall and the define basic concepts in molecular biology

CO2: By the end of the course, students will be able to describe the significance of replication machinery and process of replication in prokaryotes and eukaryotes

CO3: By the end of the course, students will be able to evaluate and discuss the DNA repair mechanisms

CO4: By the end of the course, students will be able to evaluate the molecular mechanisms involved in transcription post transcriptional modifications and could relate to the future research

CO5: By the end of the course, students will be able to identify and apply the knowledge practically in molecular biology research.

UNIT I

DNA Replication: DNA Super helicity, linking number, topological properties and mechanism of action of topoisomerases. Semiconservative replication, Experimental proof for semiconservative replication, replication forks, DNA polymerases of Prokaryotic and Eukaryotic. Continuous and discontinuous synthesis, Evidence for Okazaki model, RNA primers. Enzymes in replication-Single-stranded DNA binding proteins (SSBS), Helicases, DNA primases, DNA ligase.

UNIT – II

Prokaryotic replication mechanism: Replication of E.coli, rolling circle replication, Replication of x174, Bacteriophage M13, Negative strand(VSV), positive strand(polio virus), retrovirus, DNA virus(SV-40, Adenovirus), Eukaryotic DNA replication, Autonomous replicating sequences (ARS).

UNIT – III

Mitochondrial DNA replication, Termination and fidelity of replication; Fusion of replicons and termination signals. Telomers.

Repair of DNA: Direct reversal of damage, Excision repair, Recombination repair, SOS response. Identification of carcinogens. Inhibitors of DNA replication.

UNIT-IV

Transcription: Polynucleotide phosphorylase, RNA polymerases, Structure of E.coli RNA polymerase, Interaction between RNA polymerase and template. Chain initiation, elongation and termination. Eukaryotic RNA polymerases, Promoter and enhancer sequences.

Inhibitors of transcription, Synthesis of different RNA molecules; synthesis of ribosomal RNA, 5S- r RNA and tRNA.

UNIT – V

Maturation and processing of RNA: Methylation, cutting and trimming of rRNA, capping polyadenylation and splicing of mRNA, catalytic RNA, group I and group II intron splicing, spliceosomes, trans-splicing, RNase P.

REFERENCE BOOKS:

1) Biochemistry, 4th Edition 4th, Voet, Donald, Voet, Judith G.
2) Lubert Stryer - Biochemistry
3) Mathews, van Holde & Ahern, Biochemistry, 3rd Edition
4) Molecular biology of the cell-B.Alberts,D.Bray,J.Lewis M.Raff,K.Roberts and J.D.Watson Garland Publishing New York and London.
5) Molecular biology a comprehensive introduction to prokaryotes and eukaryotes – D.Frefeilder, (Jones and Bartlett,USA)
6) Modern genetics (2nd edition, 1984)-A.J.Ayala and W.Castra(Goom Helns,London)
7) Genes V.(1994)-Benjamin Lewin.(oxford university press).

CO-PO MAPPING TABLE:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	-	3	3	3	3	3
CO2	3	3	3	3	-	3	3	3	3	2
CO3	3	3	2	3	1	3	2	3		
CO4										
CO5										

ELECTIVE-I:

MBC 3.3. A (22): PLANT BIOCHEMISTRY

COURSE OBJECTIVES:

- To understand the basic function of plant cell and stress metabolism.
- To learn the biochemical mechanism of photosynthesis and carbon paths.
- To trace out the biochemical significance of plant hormones and secondary metabolites.
- Importance and significance of Nitrogen metabolism.
- Applied plant physiology and molecular biology.

COURSE OUTCOMES:

CO1: By the end of the course, students will be able to recite the plant physiology and functional significance of subcelluar organelles.

CO2: By the end of the course, students will be able to describe stress metabolism and anti-oxidant defence mechanisms

CO3: By the end of the course, students will be able to classify plant secondary metabolites and hormones, including their molecular mechanisms

CO4: By the end of the course, students will be able to apply knowledge to improve stress tolerance by genetic manipulation

CO5: By the end of the course, students will be able to formulate the methodology for creating transgenic plants

UNIT-I

Structure and functions of plant cell (including cell wall, plasmodesmata, meristematic cells, vacuoles, secretary systems and root quiescent zone), Isolation and characterization of subcellular organelles.

Generation of Reactive Oxygen Species (ROS): sites of cellular ROS production, the effect of ROS on cellular metabolism at high and low concentrations; Oxidative stress damage; Anti-oxidant defense mechanism including enzymatic and non-enzymatic components.

Stress physiology in plants against various environmental stresses (biotic and abiotic): Water stress on membranes, stomata, photosynthesis, and hormones. Mechanism of salt resistance and tolerance, Low and high-temperature stress; biotic stress by pathogenic organisms; metal toxicity; effect of radiation.

UNIT-II

Photosynthesis: Photosynthetic apparatus, pigments of photosynthesis, Light dependent reactions (Cyclic and non-cyclic electron flow); Calvin cycle (C3 plants), Hatch slack (C4 plants) & CAM pathways of carbon fixation and reduction. Photorespiration.

UNIT-III

Phytohormones: Structure, classification, biosynthesis, physiological roles, and molecular mechanism of auxins, cytokinins, abscisic acid, ethylene, and gibberellins.

Secondary plant metabolites: Terpenes (classification, biosynthesis), biosynthesis of nicotine and lignin, functions of alkaloids; role of protease inhibitors in plant defense.

UNIT-IV

Nitrogen Metabolism: Biological nitrogen fixation. Biochemistry and genetics of Nitrogenase complex. Nitrate and nitrite reductases and bacterial hydrogenases. Mechanism of nitrate transport and assimilation; Incorporation of Ammonium into carbon skeleton.

UNIT-V

Applied plant physiology and molecular biology: Genetic engineering principles to the production of transgenic plants: Agrobacterium and microprojectile gun mediated methods; Genetic transformation of chloroplasts. Hairy root cultures to produce secondary metabolites; Genome editing (CRISPR-Cas9) for crop improvement. Status of transgenic plants in India.

REFERENCE BOOKS:

1) Introduction to Plant Physiology: authored by William G. Hopkins and Norman P.A. Huner (4th edition 2013; Wiley).
2) Introduction to Plant Biochemistry: authored by Goodwin and Mercer (2nd Edition; 2005).
3) Biochemistry and Molecular Biology of Plants. Edited by Bob B. Buchanan, Wilhelm Gruissem, and Russell L. Jones (2nd edition 2015; Wiley Blackwell).
4) Pallavi Sharma, Ambuj Bhushan Jha, Rama Shanker Dubey, Mohammad Pessarakli, "Reactive Oxygen Species, Oxidative Damage, and Antioxidative Defense Mechanism in Plants under Stressful Conditions", Journal of Botany, vol. 2012, Article ID 217037, 26 pages, 2012. https://doi.org/10.1155/2012/217037

CO-PO MAPPING TABLE:

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	1	3	1	2	3	1	1
CO2	3	3	3	3	3	1	2	3	1	3
CO3	3	3	3	3	3	1	2	3	1	2
CO4	3	3	3	3	3	1	3	3	3	3
CO5	3	1	3	3	3	3	3	3	3	3

ELECTIVE-I
MBC 3.3. B (22): FOOD TECHNOLOGY

COURSE OBJECTIVES:

- To acquire knowledge of emerging technologies and standards in food processing and safety.
- To understand the nature of food contamination and to assess various drug residues in food
- To understand the processes and quality control management of various fermented foods.

COURSE OUTCOMES:

CO1: By the end of the course, students will be able to remember and define the need for different emerging techniques used in food processing and preservation.

CO2: By the end of the course, students will be able to describe the concepts of fermentation technology related to dairy products, beverages, and other traditional foods.

CO3: By the end of the course, students will be able to evaluate and apply the knowledge of food toxicity and quality assessment of food applicable to the industry

UNIT-I

Food Regulations and Standards, Sampling methods - Sample preparation for analysis; Statistical evaluation of analytical data - Official Methods of Food Analysis. Moisture in foods - determination by different methods - ash content of foods, wet, dry ashing, microwave ashing methods; Significance of Sulphated Ash, water soluble ash and acid insoluble ash in foods determination of dietary fiber and crude fiber.

UNIT-II

Analysis of major food components, determination of total fats in foods by different methods; Analysis of oils and fats for physical and chemical parameters, Quality standards, and adulterants; different methods of determination of protein and amino acids in foods; determination of total carbohydrates, starch, disaccharides and simple sugars in foods.

UNIT-III

Processing and preservation of foods `

Blanching, pasteurization, sterilization, microwave heating. Low Temperature-refrigeration, freezing, dehydro-freezing. Food irradiation. Processing and preservation by drying, concentration and evaporation. Non-thermal methods like High pressure, pulsed electric field, hurdle technology. Use and application of enzymes and microorganism in processing and preservation of foods. Refrigeration, freezing.

UNIT-IV `

Environmental contaminants and drug residues in food:

Fungicide and pesticide residues in foods; heavy metal and their health impacts; use of veterinary drugs (e.g. Malachite green in fish and β-agonists in pork); other contaminants in food, radioactive contamination of food, Food adulteration and potential toxicity of food adulterants. Endocrine disrupters in food.

UNIT-V

Fermentative food Products

Foods: Processes for preparing fermented products including Yogurt (curd) and other Traditional Indian Products like idli, dosa, dhokla, shrikhand, Soya based products like soya sauce, natto,.,, Cheese.; Alcoholic Beverages based on fruit juices (wines), cereals (whisky, beer, vodka,), sugar cane (rum) Process description, quality of raw materials, fermentation process controls.

REFERENCE BOOKS:

1) A first course in food analysis By A. Y. Sathe.
2) Hand book of analysis and quality control for fruit & vegetable products By S. Ranganathan.
3) Handling and storage of food grains by S. V. Pingale.
4) Food science chemistry & experimental food By Dr. M. Swaminathan.
5) Food chemistry by William Hogland Meyer.
6) Food adulotration By Thankamma Jacob.
7) Food Microbiology by William C. Frazier.
8) Preservation of Fruits and Vegetables by Giridharilal.

CO-PO MAPPING TABLE:

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	1	3	1	2	3	1	1
CO2	3	3	3	3	3	1	2	3	1	3
CO3	3	3	3	3	3	1	2	3	1	2

ELECTIVE I

MBC 3.3. C (22): ADVANCED CELL BIOLOGY

COURSE OBJECTIVES:

- To update knowledge on types of cancer, causes of cancer as well as on molecular mechanism of carcinogenesis.
- To be familiar with various methods used for cancer diagnosis and on therapeutic strategies used to control tumour cell proliferation.
- To become updated on types of stem cell, its characterization, pluripotency and niche specification.

COURSE OUTCOMES:

CO1: By the end of the course, students will be able to memorize basic concepts of cancer metabolism and its impact on life expectancy

CO2: By the end of the course, students will be able to classify various types of cancer, and discuss causes of cancer including molecular mechanisms underlying carcinogenesis

CO3: By the end of the course, students will be able to demonstrate cancer diagnosis & therapy and appraise the significance of stem cell biology concepts and applications

CO4: By the end of the course, students will be able to formulate strategies for stem cell therapy in modern biology and medicine

Unit: 1 Introduction to Cancer Biology

Definition; Cancer incidence and mortality; Origin of neoplastic cells; Cancer as cellular disease; Types of Cancer: Benign Tumours Vs. Malignant Tumours, Common Symptoms, Causes of Cancer: Carcinogenesis-Chemical and Irradiation; Oxygen Free Radicals, Aging and Cancer; Genetic Susceptibility and Cancer; Viral Carcinogenesis.

Unit: 2 Cancer Molecular Mechanism & Diagnosis

Molecular Mechanism of cancer: protooncogenes, oncogene, tumour suppressor genes involved in cancer, errors in cell cycle (Cyclins and CDKs). Apoptosis in cancer – mechanism of apoptosis, intrinsic and extrinsic pathways. Principles and methods of cancer diagnosisBiochemical, genetic, cytotoxic, cell growth and viability tests, cancer biomarkers.

Unit: 3 Cancer Diagnosis & Therapy

Cancer, Diagnosis & Therapy: Tumour Markers; Gene Expression Microarrays; Proteomic Methods; Circulating Epithelial Cells; Circulating Endothelial Cells and Endothelial Progenitor Cells; Molecular Imaging; Application of cancer database in health care and industries. Haplotype Mapping. Cancer therapy: Surgery, Radiotherapy, Chemotherapy, Hormone therapy, Immune, Prodrug and Targeted therapies, Bone marrow transplantation.

Unit: 4 Stem Cell Biology

Introduction to Stem Cell: Definition, Types of Stem cell, characterization, pluripotency, niche specification – Drosophila germ line stem cells, self-renewal and differentiation, tooth

primordia, gut specifications. Occurrence of stem cell in mammals: In Mesenchymal cells - Hemangioblasts, skeletal muscle cells, adipose cells, bladder cells; In Epidermal cells – skin, mammary gland, dental and neural cells; In Endodermal cells – liver, GI tract, pancreatic cells

Unit: 5 Stem Cell Types and Applications

Embryonic Stem Cells: Blastocyst and inner cell mass cells, Organogenesis, Adult versus embryonic stem cells, post genomic adult stem cells, stemness, characteristics, hierarchy, stem cell niche; Adult stem cell from amniotic fluid and cord blood; induced pluripotency stem cells (ips cells). Stem cell characterization techniques and cryopreservation, Shelf life of stored stem cells.

REFERENCE BOOKS:

1) Principles of Cancer Biology – 2016 by Kleinsmith; Publisher: Pearson Education India; First edition 2 Molecular biology of cancer, 3rd edition – 2014 by Pecorino; Publisher: Oxford University Press
2) The Biology of Cancer – 2013 by Robert Weinberg; Publisher: W. W. Norton & Company; 2 nd edition
3) The Molecular Basis of Human Cancer – 2018 by William B. Coleman (Editor), Gregory J. Tsongalis; ublisher: Humana Press Inc.; Softcover reprint of the original 2nd ed. 2017 edition.
4) Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics– 2012 by Pecorino; Oxford University Press; 3rd edition.
5) Stem Cells: Current Challenges and New Directions (Stem Cell Biology and Regenerative Medicine) – 2013 by Kursad Turksen; Publisher: Humana Press; 2013 edition.

CO-PO MAPPING TABLE:

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CO2	3	3	3	3	3	1	2	3	1	3
CO3	3	3	3	3	3	1	2	3	1	2
CO4	3	3	3	3	3	1	3	3	3	3

ELECTIVE II

MBC 3.4. A (22): INTERMEDIARY METABOLISM

COURSE OBJECTIVES:

- To understand metabolic pathways of carbohydrates including glycolysis and fermantaion.
- To understand the pathways of biosynthesis and degradation of lipid, amino acids and nucleic acids

COURSE OUTCOMES:

CO1: By the end of the course, students will be able to memorize and define pathways of intermediary metabolism of biomolecules, and discuss bioenergetics, hormonal regulation and cellular localization

CO2: By the end of the course, students will be able to describe various metabolic activities with their function in tissues and organs

CO3: By the end of the course, students will be able to evaluate and apply how disruptions in intermediary metabolism links disease and illustrate with relevant examples

UNIT-I

Carbohydrate Metabolism: Glycolysis and Fermentation. Different forms of fermentation. Pasteur effect. Control of glycolysis in muscle. Metabolism of fructose, galactose and mannose. Reactions of TCA cycle. Anaplerotic reactions. Amphibolic nature Energy yields and central importance of the pathway. The Coricycle. Gluconeogenesis

UNIT-II

Glucose-alanine cycle. Lactose synthesis. Glycoprotein synthesis. Hexose monophosphate shunt. Uronic acid pathway. Amino sugar pathway. Glycogen metabolism. Breakdown and synthesis of glycogen. Control of glycogen metabolism.

Mechanism of oxidative phosphorylation: Electron transport system, Organization of electron carriers and enzymes in mitochondria, Inhibitors of electron transport system, Mechanism of oxidative phosphorylation – various theories, uncouplers of oxidative phosphorylation, Microsomal electron transport.

UNIT-III

Lipid Metabolism: Fatty acid oxidation, role of carnitine, metabolism of tri acyl Glycerolsphospholipids and glycolipids. Biosynthesis of fatty acids, Regulation of fatty acid metabolism. Biosynthesis of cholesterol and its regulation. Ketone bodies metabolism, Archidonate metabolism – synthesis of prostaglandins, prostacyclins, thromboxanes and leukotrienes.

Amino acids metabolism: General modes of amino acid catabolism, decarboxylation, transamination, oxidative deamination and other mechanisms, Role of pyridoxal phosphate in amino acid metabolism. Urea cycle and its regulation.

UNIT-IV

Biosynthesis and degradation of Non Essential amino acids: Alanine, Cysteine, Glycine, Serine, Tyrosine, Asparagine, Aspartate, Glutamate, Glutamine and Proline.

Biosynthesis and degradation of Essential amino acids: Histidine, Isoleucine, Leucine, Lysine, Methionine, Phenylalanine, Threonine, Tryptophan and Valine.

UNIT-V

Biosynthesis and degradation of heme and its regulation. Biosynthesis of Biogenic amines.

Importance of Biogenic amines.

Nucleic Acid Metabolism: Biosynthesis of purines and its regulation. Biosynthesis of pyrimidines and its regulation. Salvage pathways of nucleic acid biosynthesis. Biosynthesis of deoxyribonucleotides and its control. Catabolism of purine and pyrimidines.

REFERENCE BOOKS:

1) Principles of Biochemistry. –A.L.Lehninger (CBS Publishers).
2) Biochemistry –Lubert Stryer (5 th edition).
3) Principles of Biochemistry –General aspects –Smith et al., (7 th edition)
4) Harper's Review of Biochemistry –Martin et al., (Lange).
5) Text book of Biochemistry with Clinical correlation –Thomas M.Devlin ; John Weiley)(2 nd edition).
6) Text book of Biochemistry West et al.,(1966)(Mac Milan:)
7) Biochemistry –Voet and Voet.

CO-PO MAPPING TABLE:

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	1	3	1	2	3	1	1
CO2	3	3	3	3	3	1	2	3	1	3
CO3	3	3	3	3	3	1	2	3	1	2

ELECTIVE II

MBC 3.4. B (22): GENETICS AND DEVELOPMENTAL BIOLOGY

COURSE OBJECTIVES:

The main objectives of this course are to:

- The main objective of this course is to introduce concepts in Genetics and Developmental Biology. This course emphasizes learning about the principles involved in Mendelian genetics and Non-Mendelian inheritance and techniques used to diagnose genetic diseases and mutation concepts.
- The course aims to give exposure to learn the basic concepts involved in developmental biology such as Potency, commitment, specification, induction, competence, determination and differentiations and morphogenetic gradients.
- This course also provides knowledge about Cell division in cleavage, Rudimental organs, Gametogenesis and Fertilization approaches.

COURSE OUTCOMES:

CO1: By the end of the course, students will be able to memorize basic concepts of Mendelian genetics, history, Monohybrid, Dihybrid and Trihybrid cross, Mendelian ratio of segregation, interaction of genes, alleles, Extrachromosomal inheritance, Extensions of Mendelian principles

CO2: By the end of the course, students will be able to describe the concept of determination and differentiation; morphogenetic gradients; cell fate and cell lineages and imprinting

CO3: By the end of the course, students will be able to evaluate and differentiate the process of cell division in cleavage, patterns in embryonic cleavage after fertilization. To know about the development of primary organs and Rudimental organs

CO4: By the end of the course, students will be able to distinguish the process involved in spermatogenesis, gametogenesis and fertilization

UNIT I

Principles of Mendelian inheritance; Mendel's experiments-monohybrid, dihybrid trihybrid and multi hybrid crosses.

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

Extensions of mendelian principles: Codominance, Incomplete dominance, Gene interactions, Pleiotropy, Genomic imprinting, Penetrance and expressivity, Phenocopy, Linkage and crossing over. Sex linkage, Sex limited and sex influenced characters.

Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance.

UNIT II

Gametogenesis–Origin of germ cells–Significance of gametogenesis.

Oogenesis – Types of eggs– growth, development and maturation of oocyte, Egg envelopes, Polarity and symmetry.

Spermatogenesis–Sperm Structure, Types of sperm, Fertilization – Approach of spermatozoon– Reaction of egg, essence of activation – Changes in egg cytoplasm caused by fertilization.

UNIT III

Potency, commitment, specification, induction, competence, determination and differentiation; cell fate and cell lineages.

Stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.

UNIT IV

Cell division in cleavage–Chemical changes–Patterns of embryonic cleavage – Morula and Blastula – Role of egg cortex – Morphogenetic gradients – Fate map – Gastrulation – Primary organ, Rudimental organs, Organizer – Morphogenetic movements. Anterior and posterior axis differentiation in drosophila.

REFERENCE BOOKS:

1) Molecular Biology of the cell by Alberts *et al*.
2) Cell and Molecular Biology by EDP de Robertis and EMF de Robertis.
3) Cell and Molecular Biology 2nd Ed. By P.K. Gupta, Rastogi Publ.
4) Principles of Genetics 5th Edition by Gardner, M. J. Simmons 2006, D. P. Snustad John Wiley & Sons.
5) Developmental biology, Gilbert, Scott F, Singer, Susan Sunderland, Mass Sinauer Associates, c2000. 6th ed. United States
6) Animal Regeneration, Diwan A.P., Dhakad N.K., 1996, Anmol Publications Ltd
7) Developmental Biology, Browder L.W., Erickson C.A., And Jeffery W.R, 1991 Saunder college Publishing House, Philadelphia.
8) Genetics by Gardner
9) Genetics by Suzuki
10) Molecular genetics by Klug and Cummings
11) Cell and Molecular Biology 2nd Ed. by P.K. Gupta, Rastogi Publ.

CO-PO MAPPING TABLE:

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	1	3	1	2	3	1	1
CO2	3	3	3	3	3	1	2	3	1	3
CO3	3	3	3	3	3	1	2	3	1	2
CO4	3	3	3	3	3	1	3	3	3	3

ELECTIVE II
MBC 3.4. C (22): MEDICAL BIOCHEMISTRY

COURSE OBJECTIVES:

- The aim of the course to understand the concepts various biochemical tests of hematology and metabolic processes in human body.
- It will help to acquire knowledge on advanced diagnostics methods, instruments, and their applications.
- It will help to understand basic immunological techniques with relevant laboratory Exercises

COURSE OUTCOMES:

CO1: By the end of the course, students will be able to understand and memorize the basics concepts and biological significance of various biomedical tests
CO2: By the end of the course, students will be able to describe and demonstrate diagnostic procedures consistent with a sound theoretical background
CO3: By the end of the course, students will be able to appraise and comply with ethical and good laboratory practices in biomedical work.
CO4: By the end of the course, students will be able to design experiments, identify and apply specific methods for biochemical assays to plan and carry out experiments

UNIT - I

Introduction

Organization of Clinical Immunology laboratory. Introduction and maintenance of clinical Immunology laboratory; hazards in clinical laboratory; units; 'normal range', reference values. Factors affecting reference values quality control in laboratory – use of external and internal standards; use of WHO standards.

Exercises

Collection of blood and separation of Serum and their storage. Haemagglutination tests for identification of human blood groups.

UNIT - II

Composition of blood and Lymph

Plasma and cells-RBC, WBC, platelets, blood clotting, plasma proteins, separation and applications, plasma therapy. Lymph.

Exercises

R.B.C. count, Total and differential count in human peripheral blood, Separation of mononuclear cells from human peripheral blood, Enumeration of T & B-cells from human peripheral blood.

UNIT - III

Advanced diagnostic methods

Identification of viral, bacterial and other diseases - ELISA, Western blot, RT-PCR-Tissue Histopathology, fixing, staining (H&E) and microtome sections.

Exercises

Erythrocyte Sedimentation Rate (ESR), Packed Cell Volume (PCV), Estimation of Haemoglobin (Hb), Mean Cell Haemoglobin and Mean Cell RBC volume. H &E staining.

UNIT - IV

Auto immunity

Introduction, Auto recognition, classes of auto immuno diseases. (Hashimoto disease, thyrotoxicosis, Systemic lupus erythomatosis, Autoimmune haemolytic anaemia, Rheumatoid arthritis).

Exercises

Tests for Rheumatoid arthritis, Systemic lupus erythomatosis, CRP. Detection of HCG by latex agglutination inhibition test. Widal test, VDRL test.

UNIT – V

Immunoglobulins (Igs)

Types of Igs, nature and structure of Igs –Light chain, heavy chain and functions. Adjuvants, Antibody production, enzymatic cleavage of Igs, Haptens.

Exercises

Precipitation & Agglutination reactions, Immuno diffusion & Radial diffusion, Single Radial Immunodiffusion, Ouchterlony double immuno diffusion.

REFERENCE BOOKS:

1) Essential Immunology - By I. Roitt, Publ: Blackwell
2) Immunology - By G. Reever & I. Todd, Publ: Blackwell
3) Abbas AK, Lichtman AH, Pillai S. Cellular and Molecular Immunology. Saunders Publication, Philadelphia
4) Golds by RA, Kindt TJ, Osborne BA. Kuby's Immunology. W.H. Freeman and Company, New York
5) Ronald Hoffman, Edward J. Benz Jr., Leslie E. Silberstein, Helen Heslop, Jeffrey Weitz, John Anastasi - Hematology: Basic Principles and Practice, Elsevier Health Sciences, 2012
6) Betty Ciesla, Hematology in Practice, F.A. Davis, 2011.

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CO2	3	3	3	3	3	3	2	3	3	2
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	2	3	3	2

PRACTICAL-I: MICROBIAL TECHNIQUES

PREPARATION OF LIQUID AND SOLID MEDIA FOR GROWTH OF MICROORGANISM.

1) Isolation and maintenance of organisms by plating, streaking and serial dilution methods. Slant and stab cultures.
2) Isolation of pure cultures from soil and water.
3) Determination of growth curve of bacteria (*E.coli* and *Pseudomonas*)
4) Bacterial population count by turbidimetry determination method.
5) Bacterial staining by Gram's, Acid fast and spores.
6) Effect of pH on bacterial growth.
7) Assay of antibiotics and demonstration of antibiotic resistance.
8) Bacterial transformation.
9) One step growth curve of coli phage.
10) Determination of biological oxygen demand (BOD) of water.

PRACTICAL-II: PLANT & NUTRITIONAL BIOCHEMISTRY

1) Estimation of plant pigments – Carotenoids, Chlorophyll.
2) Estimation of total phenols in plants.
3) Estimation of Flavonols and Tannins in plants.
4) Estimation of Capasicin by spectrophotometric method.
5) Estimation of reduced ascorbic acid by DCPIP method.
6) Estimation of total Ascorbic acid by DNPH method.
7) Estimation of thymine by colorimetry, Fluorimetry.
8) Estimation of riboflavin by fluorimetry.
9) Estimation of niacin by cyanogen bromide method.
10) Estimation of available lysine in fruits.
11) Estimation of magnesium, copper, iron, calcium, Phosphorus in food.
12) Estimation of protein in plant seeds by micro Kjeldahl method.
13) Estimation of fat in plant seeds (Gravimetry).
14) Determination of saponification value in seed oil.
15) Determination of iodine value in oil.

REFERENCE BOOKS:

1) Practical Clinical Biochemistry by Verly
2) Practical Microbiology by R.C.Dubey and D.K Maheshwari
3) Microbiology a laboratory manual by Cappuccino Sherman
4) Introductory practical Biochemistry by S.K. Sawhney and Randhir Singh
5) Experimental Biochemistry a Student Companion by B.Sashidhar Rao and V.Deshpande
6) Molecular Cloning –A Laboratory manual, Volume 1, 2, & 3 Sambrook.
7) Molecular biotechnology: Principles and applications of Recombinant DNA (1996)
8) Bernard R.Glick and Jack J.Pasternak (Panima Publishers Corporation).
9) Principles of Gene manipulation: An introduction to genetic Engineering(5^{th} ed.)
10) R.V. old and S.B.Primrose (Blackwell Scientific Publi.).

FOURTH SEMESTER

M.Sc. BIOCHEMISTRY

SEMESTER-IV

MANDATORY CORE-I:

MBC 4.1 (22): APPLIED BIOCHEMISTRY

COURSE OBJECTIVES:

The main objectives of this course are to:

- Emphasizes to learn about the principles involved in fermentation technology, fermentors.
- Exposure to learn the concepts involved in making recombinant proteins and their applications
- Provides knowledge about transgenic plants and animals and their applications.
- Provides basic concepts and applications of stem cells and nanomaterials
- Gain the knowledge in IPRs and Entrepreneurship.

COURSE OUTCOMES:

CO1: By the end of the course, students will be able to understand and recite the methodology and applications of industrially important product production by fermentation technology

CO2: By the end of the course, students will be able to describe the significance of trangenics in research applications

CO3: By the end of the course, students will be able to identify and apply how stem cells differentiate based on their origin and the potential of stem cell therapy to develop treatment strategies related to human diseases.

UNIT I

FERMENTATION TECHNOLOGY: Isolation and preservation and maintenance of industrial microorganisms. Media for industrial fermentation. Air and media sterilization. Basic design of fermenters-Types of fermentation processes-Analysis of batch and continuous culture systems fermentative production of citric acid, ethanol, penicillin, riboflavin, lysine, amylase. Elements of down stream processing-Production of biomass (starter cultures and single cell protein) Bioconversion and microbiological mining.

UNIT II

PROTEIN ENGINEERING: Production of recombinant proteins, with examples of insulin, somatostatin, and interferon. Polymerase chain reaction and its applications. Restriction fragment lengh polymorphism, RAPD, AFLP and its applications, Gene probes in prenatal and antenatal detection of disease. Antisense RNA technology.

UNIT III

PLANT AND ANIMAL BIOTECHNOLOGY: Outlines of plant and animal tissue culture techniques. development and use of transgenic plants and animals. Plant transformations with the Ti plasmid and A. tumefaciens. Ti plasmid-derived vector systems and cloning, physical methods of transferring genes to plants. Developing insect resistant, virus resistant and herbicide resistant plants. Development of transgenic mice retroviral vector method and DNA micro injection method and engineered embryonic stem cell method. Applications of transgenic mice.

UNIT IV

Stem cells: Introduction to stem cells, Definition, Totipotency versus pluripotency, embryonic and adult stem cells, clones and cloning. Applications of stem cells.

Nanotechnology – Introduction, preparation nano probes and chips, application of nanotechnology.

Gene therapy: Introduction and its application.

UNIT V

Intellectual property rights (IPRs): Introduction and the need for IPRs: Patent, Copyright, Trade Mark, Design, Geographical Indication. Legal implications of DNA fingerprinting.

Basic concepts of entrepreneurship: Developing Entrepreneurial Ecosystem for Innovation in Life Sciences, funding opportunities, government plans and programs, licensing and marketing.

REFERENCE BOOKS:

1) A text book on biotechnology by H.D.Kumar Affiliated East –West Press pvt.Ltd., New Delhi.
2) Molecular Biotechnology by Glick and Pasternak
3) Molecular Cloning –A Laboratory manual, Sambrook
4) Biotechnology: A text book of Industrial microbiology.
5) Molecular biotechnology: Principles and applications of Recombinant DNA (1996) Bernard R.Glick and Jack J.Pasternak (Panima publishers corporation).
6) Principles of Gene manipulation: An introduction to genetic Engineering (5^{th} ed.) R.V. old and S.B.Primrose (Blackwell Scientific Publi.).
7) Principles of biotechnology (1985) Alen Weisman (surrey university press)
8) Concepts in Biotechnology (1996) Ed., D.Balasubramanian, *et al* (University press).
9) Molecular Genetics of Bacteria 2^{nd} edition 1995, Jeremy W.Dale.-John Wiley and sons.
10) Cell biology (1993)-David E.Sadva (Jones and Barett)

REFERENCE RELATED TO IPR:

1) Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.

2) Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.
3) Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.

USEFUL WEBSITES RELATED TO IPR:

1) Cell for IPR Promotion and Management (http://cipam.gov.in/)
2) World Intellectual Property Organisation (https://www.wipo.int/about-ip/en/)
3) Office of the Control

CO-PO MAPPING TABLE:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3
CO3	3	2	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	2	2	3	3	3	3	3	3	3

MANDATORY CORE-II

MBC 4.2 (22): MOLECULAR BIOLOGY – II & BIOINFORMATICS

COURSE OBJECTIVES:

- Molecular mechanisms involved in prokaryotic and eukaryotic translation
- Mechanism of protein sorting and degradation
- Regulation of gene expression in prokaryotes and eukaryotes
- Various tools and applications of bioinformatics.

COURSE OUTCOMES:

1) By the end of the course, students will be able to understand and memorize the concepts and ideas in genetic code
2) By the end of the course, students will be able to describe how proteins are being synthesized by prokaryotes and eukaryotes
3) By the end of the course, students will be able to classify and differentiate how synthesized proteins are transported to their targeted regions within and outside the cells.
4) By the end of the course, students will be able to Able to describe the regulation of gene
5) expression in prokaryotes and eukaryotes
6) By the end of the course, students will be able to identify, apply and interpret the
7) information available on biological databases such as NCBI,EMBL, Gen Bank, Protein Data Bank, etc.

UNIT 1

Protein Synthesis: General features of genetic code and its elucidation. Structural components of Prokaryotic and Eukaryotic ribosomes. in-vitro translation systems. t-RNA structure and role in protein biosynthesis. Mechanism of protein synthesis in Prokaryotic and Eukaryotic-Aminoacyl t-RNA synthetases Aminoacylation of tRNA initiation, elongation and termination. Wobble hypothesis. Mitochondrial genetic code. Nonsense suppression. Inhibitors of protien synthesis (Antibiotics and other inhibitors).

UNIT-II

Non ribosomal biosynthesis of polypeptides: Biosynthesis of Gramicidin-s. Post translational modifications.

Protein targetting: Cell organelles and proteins involved in protein sorting. The signal hypothesis, signal sequences and signal recognition particle.

Molecular chaperones. Protein degradation, Lysosomal degradation. PEST sequences. The Ubiquitin pathway. Protein stability and the N-end rule. Translational feed back-Synthesis of ribosomes and ribosomal RNA, Interferons.

UNIT-III

Regulation of Gene Expression: Regulation of gene expression at transcriptional level. The lac repressor. Fine structure of lac operon. cAMP and the catabolic activator protein. Gal operon and concept of dual promoters. Dual functions of the repressor the ara operon. Transcriptional control by attenuation. The trp operon.

UNIT-IV

Eukariyotic Gene Regulation: Positioning chromosomes for transcription. Polytene chromosomes. Gene amplification and gene rearrangements. Transcriptional control by alternative RNA processing and enhancers.

Bioinformatics: Introduction to bioinformatics, human genome project, Biological Database Principles, applications, Primary database- Genbank, EMBL, PDB, SWISSPROT. Specialized Database SCOP/CATH. Database Querying using Key word and search engines.

UNIT-V

Homeotic genes. Gene amplification. DNA binding protein motifs-Helix-turn-helix, zinc finger and leucine zipper motifs.

Sequence Analysis-I: Concepts of DNA/Protein sequence alignments and their importance. Sequence alignment method and programmes- BLAST and FASTA. Pair wise alignment versus multiple sequence alignment. **Sequence Analysis-II.** Phylogenetic analysis and tree construction, sequence analysis of nucleic acids. Computational analysis, determining transcriptional analysis, secondary structure prediction. Primer designing. Genome analysis.

REFERENCE BOOKS:

1) Biochemistry, 4th Edition 4th, Voet, Donald, Voet, Judith G.
2) Lubert Stryer - Biochemistry.
3) Mathews, van Holde & Ahern, Biochemistry, 3rd Edition
4) Molecular biology of the cell-B.Alberts,D.Bray,J.Lewis M.Raff,K.Roberts and J.D.Watson Garland Publishing New York and London.
5) Molecular biology a comprehensive introduction to prokaryotes and eukaryotes D.Frefeilder, (Jones and Bartlett,USA)
6) Modern genetics (2nd edition, 1984)-A.J.Ayala and W.Castra(Goom Helns, London)
7) Genes V.(1994)-Benjamin Lewin.(oxford university press)
8) Bioinformatics sequence, structure and data banks ed. By Des Higgins Willie Taylor – 2000.

LEARNING OUTCOME:

- Describe the importance of genetic code, wobble hypothesis and molecular mechanisms
- involved in prokaryotic and eukaryotic translation
- Understand the various cell organelles involved in protein sorting and degradation
- Discuss the regulation of gene expression in prokaryotes and eukaryotes
- Understand the applications and various tools of bioinformatics

CO-PO MAPPING TABLE:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	-	3	3	-	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	-	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

ELECTIVE I

MBC 4.3. A (22): GENETIC ENGINEERING AND BIOSTATISTICS

COURSE OBJECTIVES:

- Introduction to Genetic Engineering mechanisms and vectors
- Enzymes involved in the process of genetic engineering
- Construction and delivery of recombinants
- Usage of Biostatistics in Biology

COURSE OUTCOMES:

CO1: By the end of the course, students will be able to recite the basic concepts of genetic engineering and vectors used in molecular cloning

CO2: By the end of the course, students will be able to describe the methodology and design of experiments in genetic engineering

CO3: By the end of the course, students will be able to apply the principles of genetic engineering to create recombinants

CO4: By the end of the course, students will be able to describe the basic concepts of biostatistics and software's used

CO5: By the end of the course, students will be able to identify and apply specific statistical tests to evaluate biological research data.

UNIT – I

Introduction to genetic engineering technology – Tools for genetic engineering: Cloning vectors – Vectors of plasmid origin Types, properties and functions, construction of plasmid, Ti-plasmid, yeast plasmid, shuttle and expression vectors, vectors of viral origin - Lambda phage, cosmids, M13 phage, phagemids, bacculovirus, animal and plant viruses, *S.cerevisiae* vectors – yeast plasmids, YACs, yeast expression vectors. Bacterial artificial chromosome.

UNIT -II

Enzymes– Restriction endonucleases, types, properties and applications. DNA and RNA polymerases, nucleases, Polynucleotide, kinase, alkaline phosphatase. DNA ligase, Topoisomerases, lambda exonuclease, terminal transferase, RNase, Reverse transcriptase and their uses in molecular cloning.

Generation of DNA fragments. RE digestion, mechanical shearing, duplex DNA synthesis, chemical synthesis of a gene. Joining of DNA fragments to vectors, Homopolymer tailing, cohesive end, blunt end ligation and linker, adopter DNA molecules and their significance in cloning.

UNIT – III

Construction of cDNA and genomic libraries Partial digestion of DNA – use of cosmids, YACs in generation of genomic libraries.

Deliver/Introduction of recombinant molecules into selected host cells Biological and non-biological means transformation, transduction microinjection, liposomes, electroporation and particle bombardment.

UNIT-IV

Screening techniques for identification of transformed host cells: Genetic, immunological probes, recombination. In situ hybridization technique and dot blot techniques. Principles and preparation of DNA and RNA probes and their applications.

Introduction to Biostatistics: Types of data distribution; Central Tendency- mean, mode, median. Measurement of the spread of data: range, variation of mean, standard deviation, variance, coefficient of variation, standard error of mean. Graphical representation of statistical Data: BAR graphs, Line diagrams, Histo grams, pie charts, and scatter plots.

UNIT – V

Statistical testing of hypothesis: Null hypothesis, level of significance, power of test, P value (one tailed and two tailed tests), statistical estimation of confidence intervals.

Level of significance (Parametric data): Students t test (paired and unpaired), chi-Square test, Analysis of Variance (one-way and two-way)Level of significance (Non-parametric data): Wilcoxan rank sum test (paired t-Test), Mann Whitney U test (unpaired t-Test), Kruskal-Wallis test (one way ANOVA), Newman-Keuls post hoc test (ANOVA) for differences in means.

Linear regression and correlation- Introduction, Pearson correlation, Spearman correlation, and correlation co-efficient

Introduction to statistical software: SPSS (Statistical Package for the Social Sciences-IBM); R (R Foundation for Statistical Computing); MATLAB (The Mathworks); Microsoft Excel; SAS (Statistical Analysis Software); GraphPad Prism; SigmaPlot; Minitab. Application of statistics in biomedical research

REFERENCE BOOKS:

1) Molecular Biotechnology by Glick and Pasternak.
2) Molecular Cloning – A Laboratory Mannual, Sambrook.
3) Principles of Gene manipulation: An introduction to genetic Engineering(5th ed.) R.V. old and S.B.Primrose (Blackwell Scientific Publi.).
4) Biostatistics:A foundation for analysis in the health (7th edition) - W.W. Daniel john Wiley and Sons Inc., New york.
5) Genetic engineering - T.A.Brown.
6) Molecular biotechnology: Principles and applications of Recombinant DNA(1996)Bernard R.Glick and Jack J.Pasternak (Panima publishers corporation).
7) Modern genetics (2nd edition, 1984)-A.J.Ayala and W.Castra(GoomHelns,London)
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CO3	3	3	3	3	3	-	3	3	3	3
CO4	2	3	3	3	3	-	2	3	1	2
CO5	3	1	3	3	2	3	2	3	3	2

ELECTIVE I

MBC 4.3. B (22): ADVANCED GENOME TECHNIQUES

COURSE OBJECTIVES:

The main objectives of this course are to:

- Know the various aspects of functional genomics.
- Understand the functioning of genes and silencing of genes.
- Know the aspects related to protein characterization using mass spectrometry and microarray methods.
- Assimilate the concepts gene characterization using different modern methods.

COURSE OUT COMES:

1) By the end of the course, students will be able to understand and recite the basic concepts of functional genomics
2) By the end of the course, students will be able to describe the significance of RNA silencing and CRISPR/Cas9 mediated gene silencing
3) By the end of the course, students will be able to describe and differentiate Protein–Ligand Interactions
4) By the end of the course, students will be able to analyze Mass Spectrometry for Protein–
5) Protein Interaction Mapping
6) By the end of the course, students will be able to demonstrate protein microarray technology, solid supports, different formats, experimental approach and detection, peptidomics in the context of protein biology.

Unit I

Basics of functional genomics: Concepts and applications, Forward genetics and Reverse genetics approaches, Loss of function, Gain of function.

Tools of functional genomics: T-DNA insertional mutagenesis, Transposon based mutagenesis (Ac/Ds), Activation tagging, Enhancer trapping, GAL4 mediated overexpression, Floxing, Viral mediated transfection.

Genome screening: TILLING (Targeted Induced Local Lesion IN Genome) – principle and experimental approach, ECO-TILLING; DEALING (Detecting Adducts Local Lesion IN Genome) – principle, experimental approach; Site directed Mutagenesis.

Unit II

RNA silencing: Antisense RNA technology, RNAi and Si RNA; SAGE for transcript profiling principle, methodology and applications; Molecular analysis of gene expression (RTPCR)., CRISPR (CRISPR/Cas9)- Mechanism and applications.

Unit III

Gene functions: Identification of Protein–Ligand Interactions.

Yeast Two-Hybrid Selection System: Analysis of genome wide protein–protein interactions in organisms, Use of M13, T7 Phage to Detect Protein– Ligand Interactions, Combining yeast two-hybrid and phage display data, Detecting Interactions with Protein Fragment Complementation Assays.

Mass Spectrometry for Protein–Protein Interaction Mapping: Overview, Identification of substrates for E. coli GroEL, Studying the transcriptome and proteome of Escherichia coli and *Saccharomyces cerevisiae*.

Unit IV

Protein microarrays: overview, principle, limitations; Protein microarray Manufacturing technology, solid supports, different formats, experimental approach and detection, peptidomics.

Unit V

Microarray for protein-carbohydrate interaction (phage display technology); protein domain microarray; protein biochips; Antibody microarray; protein microarray for drug discovery.

REFERENCE BOOKS:

1) Protein Microarrays, edited by Mark schena, Jones and Bartlet pblisher, 2005.
2) Microbial Functional Genomics, Jizhong Zhou, Dorothea K. Thompson, Ying Xu, James M. Tiedje, A John Wiley & Sons, Inc., Publication, 2004.
3) Microarrays for an Integratiul J. But. Kho and Atte, Published in India by Ane Books, 2003.
4) Gene Cloning and DNA analysis An Introduction, Sixth Edition, T. A. Brown, WileyBlackwell publications, A John Wiley & Sons, Inc., Publication, 2010.

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CO3	3	2	3	3	3	2	2	3	3	3
CO4	2	2	2	3	-	-	-	3	3	3
CO5	3	2	2	3	2	2	2	3	3	2

ELECTIVE I

MBC 4.3. C (22): RESEARCH METHODOLOGY

COURSE OBJECTIVES:

The main objectives of this course are to:

- Understand the statistical tools commonly used in biological research
- Assimilate the concepts of hypothesis testing and its importance in research
- Know the aspects fundamental to research and to understand the methods of research
- Know the nuances of technical writing of scientific documents like thesis and journal articles.

COURSE OUTCOMES:

1) Helps to collect data and organize the data
2) Gives a clear understanding about the basic statistical analysis
3) A Clear Knowledge on probability and its application
4) Provides the sampling distribution techniques and its analysis
5) Gives an idea about thesis writing, funding agencies and patenting

Unit I

Technical writing: Sentence writing, paragraph writing, story writing, review writing, various types of letters writing, critical comments writing. Project proposal preparation: Preparation of informal proposal, modified proposal and formal proposal.

Experimental design and Collection of results, submission of progress report (year wise) and submission of technical report (Format: Title page, Introduction, Aims of the proposal / research, methodology, results, references, acknowledgments, budgetary preparation). Submission of final technical Report.

Patenting and intellectual property rights.

Unit II

Introduction of computation: Computer components, storage devices, graphic devises, concepts of hardware and software, methods and types of networks. Basics of operating systems and types python, cython, Information and communication technology (ICT).

Unit III

Bio-Statistics: Data - Data types, collection of data, classification and tabulation. Measures of central tendencies. Mean, median and mode. Measures of variation - Range, quartile deviation, mean deviation and standard deviation.

Unit IV

Coefficient of variation. Probability. Addition and multiplication theories, conditional probability and probability distributors. Binomial, poission and normal distribution. Correlation and linear regression. Regression: Regression coefficients and properties. Small sample tests- t, F and chi square tests. ANOVA - one way and two way classifications.

Unit V

Research Aptitude: Meaning and scope of research, steps of Research, Article and thesis writing. Funding agencies.

Project proposal preparation, Preparation of proposal, Experimental design and implementation of project, submission of progress report (year wise), statement of expenditure (SE), Utilization certificate (UC). Research ethics, Plagiarism.

REFERENCE BOOKS:

1) Statistical methods. S.P.Gupta
2) Fundamentals of mathematical statistics. S.C Gupta &Kapoor
3) Statistical methods in biological and Health Science. J. S. Milton & J.O.Tsokan.

EXPECTED COURSE OUTCOMES:

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

CO-PO MAPPING TABLE:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	3	3	-	-	3	3	3
CO2	3	2	2	2	-	2	2	1	2	2
CO3	3	2	3	3	3	2	2	3	3	3
CO4	2	2	2	3	-	-	-	3	3	3

ELECTIVE II

MBC 4.4. A (22): ENDOCRINOLOGY

COURSE OBJECTIVES:

- Basics of endocrine system including classification, hormone receptors and signal transduction.
- Biochemistry and metabolism of vital hormones such as hypothalamic, thyroid, parathyroid, pancreatic, adrenal and gonadal, gastrointestinal etc.

COURSE OUTCOMES:

CO1: By the end of the course, students will be able to understand and memorize the general characters, classification of hormones, hormone action- signal transduction, types of receptors

CO2: By the end of the course, students will be able to describe the functions of various glands

CO3: By the end of the course, students will be able to differentiate the biosynthetic processes of thyroid hormones, pancreatic hormones and adrenal hormones

CO4: By the end of the course, students will be able to apply and analyze the assay of hormones

CO5: By the end of the course, students will be able to interpret the hormonal regulation of menstrual cycle and Pregnancy in design of research oriented experiments

UNIT-I

Introduction to endocrinology: General characters, Classification hormones. Hormone Action- Signal transduction, Receptors-Types, Structure (Insulin, Thyroid, steroid and Adrenergic receptors) Concept of second messengers (cAMP, IP3 calcium, and NO). Protein phosphorylation and dephosphorylation. Assay of Hormones.

UNIT-II

Role of Calcium: Control of cellular calcium levels, transport and regulation. Interaction between cAMP and calcium. Calcium dependent proteins.

Hypothalamic Hormones-Synthesis, secretion, transport and biological actions of hypothalamic, adenohypophysial and neurohypophysial hormones. Hypothalamic and pituitary disorders. Penial hormones-melatonin and serotonin.

UNIT-III

Thyroidal Hormones: Chemistry, function and metabolism, hypo and hyper thyroidism.

Parathyroid Hormones-Parathormone and calcitonin, their role in calcium and phosphate metabolism, abnormalities of parathyroid functions. Role of vitamin D in calcium and phosphate metabolism.

UNIT-IV

Pancreatic Hormones-Biosynthesis of insulin and glucagon. Regulation of insulin and glucagon secretions. Role in carbohydrate, lipid and protein metabolism. Endocrine disorders of pancreas- Diabetes mellitus, melliturias, hypoglycemia, Glucose tolerance test.

Adrenal Medulla- Chemistry, biosynthesis and function of adrenal medullary hormones. Disorders of Medullary hormones.

UNIT-V

Adrenal Cortex-Chemistry, biosynthesis and function of adrenal cortical hormones. Disorders of cortical hormones.

Gonadal Hormones- Chemistry, biosynthesis and functions of androgens, estrogens and progesterone. hormonal regulation of menstrual cycle and Pregnancy.

Hormones of Gastrointestinal tract- Secretin, Gastrin and cholecystikinin.

REFERENCE BOOKS:

1) General Endocrinology –Turner C.D,
2) Text book of Endocrinology –R.H.Williams
3) Harper's review of Biochemistry,
4) Lehningers Principles of Bochemistry –Nilson and cox.
5) Text book of Biochemistry with clinical correlations –Ed.Thomas, M.Devlin (John Wiley)
6) Biochemistry –Lubert Stryer,
7) Mammalian Bochemistry –White, handler and smith.
8) Endocrinology (4^{th} edition) M.E.Hadley (Prentie Hall)

LEARNING OUTCOME:

- Understand the classification, functional and signaling aspects of vital hormones
- Able to understand the significance and their physiological role of hormones in human beings

CO-PO MAPPING TABLE:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	2	-	2	2	3	2	2
CO3	3	3	3	2	-	2	2	3	3	3
CO4	3	3	-	-	1	1	2	3	2	2
CO5	2	3	3	3	-	-	2	2	3	3

ELECTIVE II

MBC 4.4. B (22): PHARMACOLOGY AND TOXICOLOGY

COURSE OBJECTIVES:

- To study about the basic principles about pharmacokinetics, routes of drug administration
- Understanding the mechanism of drug action, drug receptor interactions, factors affecting the drug receptor interaction
- This course also provides knowledge about drug discovery process, AI in drug discovery process ethical issues and preclinical toxicological studies.

COURSE OUTCOMES:

CO1: By the end of the course, students will be able to understand and memorize the basic principles involved in pharmacokinetics and routes of drug administration processes.

CO2: By the end of the course, students will be able to describe drug metabolism and excretion of drugs

CO3: By the end of the course, students will be able to critically evaluate mechanism of drug action, drug receptor interactions, Factors affecting the drug receptor interaction

CO4: By the end of the course, students will be able to appreciate knowledge on drug discovery process, and comply with ethical issues and apply of AI in drug discovery

CO5: By the end of the course, students will be able to design experiments of toxicological studies in vivo (preclinical) to develop effective dose administration methodology for LD50 and ED50

Unit:1 Basic Principles of Pharmacokinetics

General Principles: Basic principles of drug action-Pharmacokinetics: Absorption, distribution and elimination of drugs, routes of drug administration. Pharmacogenetics. origin of drug from plants and animals.

Unit:2 Drug Metabolism

Drug metabolism – general pathways of drug metabolism (different types of reaction in phase I and phase II with examples), metabolism and excretion of drugs. Mechanism of drug action, combined effect of drugs. Factors modifying drug action, tolerance and dependence.

Unit:3 Pharmacodynamics

Pharmacodynamics - receptor concepts, theory, drug receptor interaction (DRI), Factors affecting DRI, Cholinergic and anticholinergic drugs, Adrenergic and adrenergic blockers, General anesthetics, Local anesthetics. Adverse reactions to drugs and common drug receptor interactions.

Unit:4 Application for New Drug Discovery

Application for New Drug Discovery (NDD) according to Indian Control Authority and USFDA guidelines. Ethical considerations in utilizing human subjects for drug discovery process. Helsinki's declaration. Regulatory requirements for conducting clinical trials. Overview of drugs and cosmetics act.

Unit:5 Toxicology

Principles of toxicology and treatment of poisoning. Heavy metals and antagonists. Non metallic environmental toxicants. Methods involved in the development of new drugs. Role of Artificial intelligence in drug discovery. Preclinical toxicological studies: Calculation of LD50 and ED50.Acute, subacute and chronic toxicity studies; Irwin profile test, Pre-clinical pharmacokinetic and dynamic studies. Lipinski's rule for drug like molecule, High throughput screening (in-vitro and in-vivo) for pre-clinical pharmacokinetic and pharmacodynamic studies.

REFERENCE BOOKS:

1) Satoskar, R.S and Bhandarkar, S.D. (2000) Pharmacology and Pharmacotherapeutics, 13th edition, Vol. I and II, Popular Prakeshan PVT Ltd, Mumbai.
2) Tripathi, K.D. (2013) Essentials of Medical Pharmacology, 7th edition, Jaypee brothers medical publishers, New Delhi.
3) Rang, H.P., Dale, M.M., Ritter, J. and Flower, R.J. (2007) Pharmacology, 6th edition, Churchill Living Stone Elsevier
4) Brenner, G.M. and Stevens, C.W. (2010) Pharmacology, Reed Elsevier India Pvt. Ltd.
5) Sharma, P.D. (2003) Toxicology, 2nd edition, Rastogi Publications, Meerut

CO-PO MAPPING TABLE:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	2	-	2	2	3	2	2
CO3	3	3	3	2	-	2	2	3	3	3
CO4	3	3	-	-	1	1	2	3	2	2
CO5	2	3	3	3	-	-	2	2	3	3

ELECTIVE II

MBC 4.4. C (22): ENVIRONMENTAL BIOCHEMISTRY

COURSE OBJECTIVES:

The main objectives of this course are to:

- Educate students about renewable sources and their importance
- This course provides basic concepts about causatives of environmental pollution.
- Provide knowledge on ecological concepts and environtment.
- This course also provides knowledge about Disaster management and role of Big data in Disaster management.

COURSE OUTCOMES:

CO1: By the end of the course, students will be able to understand and memorize the concepts of ecology and renewable energy sources

CO2: By the end of the course, students will be able to describe different types of environmental pollutions such as water, soil, marine, noise, thermal, etc.

CO3: By the end of the course, students will be able to analyze disaster management concepts and appraise the role of big data application in disaster management

CO4: By the end of the course, students will be able to design pollution case studies

CO5: By the end of the course, students will be able to interpret the population growth and its effect on global environment and public health across various nations to formulate mitigation strategies

Unit I

Renewable and non-renewable resources. Definition, scope and importance, need for public awareness

Forest resources: Use and over-exploitation, deforestation, case studies. Water resources, Mineral resources, Food resources, Food resources, Energy resources, Role of an individual in conservation of natural resources.

Unit II

Ecosystems, Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and

ecological pyramids.

Introduction, types, characteristic features, structure and function of the following ecosystems: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems and Biodiversity and its conservation

Unit III

Environmental Pollution Definition, Cause, effects and control measures of: Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards.

Unit IV

Solid waste Management: Causes, effects and control measures of urban and industrial wastes, Role of an individual in prevention of pollution, Pollution case studies, Disaster management: floods, earthquake, cyclone and landslides.

Unit V

Human Population and the Environment, Population growth, variation among nations, Population explosion –Family Welfare Programme.

Environment and human health, Human Rights, Value Education HIV/AIDS, Women and Child Welfare, Role of Information Technology in Environment and human health, Case Studies.

REFERENCE BOOKS:

1) Environmental Biochemistry - Neelima Rajvaidya, Dilip Kumar Markandey (2005).
2) Environmental and Ecological Biochemistry -P.W. Hochachka T.P. Mommsen
3) Environmental Biochemistry Hardcover – 2005 by D. K. Markandey, N. Rajvaida

CO-PO MAPPING TABLE:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	2	-	2	2	3	2	2
CO3	3	3	3	2	-	2	2	3	3	3
CO4	3	3	-	-	1	1	2	3	2	2
CO5	2	3	3	3	-	-	2	2	3	3

PRACTICAL-I: TECHNIQUES IN MOLECULAR BIOLOGY

1) Isolation of DNA from Bacterial, Plant and animal cells.
2) Estimation of DNA by Diphenylamine and spectrophotometric method.
3) Isolation of RNA from yeast cells.
4) Estimation of RNA by orcinol and spectrophotometric method.
5) Estimation of DNA and purity determination by UV absorption method.
6) Determination of melting temperature(Tm).
7) Separation of Restriction digested DNA fragments on agarose gel electrophoresis.
8) Detection and differentiation of open circular, Linear and closed covalent circular (ccc) plasmid DNA by submarine gel electrophoresis.
9) Isolation of Plasmid PJA from E.coli HB.
10) Trasformation of E.coli HB 101/JM 10 3 with ampicillin resistant plasmid PJA.
11) Transfection of M13 DNA into E.coli JM 103.
12) Isolation of phage M13; Isolation of single and double stranded M13 DNA.
13) Conjugation: Use of broad host range plasmid RF in demonstrating conjugal transfer of plasmid in Bacteria.
14) Catabolite repression: Evidence of B-Galactosidase induction in presence of Lactose in E.coli lac strains.

PRACTICAL-II: ENDOCRINOLOGY & BASICS IN BIOINFORMATICS

1) Detection of Thyroid hormone
2) Detection of HCG in urine samples
3) BIOINFORMATICS- PRACTICALS
4) Bioinformatics Resources: NCBI, EBI, DDBJ, RCSB, ExPASy
5) Open access literature review databases: PubMed, BioMed Central, Public Library of
6) Sciences (PloS) and CiteXplore.
7) Sequence Databases: EMBOSS, NCBI ToolKit, ExPASy tools
8) Sequence Alignment:
    a. Pair-wise – Global and local alignment methods
    b. Multiple sequence alignment: Clustal Omega, EMBOSS Cons
9) Primer Designing software tools: NCBI's Primer Blast (Primer3)
10) Phylogenetic tree analysis using Simple Phylogeny (EMBL-EBI)

COURSE LEARNING OUTCOMES:

- Students will understand the basic information of Bioinformatics,
- Modern research applications, various databases, and exercises using free online software.

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