Maharani Lakshmi Ammanni College for Women Autonomous
Affiliated to Bengaluru City University
Re-accredited by NAAC with "A" grade, Recognised by UGC
under Section 2(f) and 12(b) of the UGC Act 1956
Conferred the Status of 'College with Potential for Excellence' by UGC

Syllabus for

B. Sc. degree in Biochemistry

and

Discipline specific open elective course

under

National Education Policy (NEP) 2020

(With effect from 2021-22 onwards)

Department of Biochemistry,
mLAC, Autonomous
Bangalore -560 012

October 2021

B.Sc. BIOCHEMISTRY

1. Preamble

As one of the basic science disciplines which lead to biotechnological advancement, Biochemistry is a branch of science that explores the chemical processes within and related to living organisms. It focuses on processes at cellular and molecular level. A trained biochemist employs chemical knowledge and bio-analytical skills, in order to unravel biological problems pertaining to physiological processes, diseases related to their malfunctions, diagnostics, prevention, therapy and prognostics. Considering far-reaching advances in modern biology in 21st century, it is imperative to incorporate emerging concepts of biochemistry in academic curriculum. The proposed pattern is designed for multi-faceted development of students, giving the freedom to choose a combination of courses of study from Biochemistry as well as from the allied disciplines. While 14 Discipline Specific Courses with 70 credits (12 with practical components for 61 credits and 3 without practical for 9 credits), three Discipline Specific Electives (9 credits) provide fundamental and advanced courses in Biochemistry, two vocational courses for 6 credits, research project in VIII semester provides much needed orientation and exposure to experimental research. With the Biochemistry major, the candidate can choose a minor from other disciplines such as Botany, Zoology, Environmental science, physics, Electronics, Mathematic, and other allied disciplines for 34 credits, depending on the subject's expertise available in the respective College, University or Institutions. Further, 24 credit courses shall be from ability enhancement courses (during first two years), and 4 credits shall be from compulsory environmental studies and Constitution of India. Skill enhancement courses for 8 credits earned over first six semesters include Digital fluency, Artificial intelligence, and Cyber security, and Professional communication. Value based courses of Physical education and health and wellness for 12 credits provide opportunities for personality development. The current pattern is designed to impart concept based learning with emphasis on hands-on training, skill development and research. The course seeks to discover and nurture typical attributes of a competent science graduate such as; spirit of inquiry, critical thinking, problem solving, analytical reasoning, aptitude to research/industry and entrepreneurial instincts.

The curricular framework approved by the Karnataka State Higher Education Council and Govt. of Karnataka as part of National Education Policy (NEP-2020) programme shall thus provide understanding of fundamentals, acquiring practical training and application of the subject knowledge in diversified areas of Biochemistry equipping students with requisite knowledge, skill and personality.

2. Programme Learning Outcome

The learning outcome-based curriculum is specific in terms of changes in cognitive and psychomotor behavior of students. Biochemistry Honors course is intended to provide a broad framework enabling students to acquire a skill set that helps them understand and appreciate the field of biochemistry. The structure or design of this framework shall ensure a high standard of the Honors degree in Biochemistry at national level. The programme specification are intended as a reference point for prospective students, current students, academic in delivering the programme and realizing its objectives.

Keeping in pace with the developmental trends in Biochemistry and allied areas, it is expected that the students undertaking Biochemistry (Honors) course become conversant with the essence of Biochemistry and exhibit certain levels of learning outcomes as proposed below;

PROGRAMME OUTCOME (PO)

PO1- To create interest in Biochemistry and appreciation for chemical basis of biological processes.

PO2- To inculcate the spirit of inquiry and value of systematic study of a discipline. Provide a general understanding of the related disciplines with a holistic knowledge generation in biological sciences.

PO3- To provide an in-depth understanding of chemical reaction mechanisms in biological processes.

PO4- To provide a flavor of historical developments of enzymes and their applications in research, diagnostics and various industries.

PO5- Gain proficiency in basic laboratory techniques and be able to apply the scientific method to the processes of experimentation, hypothesis testing, data interpretation and logical conclusions.

PO6- Develop problem solving and analytical skills through case studies, research papers and hands-on-experience

PO7- To appreciate biochemical mechanistic basis of physiological processes, metabolism under normal and pathological conditions importance and levels of metabolic regulations.

PO8- to apply and effectively communicate scientific reasoning and data analysis in both written and oral forms. They will be able to communicate effectively with well-designed posters and slides in talks aimed at scientific audiences as well as the general public.

PO9- To bridge the knowledge and skill gap between academic out and industry requirements.

P10- To give students experience in conducting independent, hypothesis-driven, biological research, project planning and management

P11- To provide skills to publish research findings, and awareness of IP rights, and scientific publication ethics and problems of plagiarism.

P12- To prepare competent human resource with better knowledge, hands-on-experience and scientific attitude, at national and global levels for careers in research and development, academia and Pharma-, biotech- and agro-, and food processing industries.

1. **Graduate Attributes <u>B.Sc. BIOCHEMISTRY (Honors):</u>**

Graduates with strong academic knowledge, discipline-specific and generic skills complemented with social responsibility are greatest asset of the country. The curriculum frame work under NEP for Biochemistry graduates aims to build the following attributes;

Disciplinary Knowledge:

a) Ability to comprehend fundamental concepts of biology, chemistry and apply basic principles of chemistry to biological systems.

b) Ability to relate various interrelated physiological and metabolic events.

c) Ability to critically evaluate a problem and resolve to challenge blindly accepted concepts

d) Ability to think laterally and in an integrating manner and develop interdisciplinary

e) Good experimental and quantitative skills and awareness of laboratory safety

f) A general awareness of current developments at the forefront in biochemistry and allied subjects.

g) Awareness of resources, and their conservation.

Communication Skills:

a) Ability to speak and write clearly in English and local language

b) Ability to listen to and follow scientific viewpoints and engage with them.

c) Ability to understand and articulate with clarity and critical thinking one's position.

Critical Thinking:

a) Ability to conceptualize critical readings of scientific texts in order to comprehend.

b) Ability to place scientific statements and themes in contexts and also evaluate them in terms of generic conventions.

Problem Solving:

a)Ability make careful observation of the situation, and apply lateral thinking and analytical skills.

Analytical Reasoning:

a) Ability to evaluate the strengths and weaknesses in scholarly texts spotting flaws in their arguments.

b) Ability to use scientific evidences and experimental approach to substantiate one's argument in one's reading of scientific texts.

Research Skills:

a)Ability to formulate hypothesis and research questions, and to identify and consult relevant

sources to find answers.

b)Ability to plan and write a research paper.

Teamwork and Time Management:

a)Willingness to participate constructively in class room discussions and contribute to group work.

b)Ability to meet a deadline.

Scientific Reasoning:

a)Ability to analyze theories and beliefs, evaluate ideas and scientific strategies.

b)Ability to formulate logical and convincing arguments.

Reflective Thinking:

a)Ability to locate oneself and see the influence of location—regional, national, global— on critical thinking.

Self-Directing Learning:

a)Ability to work independently in terms of organizing laboratory, and critically analyzing scientific literature.

b)Ability to postulate hypothesis, questions and search for answers.

Digital Literacy:

a)Ability to use digital resources, and apply various platforms to convey and explain concepts of biochemistry.

Multicultural Competence:

a)Ability to engage with and understand cultures of various nations and respect and transcend differences.

Moral and Ethical Values:

a)Ability to interrogate one's own ethical values, and to be aware of ethical and environmental issues.

b) Ability to read values inherited in society and criticism vis-a-vis, the environment, religion, spirituality, and structures of power.

Leadership qualities:

a) Ability to lead group discussions, to formulate questions related to scientific and social issues.

Life-long Learning:

a)Ability to retain and build on critical thinking skills, and use them to update scientific knowledge and apply them in day to day business.

Job opportunities in Biochemistry Core Course

Exit After ONE Year: CERTIFICATE COURSE

Knowledge	Skill Acquired	Employability
Fundamental properties of elements, atoms, acids and bases, metals, non-metals, alloys and composites. Biological significance of elements. Understanding of chemical bonding, Physical properties of molecules, chemistry of toxic chemicals. Chemical Kinetics, Colligative properties, Properties of matter and electro chemistry, fundamentals and applications of nuclear and radio chemistry. Classification, structure, reactivity and biological significance of major organic compounds. A general scientific spirit of inquiry	Numerical calculations, data generation and analysis, including the application of data transformations. Laboratory, safety and precautions, proficiency in preparation of laboratory reagents, use of glassware, Demonstration of basic oxidation and reduction reactions, primary and secondary standards. Handling basic instruments. Communication interpersonal and leadership skills, and ability enhancements complementing the core biochemistry, Entrepreneurship	Small and medium size chemistry/pharma based laboratories; as Jr. laboratory assistant assisting chemists /scientists. QC assistants in Laboratories dealing with QC service. Toiletries, chemicals, perfumery, oil industries, distilleries/ textiles/ pollution control units. Entrepreneurship

Exit After two Year: DIPLOMA COURSE

Knowledge	Skill Acquired	Employability
Basic chemistry of natural compounds, alkaloids, terpenes, heterocyclic compounds, drugs, stereochemistry, biological relevance of these compounds, outlines of Photochemistry and environmental chemistry. History of Biochemistry, Comprehensive knowledge and hand-on training in laboratory techniques of biochemistry. Analytical instrumentation and methodology	Acquaintance with analytical techniques that will permit them to study the biological system. Demonstrating skills of fractionating organic compounds. Hands on experience of handling instruments and analysis of data. Improving personality traits, team work, organizing abilities. Communication skills	Assistants in Health care/paramedical laboratories. Supervision and maintenance of laboratories. QC assistants in analytical laboratories dealing with biochemical/clinical/Food processing/pharma industrial settings. Marketing Entrepreneurial opportunities, Material safety data sheet maintenance, curation of chemical/drug stores, chemical store keeping

Exit After three Years: B.Sc. degree

Knowledge	Skill Acquired	Employability
Comprehensive knowledge of biomolecules: higher order structure s of proteins, nucleic acids and their functions. Bioenergetics, metabolism, enzyme kinetics, basic molecular biology, industrial microbiology, Immunology recombinant DNA technology. Understanding interrelated physiological and metabolic events. Overall knowledge of the avenues for research and higher academic achievements in the field of biochemistry and allied subjects.	Basic skills in clinical laboratory techniques, Immunology and molecular biological experimental skills. Demonstrate the overall ability to independently design experiment and analyse data. Basic statistical handling of data. Oral and written skills to convey scientific experimental results. Ability to understand research findings and disseminate to common public. Teaching skills	Scientific assistants in biotech based industries. Chemical/pharma/animal feeds/scientific data mining, / Forensic science labs. Blood Banks, Public heath support staff, Clinical research, Drug discovery R&D, Medical coding, medical transcription, Medical content writing Teaching at secondary school level
B.Sc. (Hons.)		
Knowledge	**Skill Acquired**	**Employability**
Introduction to advanced concepts in Biochemistry; Molecular Biology, Recombinant DNA technology, Clinical Biochemistry/ Plant Biochemistry, Immunology, Nutrition and Dietetics, Biochemical Pharmacology, Research methodology, Intellectual property rights, Bioinformatics skills, data analysis, Pharmacogenomics, Introduction to Intellectual property rights. A strong theoretical and practical knowledge of clinical and molecular setting, core research exposure.	Skills to isolate, identify and assay the biomolecules. Conducting independent research as part of project work. Hand on training in modern techniques in molecular biology. R-DNA techniques Computation skills, Prism, graph pad, Excel, Scientific writing skills: general articles, research reviews, Debating on scientific inventions and social implications.	Research staff, Clinical Biochemist, Forensic science technician, Biomedical scientist, Nutrition Dept. Pharma industry, Clinical research industries, R&D divisions of Pharma industries, Vaccine industry. Medical coding, Bioinformatics, Medical content writing, Patent examiner, Toxicological asst. Medical Science Liaison officer, Environmental science

II A MODEL PROGRAMME STRUCTURE FOR THE UNDERGRATUATE PROGRAMS IN UNIVERSITIES AND COLLEGES [SUBJECTS WITH PRACTICLES] WITH ONE MAJOR AND ONE MINOR

Sem.	Discipline Core (DSC) (L+T+P)	Discipline Elective(DSE) / Open Elective (OE) (Credits)	Ability Enhancement Compulsory Courses (AECC), Languages (L+T+P)		Skill Enhancement Courses (SEC)		Total Credits
					Skill based (Credits) (L+T+P)	Value based (L+T+P)	
I	**Biochem-1 (4 + 2) CHEMICAL FOUNDATION OF BIOCHEMISTRY -1** **DISCIPLINE B1 (4+2) CHEMICAL FOUNDATION OF BIOCHEMISTRY -1** **PRACTICALS – 1**	**OE – 1 (3 CREDITS)** **BIOCHEMISTRY IN HEALTH AND DISEASES**	**L1-1 (3), L2-1(3)**		**SEC-1: Digital Fluency (2) (1+0+2)**	Physical Education- Yoga (1) (0+0+2) Health and Wellness (1) (0+0+2)	**25**
II	**Biochem-2 (4 + 2) CHEMICAL FOUNDATION OF BIOCHEMISTRY -2** **DISCIPLINE B2 (4+2) CHEMICAL FOUNDATION OF BIOCHEMISTRY -2** **PRACTICALS – 2**	**OE – 2 (3 CREDITS)** **NUTRITION AND DIETETICS**	**L1-2(3), L2-2 (3) (3+1+0 each)**	**Environmental Studies (2)**		Physical Education-Sports (1) (0+0+2) NCC/NSS/R&R (S&G)/ Cultural (1) (0+0+2)	**25**
Exit option with Certificate (50 credits)							
III	**Biochem-3(4 + 2) BIOORGANIC CHEMISTRY** **DISCIPLINE B3 (4+2) BIOORGANIC CHEMISTRY** **PRACTICALS – 3**	**OE – 3 (3 CREDITS) BIOCHEMICAL TECHNIQUES**	**L1-3 (3), L2-3(3) (3+1+0 each)**		**SEC-2: Artificial Intelligence (2)(1+0+2)**	Physical Education-Sports (1) (0+0+2) NCC/NSS/R&R (S&G)/ Cultural (1) (0+0+2)	**25**

IV	**Biochem- 4 + 2) ANALYTICAL BIOCHEMISTRY** **DISCIPLINE B4 (4+2) ANALYTICAL BIOCHEMISTRY** **PRACTICALS – 4**	**OE – 4 (3 CREDITS) BIOCHEMICAL TOXICOLOGY**	**L1-4 (3), L2-4(3) (3+1+0 each)**	**Constitution of India (2)**		Physical Education-Sports (1) (0+0+2) NCC/NSS/R&R (S&G)/ Cultural (1) (0+0+2)	**25**
Exit option with Diploma (100 credits)							
Choose any one Discipline as Major, the other as the Minor							
V	**Biochem-5 (3 + 2) BIOCHEMISTRY OF MACROMOLECULES** **Biochem-6 (3 + 2) HUMAN PHYSIOLOGY AND CELL BIOLOGY** **DISCIPLINE B5 (3 + 2) BIOCHEMISTRY OF MACROMOLECULES** **PRACTICALS – 5 & 6**	**Vocational-1** **(3 CREDITS) BASIC MOLECULAR BIOLOGY**			**SEC-3: Cyber Security (2) (1+0+2)**	Physical Education-Sports (1) (0+0+2) NCC/NSS/R&R (S&G)/ Cultural (1) (0+0+2)	**22**
VI	**Biochem-7 (3 + 2) ENZYMOLOGY** **Biochem-8 (3 + 2)** **INTERMEDIARY METABOLISM** **DISCIPLINE B6 (3 + 2) BIOENERGETICS AND METABOLISM** **PRACTICALS – 7 & 8**	**Vocational-2 (3 CREDITS) CLINICAL** **BIOCHEMISTRY** **Internship (2 CREDITS)**			**SEC-4: Professional/ Societal Communication (2)**	Physical Education-Sports (1) (0+0+2) NCC/NSS/R&R (S&G)/ Cultural (1) (0+0+2)	**24**

Exit option with Bachelor of Arts, B.A. / Bachelor of Science, B. Sc. Basic Degree (146 credits)							
VII	**Biochem- 9 (3 + 2)** **MOLECULAR BIOLOGY** **Biochem-10 (3 + 2)** **BIOCHEMISRY OF HORMONES** **PRACTICALS – 9 & 10** **Biochem-11 (3)** **MEMBRANE BIOCHEMISTRY**	**Biochem E-1** **(3 CREDITS)** **BASIC IMMUNOLOGY** **Biochem E-2** **(3 CREDITS)** **RESEARCH METHODOLOGY** **(3 CREDITS)**					**22**
VIII	**Biochem-12 (3+2)** **MOLECULAR IMMUNOLOGY** **Biochem-13 (3)** **GENETIC ENGINEERING** **Biochem-14 (3)** **PLANT BIOCHEMISTRY** **PRACTICALS-12**	**Biochem E-3** **(3 CREDITS)** **BIOSTATISTICS AND BIOINFORMATICS** **RESEARCH PROJECT** **(6 CREDITS)**					**20**
Award of Bachelor of Science/ B.Sc. BIOCHEMISTRY (Hons) degree in a discipline (188 credits)							

***In lieu of the research Project, two additional elective papers/ Internship may be offered**

CURRICULUM STRUCTURE FOR UNDERGRADUATE DEGREE PROGRAM

(Inputs to this document: Program Outcomes of a program, List of core courses of the same program)

A) Name of the Degree: B.Sc. **B) Specialization: Biochemistry**

C) Program Articulation Matrix:

This matrix lists only the core courses. Core courses list the courses that are essential for every student to earn his degree. It includes all types of courses (theory, lab, tutorial, Project, Internships … that every student of the course). Electives are not part of this list.

Sem	Name of the Core course	What all program outcomes the course addresses (not exceeding three per course)	Pre-requisite course(s)	Concurrent course#	Pedagogy##	Assessment$
1	BIO A1	PO1 AND PO2	CHEMISTRY/ BIOLOGY	CORE COURSE PRACTICALS	MOOC, Desk work, Problem solving, Book Chapter Seminar, Project based	Class work Seminar Assignment Class Tests Open discussion
	BIO B1					
2	BIO A2	PO2 AND PO3				
	BIO B2					
3	BIO A3	PO3 AND PO4				
	BIO B3					
4	BIO A4	PO5 AND PO6	BIOA1 , BIOA2			
	BIO B4					
5	BIO A5	PO6 AND PO7				
	BIO A6	PO4 AND PO5				
	BIO B5					
6	BIO A7	PO8 AND PO9				
	BIO A8	PO4 AND PO8,PO9				
	BIO B6					

7	BIO A9	PO7 AND PO8			learning, Term paper	Articles writing, Interpretation of results
	BIO A10	PO10 AND PO9		CORE COURSE PRACTICALS	Assignment, Group Discussion	
	BIO A11	PO9 AND PO10				
8	BIO A12	PO9 AND PO10				Articles writing, Project proposal writing
	BIO A13	PO10,PO11 AND PO12			Research Project Instrumentation	
	BIO A14	PO11 AND PO12				

#Concurrent course is a core (lab / tutorial / project/…) course that a student has to take along with this course in the same semester for effective learning. Course design of concurrent courses is preferred to be done by the same team.

##Pedagogy for student engagement is predominantly lectures. However, other pedagogies enhancing better student engagement to be recommended for each course. This list includes active learning / course projects / Problem Based or Project Based Learning / Case studies / Self-study like seminar, term paper or MOOC)

$Every course needs to include assessment for higher order thinking skills (Applying / Analyzing / Evaluating / Creating). However, this column may contain alternate assessment methods that help formative assessment (i.e. assessment for learning).

Scheme for Theory and Practicals

Biochemistry as Major

Sem	Code	Title of the paper	Lecture/ practical per week	Duration of Exam	IA marks	Max Marks	Total	Credits
I	BC101	Biochemistry-I	04	02	40	60	100	4
	BC102	Practical-I	04	03	25	25	50	2
II	BC201	Biochemistry-II	04	02	40	60	100	4
	BC202	Practical-II	04	03	25	25	50	2
III	BC301	Biochemistry-III	04	02	40	60	100	4
	BC302	Practical-III	04	03	25	25	50	2
IV	BC401	Biochemistry-IV	04	02	40	60	100	4
	BC402	Practical-IV	04	03	25	25	50	2
V	BC501	Biochemistry-V	03	02	40	60	100	3
	BC502	Biochemistry-VI	03	02	40	60	100	3
	BC503	Practical-V	04	03	25	25	50	2
	BC504	Practical-VI	04	03	25	25	50	2
	BC505	VOC-1	03	02	40	60	100	3
VI	BC601	Biochemistry-VII	03	02	40	60	100	3
	BC602	Biochemistry-VIII	03	02	40	60	100	3
	BC603	Practical-VII	04	03	25	25	50	2
	BC604	Practical-VIII	04	03	25	25	50	2
	BC605	VOC-2	03	02	40	60	100	3
	BC606	Internship	Internship	3-4 weeks	25	25	50	2
VII	BC701	Biochemistry-IX	03	02	40	60	100	3
	BC702	Biochemistry-X	03	02	40	60	100	3
	BC703	Practical-IX	04	03	25	25	50	2
	BC704	Practical-X	04	03	25	25	50	2
	BC705	Biochemistry-XI	03	02	40	60	100	3
	BC706	Biochemistry-E1	03	02	40	60	100	3
	BC707	Biochemistry-E2	03	02	40	60	100	3
	BC708	Res. Methodology	03	02	40	60	100	3
VIII	BC801	Biochemistry-XII	03	02	40	60	100	3
	BC802	Practical-XI	04	03	25	25	50	2
	BC803	Biochemistry-XIII	03	02	40	60	100	3
	BC804	Biochemistry-XIV	03	02	40	60	100	3
	BC805	Biochemistry-E3	03	02	40	60	100	3
	BC806	Research Project	12	Report evaluation	60	40+100	200	6

Scheme for Theory and Practicals

Biochemistry as Minor

Sem	Code	Title of the paper	Lecture/ practical per week	Duration of Exam	IA marks	Max Marks	Total	Credits
I	BC101	Biochemistry-I	04	02	40	60	100	4
	BC102	Practical-I	04	03	25	25	50	2
II	BC201	Biochemistry-II	04	02	40	60	100	4
	BC202	Practical-II	04	03	25	25	50	2
III	BC301	Biochemistry-III	04	02	40	60	100	4
	BC302	Practical-III	04	03	25	25	50	2
IV	BC401	Biochemistry-IV	04	02	40	60	100	4
	BC402	Practical-IV	04	03	25	25	50	2
V	BC501	Biochemistry-V	03	02	40	60	100	3
	BC502	Practical-V	04	03	25	25	50	2
VI	BC601	Biochemistry-VI	03	02	40	60	100	3
	BC602	Practical-VI	04	03	25	25	50	2

Semester-I

Course Title: CHEMICAL FOUNDATION OF BIOCHEMISTRY -1	**Course Credits: 4**
Total Contact Hours:56	**Duration of ESA:02**
Formative Assessment Marks: 40	**Summative Assessment Marks:60**

Course learning outcome:

1. Understand the basic fundamentals of Biochemistry, as a discipline and milestone discoveries in life science.
2. Understand and apply the concepts of stoichiometry, atomic structure, chemical bonds, redox reactions and electrochemistry
3. Evaluate the theories of bond formation and chemical properties of biological elements and compounds.
4. Gain knowledge of the fundamental properties of elements and analyze their role in the formation of biomolecules and in chemical reactions within living organisms.
5. Relate and analyse the scope of fundamental chemistry in biological systems.

UNIT -1: Introduction to Biochemistry and Units of Measurement

Origin of life, Miller's experiment, types of organisms - unicellular, multicellular, prokaryotes, eukaryotes, compartmentalization of functions in lower and higher organisms, and common physiological events of organisms (RQ), chemical composition of living organisms, subcellular organelles: Structure, function and inter-relationship.

SI units, mass, volume, temperature, amount, length and time. An overview on the metric system, atomic mass, molecular mass, equivalent weight, basicity of acids, acidity of bases, concentration: molarity, normality, molality, Dalton concept, mole concept, mole fraction, ppm, Avogadro`s number, mole to molar conversion, oxidation number and its significance, density and specific gravity, their significance.

14 hrs

UNIT - 2: Atomic structure and chemical bonds

Structure of an atom and Quantum numbers, orbitals, shapes of orbitals, s, p, d, and f subshells, K, L,M,N,O,P and Q shells. Illustration of Pauli`s exclusion principle, Aufbau principle, and Hund`s rule of maximum multiplicity, electron configuration (upto 30 atomic no.), octet rule. Formation and properties of non- covalent and covalent bonds, Sigma, pi and co-ordinate bonds, hydrogen bonds, ionic bonds, van der Waals interactions, London forces, dipole-dipole interactions, electrostatic interactions, and hydrophobic interactions, back bonding. Corresponding energy associated, concept of hybridization, outline of theories of bonding (VBT, CFT, MOT). **14 hrs**

UNIT 3: Buffers and colligative properties

Acids, bases, Arrhenius concept, Lowry and Bronsted concept Lewis concept- limitations. Amphoteric nature of water and amino acids. Buffers, composition, pH, pH scale, common ion effect and solubility product, Henderson-Hasselbalch equation, titration curve of H_3PO_4, pK value, isoelectric pH, ionization of HCl, CH_3COOH, NH_4OH and H_2SO_4. Colligative properties and anomalous colligative properties of solutions, structure of water (based on VSEPR theory), ionic product of water, special properties of water, buffers in animal system (in context of blood). solutions and types, ionizable solutes, non-ionizable solutes, vapor pressure and its application in distillation, Vant Hoff law (Boyle's and Charles law), Roult`s law of relative lowering of vapour pressure, boiling point, freezing point, de-icing, osmosis and osmotic pressure determination by Berkley Hartley method, reverse osmosis- definition and significance. **14 hrs**

UNIT – 4 : Electrochemistry and redox reactions

Scope of electrochemistry, electrochemical cells, Daniel cell, galvanic cell, electrode potential and its measurement, electrolysis, types of electrolytes, primary and secondary batteries -definition and examples, electrodes- primary, secondary and glass electrode, half cell reaction, standard electrodes. Laws of thermodynamics, entropy and enthalpy, their relation, Gibb`s free energy, standard free energy, free energy change, endergonic and exergonic reactions with examples, importance in biological systems, ions, redox reactions, types, Stock's notations, change in oxidation number na dcombination. Redox potential, application of redox potential, energy linked to redox reactions, reduction of oxygen, oxidation and reduction of iron in hemoglobin, biological active forms of zinc, calcium, nickel, molybdenum, selenium, magnesium and cobalt, NAD^+/NADH, $NADP^+$/NADPH, $FAD/FADH_2$, $FMN/FMNH_2$. **14 hrs**

References :

1. Advanced Inorganic Chemistry: A comprehensive Text,1999, Cotton A and Geoffrey Wilkinson, 6th edition , Wiley publication
2. Inorganic Chemistry, 2014, Miessler GL , Paul Fischer PJ, and Tarr DA, 5th edition, Pearson Publication
3. Inorganic Chemistry, 2004, Catherine E and Sharpe AG, ACS publication
4. Inorganic Chemistry , 2015, Overton, Rourke , Weller , Armstrong and Hagerman, Oxford Press
5. Physical Chemistry: A molecular approach ,2019, Donald A, McQuarrie and Simon JD, Viva Books Publication
6. Physical chemistry 2019, Atkins P, Paula JD, Keeler J , 11th edition , Oxford press

PEDAGOGY: MOOC/DESK WORK/BOOK CHAPTER/PROBLEM SOLVING /ASSIGNMENT

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CLASS TEST (2 CLASS TESTS)	20
SEMINARS / CLASS WORK	10
ASSIGNMENT/ OPEN DISCUSSION	10
TOTAL	40

SEMESTER -1

PRACTICALS - 1

Course Title : VOLUMETRIC ANALYSIS – PRACTICALS-1	**Course Credits: 2**
Total Contact Hours: 4 Hours/ Week	**Duration of ESA : 03**
Formative Assessment Marks : 25	**Summative Assessment Marks : 25**

Course Outcome:

1. Acquire skills in learning safety and precautionary measures, calibration and basic calculations of working in a biochemistry laboratory.
2. Develop proficiency in preparation of standard solutions, indicators, reagents and handling of glassware for conducting volumetric analysis experiments.
3. Understand the use of volumetric analysis in biological research and industrial applications.

Experiments:

1. Calibration of volumetric glassware's (Burette, pipette, Standard flask).
2. Concept of molarity, molality and normality. Calculation and preparation of molar solutions. (Problems to be given in exams). Calculation and preparation of normal solutions and percent solutions and dilute solutions.
3. Preparation of standard Sodium carbonate solution, standardization of HCl (Methyl orange) and estimation of NaOH in the given solution. (methyl orange or phenolphthalein).
4. Preparation of standard Oxalic acid. Standardization of NaOH and estimation of H_2SO_4 in the given solution (phenolphthalein).

5. Preparation of standard Oxalic acid. Standardization of $KMnO_4$ and estimation of H_2O_2in the given solution.
6. Preparation of standard $K_2Cr_2O_7$. Standardization of $Na_2S_2O_3$ and estimation of $CuSO_4$ inthe given solution.
7. Preparation of $ZnSO_4$. Standardization of EDTA and estimation of total hardness of water using Eriochrome black-T indicator.
8. Preparation of standard potassium bipthalate. Standardization of NaOH and estimation ofHCl in the given solution. (Phenolphthalein).
9. Estimation of sulphuric acid and oxalic acid in a mixture using standard sodium hydroxide solution and standard potassium permanganate solution.
10. Preparation of standard Potassium dichromate and estimation of ferrous/ferric mixtureusing diphenylamine indicator (Demonstration).
11. Preparation of standard oxalic acid solution. Standardization of NaOH solution andestimation of acidity in vinegar.
12. Preparation of standard potassium biphthalate solution, standardization of sodiumhydroxide solution and estimation of alkalinity of antacids.
13. Preparation of standard Oxalic acid solution. Standardization of $KMnO_4$ solution and estimation of calcium in milk.
14. Preparation of buffers- Acetate, Phosphate and bicarbonate buffer
15. Construction of Daniel cell and measurement of emf.

REFERENCES:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Dr. O. P. Pandey, D. N. Bajpai, dr. S. Giri, Practical Chemistry S. Chand and Co. Ltd.,
4. Principles of Practical Chemistry- M. Viswanathan
5. Instrumental Methods of chemical Analysis B.K Sharma.
6. Experiments in Physical Chemistry R.C. Das and B. Behra, Tata Mc Graw Hill
7. Advanced Practical Physical Chemistry J.B.Yadav, Goel Publishing House
8. Advanced Experimental Chemistry. Vol-I J.N.Gurtu and R Kapoor, S.Chand and Co.
9. Practical Chemistry K.K. Sharma, D. S. Sharma (Vikas Publication).
10. General Chemistry experiment – Anil J Elias (University press).
11. Vogel textbook of quantitative chemical analysis G.H. Jeffery, J. Basset.
12. Quantitative chemical analysis S. Sahay (S. Chand & Co.).
13. Practical Chemistry Dr O P Pandey, D N Bajpai, Dr S Giri. S. Chand Publication
14. College Practical Chemistry. V K Ahluwalia, Sunitha Dingra, Adarsh Gulati
15. Practical Physical Chemistry- B. Viswanathan, P S Raghavan. MV Learning Publication

PEDAGOGY:MOOC/DESK WORK/BOOK CHAPTER/PROBLEM SOLVING /ASSIGNMENT

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CONTINUOUS EVALUATION AND CLASS TEST	15
RECORD / VIVA VOCE	10
TOTAL	25

SEMESTER - II

COURSE TITLE : CHEMICAL FOUNDATION OF BIOCHEMISTRY -2	**COURSE CREDITS: 4**
TOTAL CONTACT HOURS: 56	**DURATION OF ESA : 02**
FORMATIVE ASSESSMENT MARKS : 40	**SUMMATIVE ASSESSMENT MARKS : 60**

Course Outcome:

1. These topics will enable students to understand the fundamentals of chemical processes in biological systems
2. Students will gain the knowledge of role of stereochemistry in biological system
3. To understand the preparation and application of organometallic compounds.
4. Appreciation of the roles of metals, non-metals, transition metals and coordination compounds in biological systems.
5. Understand the Chemical toxicity and free radical scavenger mechanism.

UNIT -1: Chemical Kinetics and Colloids

Introduction, Rate of reactions, rate law or Rate equation, Molecularity and order of a reaction with examples, velocity constant or rate constant and half-life period expressions for zero, first and second order reactions with derivations ($a=b$ and $a\neq b$) and rate constant of irreversible reaction, kinetics of reversible reaction (without derivation), Numerical problems. Effect of temperature, Pressure and catalyst on rate of a reaction, Arrhenius equation and Arrhenius interpretation of energy of activation, Transition state theory with brief explanation.

Colloids and True solutions, classification, Brownian movements, electric properties, coagulation, mutual lyophillic sols, peptisation, purification, ultrafiltration, boiling, dialysis, electro and persistent dialysis, addition of electrolytes, colloids in daily life and applications. Emulsion, types, micelles with biomolecules and its biological applications. **14 hrs**

UNIT -2: Nomenclature of Organic Compounds

Classification, homologous series, naming, IUPAC nomenclature, compounds containing one, two functional groups with chains. Stereochemistry, geometrical and structural Isomerism, conformation, and free rotation. Optical isomerism, elements of symmetry, plane polarized light and optical purity, calculations. Nomenclature of enantiomers, diastereomers, epimers, recemic mixture, resolution. Fischer and Newmann projection formulae, a molecule with one and two chairal and achairal centers, spyrenes. Priority rules; E and Z, R and S (CIP rules), D and L notations, absolute (r and s) and relative (d and l) configuration. Role of stereochemistry in biological systems. **14 hrs**

UNIT-3: Organometallic Compounds

Metal atom linked organic compounds. Preparation of Grignard reagents and structure, limitations, protonolysis and reactions. Organolithium compounds- preparation and reactions, Organozinc compounds, organoboranes, its mechanism, Organomercury compounds methods of preparation and applications, reactions- mercuration of aromatic compounds, solvomercuration, oxymercuration-demercuration. Organoaluminium compounds, Organosilicone compounds- methods of preparation and applications, general reactions of trialkyl silyl halides with ethers, esters, carbamides, epoxides and acetals. Ferrocenes.

Porphyrins and Metal ions: Role of metal ions in biological systems, Fe, Cu, Zn, structure and functions of porphyrins, metalloporphyrins and iron-sulphur clusters with suitable examples and their role in biological systems. **14 hrs**

UNIT-4: Inorganic Chemistry

Nomenclature of inorganic molecules and coordination compounds, formula. IUPAC nomenclature. Central metal ion, ligand, coordination number, sphere, complex ion, oxidation number of central atom, homoleptic and heteroleptic complexes. Isomerism in complexes, structural, ionisation, solvate (hydrate), linkage and coordination Stereoisomerism, geometrical, optical isomerism with simple inorganic complexes. Applications of qualitative/ quantitative analysis in photography, metallurgy, medicine, catalysis and biosystems.

Chemical Toxicity: Introduction, poisons, toxin and toxicity, lead, mercury, aluminium, arsenic, corrosives, cyanide, irritants, phosphorus, CO_2, SO_2, SO_3, NO_2, halides and acid fumes, poisoning, sources, signs and symptoms. Free radicals: introduction, definition, generation and scavenger systems. **14 hrs**

REFERENCES

1. Physical Chemistry 2006, Peter Atkins. 8th edition, W.H. Freeman and Company
2. Inorganic Chemistry: Principles of structure and Reactivity, 2006, Huheey JE, Keiter EA,Keiter RL , Pearson Education India
3. Stereochemistry: Conformation and Mechanism, 2009, Kalsi PS, New Age International Publications
4. Introduction to Stereochemistry 2012, Kurt Mislow, Dover Publications
5. A text book of Organic Chemistry 2016, Raj K Bansal, 6th edition, New Age International Publications
6. Advanced Inorganic Chemistry 1999, Cotton et al , 6th edition, A Wiley – International
7. Principles of physical Chemistry, Puri, Sharma and Pathania.
8. Physical Chemistry, R.L. Madan, G.D. Tuli. S. Chand and Co.
9. A Text Book of Physical Chemistry, K.L. Kapoor, Vol.2. McMillan Publisher, India Ltd.
10. Advanced Organic Chemistry, Bahl and Bahl.
11. Principles of oraganometallic Chemistry, 1991, P. Powell, 2nd Edition, ELBS.
12. Inorganic Chemistry, 1983, 3rd Edition, J.E. Huheey, Harper International.
13. Organic Chemistry, Claden J., Greeves, N., Warren, S. 2012, Oxford University Press.
14. Inorganic Chemistry, 1987, R.W. Hay, Ellis Harwood.
15. Bioinorganic Chemistry, 2002, R.M. Roat-Malone, John-Wiley.
16. Basic Organometallic chemistry, 2nd Edition, B.D. Gupta and A.J Elias.

PEDAGOGY: MOOC/DESK WORK/BOOK CHAPTER/PROBLEM SOLVING/ ASSIGNMENT

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CLASS TEST (2 CLASS TESTS)	20
SEMINARS / CLASS WORK	10
ASSIGNMENT/ OPEN DISCUSSION	10
TOTAL	40

SEMESTER - II
PRACTICALS - 2

Course Title: QUALITATIVE AND QUANTITATIVE ANALYSIS – PRACTICALS – 2	**Course Credits: 2**
Total Contact Hours: 4 Hours/ Week	**Duration of ESA : 03**
Formative Assessment Marks : 25	**Summative Assessment Marks :25**

Course Outcome

The Course Objective is to provide experimental practice of quantitative and qualitative analysis. Also it provides training in physical chemistry laboratory techniques. Upon successful completion, students should develop skills in handling instruments and understand its application in research work.

Experiments:

2. Semi micro Qualitative Analysis of Inorganic salt Mixtures
    a. Systematic semi micro qualitative analysis of two acid and two basic radicals in the given inorganic salt mixture. The constituent ions in the mixture to be restricted to the following. (Any four binary mixtures shall be given)

Anions: HCO_3^-, CO_3^{2-}, Cl^-, Br^-, NO_3^-, BO_3^{3-}, SO_4^{2-} and PO_4^{3-}.

Cations: Pb^{2+}, Al^{3+}, Fe^{2+}, Fe^{3+}, Mn^{2+}, Zn^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Mg^{2+}, K^+, Na^+ and NH_4^+.

    b. Qualitative analysis of NPK fertilizer.

3.Determination of density and viscosity of the given liquid using specific gravity bottleand Ostwald's viscometer.

4. Determination of density and surface tension of the given liquid using specific gravitybottle and stalagmometer.

5. Determination of molecular weight of non-volatile solute by Walker-Lumsden method.

6. Determination of rate constant of decomposition of H_2O_2 using $KMnO_4$ by volumetricanalysis method using ferric chloride as catalyst.

7. Determination of distribution coefficient of benzoic acid between water and benzene or iodine between water and carbon tetrachloride. Separation of Two Components from given Binary Mixture of Organic Compounds Qualitatively.(Types of binary mixtures- Solid – Solid, Solid – Liquid, Liquid – Liquid)

8. Verification of Beer's Law.
    i. Estimation of unknown concentration of a biomolecule by using colorimeter
    ii. Molar extinction coefficient.

8. Calibration of pH meter and determination of pH of aerated soft drinks.

REFERENCES:

i. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
ii. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
iii. Dr. O. P. Pandey, D. N. Bajpai, dr. S. Giri, Practical Chemistry S. Chand and Co. Ltd.,
iv. Principles of Practical Chemistry- M. Viswanathan
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vi. Experiments in Physical Chemistry R.C. Das and B. Behra, Tata Mc Graw Hill
vii. Advanced Practical Physical Chemistry J.B.Yadav, Goel Publishing House
viii. Advanced Experimental Chemistry. Vol-I J.N.Gurtu and R Kapoor, S.Chand and Co.
ix. Practical Chemistry K.K. Sharma, D. S. Sharma (Vikas Publication).
x. General Chemistry experiment – Anil J Elias (University press)

xi. Vogel textbook of quantitative chemical analysis G.H. Jeffery, J. Basset.
xii. Quantitative chemical analysis S. Sahay (S. Chand & Co.)
xiii. Practical Chemistry Dr O P Pandey, D N Bajpai, Dr S Giri. S. Chand Publication
xiv. College Practical Chemistry. V K Ahluwalia, Sunitha Dingra, Adarsh Gulati
xv. Practical Physical Chemistry- B. Viswanathan, P S Raghavan. MV Learning Publication

PEDAGOGY : MOOC/DESK WORK/BOOK CHAPTER/PROBLEM SOLVING /ASSIGNMENT

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CONTINUOUS EVALUATION AND CLASS TEST	15
RECORD / VIVA VOCE	10
TOTAL	25

SEMESTER - I
OPEN ELECTIVE - 1

Course Title : BIOCHEMISTRY IN HEALTH AND DISEASE	**Course Credits: 3**
Total Contact Hours: 42	**Duration of ESA : 02**
Formative Assessment Marks : 40	**Summative Assessment Marks : 60**

Course Outcome:

1. Gain an elementary knowledge of human health and related terminologies used in health and diseased conditions.
2. Understand various disease conditions, causes, treatment and their prevention.
3. Acquire knowledge on health promotion including insights into mental health and differentiate between communicable and non-communicable diseases.

UNIT – 1: Health and Wellness

Introduction: WHO definition of health, Health and hygiene, General health care, Factors affecting health, Indices and evaluation of health, Disease patterns in developed and developing world; Classification of diseases - Endemic, Epidemic, Pandemic; Professional health hazards.

Disease conditions: Acute disease, Chronic disease, Incurable disease, Terminal disease, Illness, disorders, Syndrome, Pre-disease.

Treatment: Psychotherapy, Medications, Surgery, Medical devices, and Self-care. Dimensions of Health: Physical, Mental, Spiritual, Emotional, Environmental, Philosophical. **14 hrs**

UNIT – 2: Diseases and Disorders

Communicable diseases: Tuberculosis, Cholera, Typhoid, Conjunctivitis.

Sexually transmitted diseases (*STD*): Information, statistics, and treatment guidelines for STD, Prevention: Syphilis, Gonorrhea, AIDS.

Non-communicable diseases: Malnutrition- Under nutrition, Over nutrition, Nutritional deficiencies; Anemia, Stroke, Rheumatic heart disease, Coronary heart disease, Cancer, blindness, accidents, mental illness, Iodine deficiency, Fluorosis, Epilepsy, Asthma.

Genetic disorders: Down's syndrome, Klinefelter's syndrome, Turner's syndrome, Thalassemia, Sickle cell anemia.

Lifestyle disorders: Obesity, Liver cirrhosis, Diabetes mellitus, Hypertension (Causative agents, symptoms, diagnosis, treatment, prognosis, prevention) **14 hrs**

UNIT – 3: Health and Awareness

Health promotion: Preventing drug abuse, Oral health promotion by tobacco control.

Mental hygiene and mental health: Concepts of mental hygiene and mental health, Characteristics of mentally healthy person, Warning signs of poor mental health, Promotive mental health, strategies and services, Ego defense mechanisms and implications, Personal and social adjustments, Guidance and Counseling.

Infection control: Nature of infection, Chain of infection transmission, Defenses againstinfection transmission. **14 hrs**

REFERENCES

1. Modern Nutrition in Health and Disease 2006 10th Edition by Maurice E. Shils,Moshe Shike, A Catharine Ross.
2. Clinical Biochemistry and Metabolic Medicine , 2012 Eighth Edition by MartinAndrew Crook, CRC Press,
3. Nutrition & Health in Developing Countries, 2000, Editors: R. Semba and M.W.Bloem, Humana Press

PEDAGOGY:MOOC/DESK WORK/BOOK CHAPTER/PROBLEM SOLVING /ASSIGNMENT

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CLASS TEST (2 CLASS TESTS)	20
SEMINARS / CLASS WORK	10
ASSIGNMENT/ OPEN DISCUSSION	10
TOTAL	40

SEMESTER - II
OPEN ELECTIVE- 2

Course Title : NUTRITION AND DIETETICS	**Course Credits: 3**
Total Contact Hours: 42	**Duration of ESA : 02**
Formative Assessment Marks : 40	**Summative Assessment Marks : 60**

Course outcomes:

1. The student will gain knowledge about energy requirements and the Recommended Dietary Allowances.
2. The student will understand the functions and role of macronutrients, their requirements and the effect of deficiency and excess & impact of various functional foods on our health
3. The student will be able to apply basic nutrition knowledge in making foods choices and obtaining an adequate diet and gain competence in connecting the role of various nutrients in maintaining healthand learn to enhance traditional recipes.

UNIT – 1: Basic concepts of Nutrition

Introduction, Basic principles of a balanced diet to provide energy and nutrients. Composition of foods and proximate analysis of foods. Calorific value of foods, and Basal metabolism. Basal Metabolic Rate (BMR), Factors affecting BMR, Energy requirements for different physical activities, Specific dynamic action of food, Nutritive value of proteins. Energy requirements and recommended dietary allowance (RDA) for infants, children and pregnant women. Protein calorie malnutrition. **14 hrs**

UNIT– 2: Macronutrients and Micronutrients

Carbohydrates- Digestible and non-digestible, Dietary fibres, Essential fatty acids, lipoproteins and Cholesterol. Essential amino acids, Fortification of foods, Protein requirement for different categories. **Vitamins**-Sources, requirements, functions and deficiency symptoms of Vitamin-C, Thiamine, Riboflavin, Pyridoxine, Folic acid, Vitamin B12. Absorption of fat soluble vitamins- A, D, E and K. **Minerals**: Sources, Daily requirement, functions and deficiency disease symptoms of Macro minerals (Ca, P, and Cl) and micro minerals/trace elements (I, Fe, Zn and Se). **14 hrs**

UNIT – 3: Dietetics and Diet Therapy

Food pyramid. Diet planning and introduction to diet therapy. Nutritional requirements for different age groups, anemic child,expectant women, and lactating women. Diet planning for prevention and cure of nutritional deficiency disorders. Diet therapy: Functional foods, Anthropometric measurements, dietary considerations during fever, malaria, and tuberculosis. Prevention and correction of obesity, underweight, and metabolic diseases by diet therapy. Dietary interventions to correct and or manage the gastrointestinal diseases (indigestion, peptic ulcer, constipation, diarrhoea, steatorrhoea, irritable bowel syndrome. Functional foods based diet therapy for diabetes, cardiovascular disease and cancer. **14 hrs**

REFERENCES:

1. Clinical Dietetics and Nutrition, 2002, Antia FP and Abraham P. Oxford University Press; 4th Edition. ISBN-10: 9780195664157.
2. Oxford Handbook of Nutrition and Dietetics, 2011, Webster-Gandy J, Madden A and Holds worth
3. M. Oxford University Press, Print ISBN-13: 9780199585823.
4. Krause's Food, Nutrition and Diet therapy, 2003, Mahan KL and Escott-Stump S. Elsevier, ISBN: 9780721697840.

5. Human Nutrition and Dietitics. 1986, Passmore R. and Davidson S. Churchill Livingstone Publications, ISBN-10: 0443024863.
6. Rosemary Stanton's Complete Book of Food & Nutrition, 2007, Simon & Schuster Publishers, Australia, ISBN 10: 0731812999
7. Food Science and Nutrition, 2018, Roday S. Oxford University Press Publishers, ISBN: 9780199489084/0199489084.
8. Food Science, 2007, Srilakshmi S. New Age International (P) Limited Publishers, ISBN: 9788122420227/ 8122420222.

PEDAGOGY:MOOC/DESK WORK/BOOK CHAPTER/PROBLEM SOLVING /ASSIGNMENT

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CLASS TEST (2 CLASS TESTS)	20
SEMINARS / CLASS WORK	10
ASSIGNMENT/ OPEN DISCUSSION	10
TOTAL	40

SEMESTER - III

COURSE TITLE	**BIO-ORGANIC CHEMISTRY**
COURSE CREDITS	**04**
TOTAL CONTACT HOURS	**56**
DURATION OF ESA	**03**
FORMATIVE ASSESSMENT MARKS	**40**
SUMMATIVE ASSESSMENT MARKS	**60**

Course Outcome:

These topics will enable students to understand the fundamentals of organic chemistry pertinent to their importance in understanding biochemical reactions.

UNIT - 1: Reaction mechanisms and aliphatic hydrocarbons: 14hrs

Introduction, meaning of the term, kinetic and non-kinetic. Fundamental aspects: Homo and heterolytic cleavage. Concept of inductive effect, mesomeric effect, resonance and hyper conjugation. Classification of organic reactions (substitution, addition, elimination and re-arrangement), with two examples for each. Concepts of reactive intermediates of the following – free radicals, carbocations and carbanions, carbenes, nucleophiles and electrophiles(Formation and Stability).

Hydrocarbons - Markownikoff's rule. Mechanism of addition of HCl to propene. Peroxide effect, Alkenes – Ozonolysis, oxidation. Alkynes – formation of acetylides and their importance. Dienes– types with examples. Conjugate dienes, 1,3-butadiene – stability, mechanism of additionof HBr.

UNIT - 2: Mechanism of Substitution, Elimination and Addition reactions 14 hrs

SN_1 and SN_2 reactions on tetrahedral carbon, energy profile diagrams, Stereochemistry, factors affecting SN_1 and SN_2 reactions. The Elimination reactions- E_1, E_2 and E_{1cb} reaction, Zaitsev rule. Stereochemistry of E_1 & E_2 reactions, E_1 & E_2 elimination in cyclic compounds.

Addition reactions - Aldehydes and Ketones - nucleophilic addition of acetals & ketals. Additionof ammonia, primary amines and other ammonia derivatives(hydrazine and hydroxylamine**)**. Conjugate addition - addition in alpha and beta unsaturated aldehydes and ketones, 1, 2 and 1,4 addition.

Carbonyl compounds - General properties. Keto-enol tautomerism. Mechanisms: addition of HCNto acetaldehyde, Claisen and aldol condensations. Quinones: o and p-benzoquinones- structure and properties.

UNIT - 3: Mechanism of electrophilic aromatic substitution reactions 14 hrs

Aromatic compounds - aromaticity, criteria for aromaticity, anti-aromatic and non-aromatic compounds with examples. Mechanism of electrophilic aromatic substitution reactions- halogenation, nitration, sulfonation, Friedel Crafts alkylation and Friedel Crafts acylation. Relative reactivity of substituted benzenes, polycyclic benzenoid hydrocarbons.

Role of coenzymes?– definition of coenzymes, Structure and role of thiamine pyrophosphate in decarboxylation of alpha- keto acids, Biotin in carboxylation of important biochemical reactions ofcarbohydrate and lipid metabolism. Vit B_{12} - role in rearrangement reactions. Vit B_2 - role in redox reactions with suitable examples.

UNIT – 4 : Bio-organic compounds 14 hrs

Alcohols: Classification, monohydric alcohols: examples, general and distinguishing reactions. Dihydric alcohols: glycols, Tri hydric alcohols: glycerol – synthesis from propene, properties and uses.

Phenols: Classification, electronic interpretation of acidity of phenols, mechanism of Kolbe, Reimer– Tiemann and bromination reactions.

Carboxylic acids:

Hydroxy acids: Structure &biological significance(properties): lactic acid, citric acid and isocitric acid. Dicarboxylic acid: maleic and fumaric acid. Ketoacids: pyruvic, α-ketoglutaric, oxaloacetic acid.

Amines: Classification, properties, functional group – Basicity of amines, acylation. Reaction with HNO_2 & Schiff's base formation. Distinguishing reactions of primary, secondary andtertiary amines.

Heterocyclic compounds: Definition, classification with examples, structure and biological importance of furan, pyrrole, thiophene, pyridine, pyran, thiazole, pyrimidine, purine, indole, imidazole. Aromaticity and basicity of pyrrole and pyridine.

Terpenes: Definition, Isoprene rule, classification, General method of isolation. Structure and biological importance of menthol, camphor, farnesol, phytol, lanosterol, lycopene and dolichols.

Steroids: Basic ring structure in steroids. Structure and biological importance of cholesterol, phytosterols, ergosterol, cortisol, β-estradiol, testosterone, and aldosterone. Bile acids (Mono, Di & Tri cholic acids).

Alkaloids: Definition, classification based on their structure and biological functions, Isolation of alkaloids, structure and physiological action of morphine, nicotine and atropine.

REFERENCES:

1. Textbook of Organic Chemistry 22 nd Edition S. Chand Publishers 2019.
2. Organic Chemistry. Vol.I. Fundamental principles. I. L .Finar. 6th Edn. ELBS , 2002
3. Organic Mechanisms, Peter Sykes, Longman, 1977
4. Organic Chemistry. R.T. Morrison and R.N.Boyd. 6th Edn. Prentice Hall, India, 2018
5. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications 2012
6. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Edn. Karen C. Timberlake, Benjamin Cummings, 1999
7. Reaction Mechanisms at a glance, ed. M. Moloney, Blackwell Science 2000.

PEDAGOGY: MOOC/DESK WORK/BOOK CHAPTER/PROBLEM SOLVING /ASSIGNMENT

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CLASS TEST (2 CLASS TESTS)	20
SEMINARS / CLASS WORK	10
ASSIGNMENT/ OPEN DISCUSSION	10
TOTAL	40

SEMESTER - III

PRACTICALS - III

COURSE TITLE	**BIO-ORGANIC CHEMISTRY**
COURSE CREDITS	**02**
TOTAL CONTACT HOURS	**4 Hours/ Week**
DURATION OF ESA	**03**
FORMATIVE ASSESSMENT MARKS	**25**
SUMMATIVE ASSESSMENT MARKS	**25**

Course Outcome:

This course aims to familiarize students with the principles of organic chemistry and basic Qualitative analysis of organic compounds. Course Objective is to provide experimental practice of preparation of organic compounds and extraction of biologically important compounds.

Experiments:

I. Systematic Qualitative Analysis of organic compound (6 practical's)

1. Urea	2. Glucose	3. Aniline
4. Benzoic Acid	5. Salicylic acid	6. Benzaldehyde
7. Acetophenone	8. Chlorobenzene	9. Nitrobenzene

II. Preparation of following organic compounds (2 practical's)

1. Acetylation: Preparation of acetyl salicylic acid from salicylic acid.
2. Oxidation: Preparation of benzoic acid from benzaldehyde.
3. Nitration: Preparation of m-dinitrobenzene from nitrobenzene.
4. Hydrolysis: Preparation of benzoic acid from ethyl benzoate.

III. Extractions:

1. Extraction of caffeine from tea leaves
2. Extraction of starch from potatoes
3. Extraction of casein from milk

REFERENCES:

1. Practical Organic Chemistry: Qualitative Analysis by S.P. Bhutani, A. Chhikara 2009
2. Textbook of Practical Organic Chemistry Including Qualitative Organic Analysis by Arthur Israel Vogel 2003
3. Comprehensive practical organic chemistry- preparation and quantitative analysis. V. K. Ahluwalia and Renu Aggarwal 2004
4. Practical Hand Book of Systematic Organic Qualitative Analysis. Md. Rageeb Md.Usman, S. S. Patil 2017
5. Laboratory Manual of Inorganic & Organic Chemistry (Qualitative Analysis) Kalpa Mandal, Sonia Ratnani 2020

PEDAGOGY: MOOC/DESK WORK/BOOK CHAPTER/PROBLEM SOLVING/ ASSIGNMENT

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CONTINUOUS EVALUATION AND CLASS TEST	15
RECORD / VIVA VOCE	10
TOTAL	25

SEMESTER – III

OPEN ELECTIVE – 1

COURSE TITLE	**BIOCHEMICAL TECHNIQUES**
COURSE CREDITS	**03**
TOTAL CONTACT HOURS	**42**
DURATION OF ESA	**03**
FORMATIVE ASSESSMENT MARKS	**40**
SUMMATIVE ASSESSMENT MARKS	**60**

Course Outcome:

- Develop competence in handling various chromatographic, electrophoretic and isotope techniques and apply them in isolating and characterizing different biological molecules

UNIT - 1 14 hrs

Microscopy: Different types of microscopes – Principle and applications of light microscope. Electron microscopy – TEM, SEM, applications. Fluorescence and confocal microscopes used in fine structure studies.

Centrifugation Techniques: Introduction, basic principle and applications of sedimentation. Centrifuges and their use - small bench centrifuges, refrigerated centrifuges - large capacity and high speed, continuous flow centrifuges, ultracentrifuge - preparative and analytical and density gradient centrifuge.

UNIT – 2 14 hrs

Chromatography: Introduction, classification of chromatographic techniques. Principle and applications of paper chromatography, Thin layer chromatography, Column chromatography-Adsorption chromatography, Gel permeation, Ion exchange chromatography, Affinity chromatography, Gas chromatography, FPLC, High performance/pressure liquid chromatography

Electrophoresis Techniques: Introduction, principle and applications of electrophoretic techniques - Paper electrophoresis, starch-gel electrophoresis, polyacrylamide gel electrophoresis (native and SDS), agarose gel electrophoresis, isoelectric focusing, isotachophoresis.

UNIT – 3 14 hrs

Isotope Techniques: Introduction to isotopes; radioisotopes. Radioactive decay, Units of radioactivity, Measurement of radioactivity- GM counters, Scintillation counters, autoradiography. Applications of radioisotopes in the biological Sciences.

Spectroscopy: Introduction, Nature of electromagnetic radiations. Beer-Lamberts law. Principle and applications of spectroscopic techniques in biochemical investigation - UV-Vis spectroscopy, Colorimetry, Fluorescence spectroscopy, Infrared spectroscopy, Circular dichroism (CD) spectroscopy, Electron spin resonance (ESR), Atomic Absorption spectroscopy (AAS), Nuclear Magnetic resonance (NMR) spectroscopy and Mass spectroscopy.

REFERENCES:

1. Modern experimental Biochemistry: Rodney Boyer, 3rd Edn. Benjamin Cummings , 2000
2. Practical Skills in biomolecular sciences : R Reed, D.Holmes, J Weyers and A.Jones 1998
3. Physical Biochemistry: David Frifielder 2nd Edition , 1983
4. Biophysical chemistry Upadya and Upadya , 2016
5. Introductory practical Biochemistry: SK Sawhney and Randhir Singh, 2001

PEDAGOGY: MOOC/DESK WORK/BOOK CHAPTER/PROBLEM SOLVING /ASSIGNMENT

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CLASS TEST (2 CLASS TESTS)	20
SEMINARS / CLASS WORK	10
ASSIGNMENT/ OPEN DISCUSSION	10
TOTAL	40

SEMESTER – III OPEN ELECTIVE - 2
(Non-Science Students)

COURSE TITLE	**HORMONES - BIOCHEMISTRYAND FUNCTION**
COURSE CREDITS	**03**
TOTAL CONTACT HOURS	**42**
DURATION OF ESA	**03**
FORMATIVE ASSESSMENT MARKS	**40**
SUMMATIVE ASSESSMENT MARKS	**60**

Course Outcome:

- Understand the function of hormones and their regulation.
- Know how hormonal systems act in an integrated manner to regulate overall body functions.
- Understand how failure of these normal physiologic functions and integrations are associated with some endocrine disorders.

UNIT – 1: Endocrine system **14 hrs**

Endocrine System: General study of the following glands: Adrenal, Pancreas, Thyroid and Pituitary and gonads, location and shape of the gland, hormones they secrete. Difference between Endocrine and Exocrine glands.

Introduction to Hormones – definition, classification (origin, chemical nature, location and mechanism of action). Physiological role of pituitary, pineal, thyroid and parathyroid hormones. Hypothalamus and Neurohypophysis- its secretions – ADH and oxytocin. General mechanism of steroidal and non-steroidal hormones.

UNIT – 2: Physiology of hormone action **14 hrs**

Physiological role of pancreas, adrenal, and placenta. Introduction to Gastrointestinal hormones and their physiological effects. Neurotransmitters (Acetyl Choline, GABA, Serotonin). Sex hormones and their functions. Hormones during ovarian and uterine phases of menstrual cycle; placental hormones; role of hormones during parturition and lactation.

UNIT – 3: Clinical endocrinology **14 hrs**

Blood, plasma, serum - Separation and storage. normal range of hormones in tissues, common

hormonal disorders. Thyroid function test – Significance of the determination of T3, T4, and TSH and Infertility profile (Procedures not required). Major manifestations of disease of the endocrine pancreas, thyroid, hypothalamus and pituitary disease (Mentioning of the name of the disease/disorder and its symptoms)

REFERENCES:

1. Norman AW, Litwack G (1997), Hormones, 2nd Edition, Elsevier Publications.
2. Bolander F (2004), Molecular Endocrinology, 3rd Edition, Elsevier Publications.
3. Rifai N (2007), Teitz Fundamentals of Clinical Chemistry, 6th Edition, Elsevier Publications.
4. Henry's Clinical Diagnosis and Management by Laboratory Methods (2011), 22nd Edition,Elsevier.
5. Vasudevan DM (2011), Text book of Medical Biochemistry, 6th Edition, Jaypee Publishers.
6. Chatterjea MN & Shinde R (2012), Text book of Medical Biochemistry, 8th Edition, JayppePublications.
7. Bishop ML, Fody EP, Schoeff LE (2013), Clinical Chemistry: Principles, Techniques, andCorrelations, 7th Edition, Wiley Publications.
8. J N Singh (2017), Biochemistry General, Hormonal and Clinical - 1st Edition, Atithi booksPublishers.
9. Rifai N (2017), Teitz Text book of Clinical Chemistry and Molecular Diagnostics, 6th Edition Saunders Publications.

PEDAGOGY: MOOC/DESK WORK/BOOK CHAPTER/PROBLEM SOLVING /ASSIGNMENT

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CLASS TEST (2 CLASS TESTS)	20
SEMINARS / CLASS WORK	10
ASSIGNMENT/ OPEN DISCUSSION	10
TOTAL	40

SEMESTER – IV

COURSE TITLE	**ANALYTICAL BIOCHEMISTRY**
COURSE CREDITS	**04**
TOTAL CONTACT HOURS	**56**
DURATION OF ESA	**03**
FORMATIVE ASSESSMENT MARKS	**40**
SUMMATIVE ASSESSMENT MARKS	**60**

Course Outcome:

- Understanding the concept of biological sample preparation
- Appreciate chemistry and application of analytical instruments.
- Get acquainted with Care & Maintenance of Equipment & Chemicals.
- Clinically relevant biochemical analysis for deeper understanding of all biochemical components i.e., Proteins, Electrolytes, Hormones etc.
- Basic knowledge of clinical and forensic analytical methods and their principles.

Course Outcomes /Program Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
Aptitude	X	X	X	X								
Critical thinking		X				X						
Subject clarity	X	X						X				X
Analytical Skill				X	X	X	X	X	X	X	X	X

UNIT - 1: Biological sample preparation and fractionation 14hrs

Introduction and objectives of bioanalysis and extraction of molecules from tissues and cells. Sample preparation, types of sample - live, postmortem extraction of macromolecules from tissues; fractionation - liquid-liquid, liquid-solid and precipitation methods.

Centrifugation - Introduction, principles of centrifugation, angular velocity, sedimentation, sedimentation coefficient, centrifugal field, relative centrifugal field. Types of centrifugation- Preparative and analytical. Differential, density gradient and ultra-centrifugation. Basic instrumentation; types of rotors and their design. Laboratory centrifuge; operational instruction and applications. Analytical centrifuges- Optics; Application in sub-cellular fractionation. Care and maintenance of the instrument.

UNIT - 2: Chromatography 14 hrs

History of chromatography. General principle of chromatography. Classification based on stationary and mobile phase - Planar and column chromatography, based on types of mobile and/or liquid phase - adsorption and partition - Gas chromatography and liquid chromatography. Based on stationary phase-thin layer chromatography, Paper chromatography – Ascending, descending and circular, 2-D chromatography, Rf value.

Principles, methodologies and applications of adsorption-, partition-, ion-exchange-, gel-filtration- and affinity- chromatography. Advanced chromatography- working principle and applications of HPLC, FPLC, UPLC and GLC.

UNIT - 3: Electrophoretic and radio isotopic methods 14 hrs

Electrophoresis- General principle of electrophoresis, velocity of a charged molecule in the applied electric field, relevance of Ohm's law in electrophoretic separations. Supporting media for electrophoresis; work of Tiselius, paper, cellulose acetate, agarose, polyacrylamide. Chemistry of polymerization of acrylamide gels, methodology and applications of native PAGE and SDS-PAGE, 2-D electrophoresis. Identification of proteins post electrophoresis- dyes and in-gel biological activities. Applications of agarose gel, pulse field electrophoresis, capillary electrophoresis and isoelectric focusing. Principle and applications of immune-electrophoresis.

Radioisotopic methods: Radioactivity–Types of radioactive decay, Properties of α, β, γ radiations. Group displacement law. Decay law - decay constant, Half-life period and average life of a radioactive element. Detection of radioactivity – GM counter and scintillation counters (only principle and working) Applications of radioisotopes – ^{3}H, ^{14}C, ^{131}I, ^{60}Co and ^{32}P. Biological effects of radiations. Radiolabelling, safety measure in handling radio isotopes.

UNIT – 4: Spectroscopy 14 hrs

Wave-particle duality of light, electromagnetic spectrum. Beer's law and its limitations, determination of molar absorption coefficient of molecules. Principle, design and application of colorimeter and UV-Vis spectrophotometer. Working principle and application of flame photometer and fluorimeter. Principle and applications of IR, Raman, ESR, NMR, AAS, and Mass spectroscopy.

REFERENCES:

1. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer 2011
2. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology 8th Edn. Andreas Hoffman and Samuel Clockie, Ed., Cambridge University Press, 2018.
3. Biochemistry and Molecular Biology; 5th Edn. D. Papachristodoulou, A. Snape, W.H. Elliott, and D. C. Elliott, Oxford University Press 2014

PEDAGOGY: MOOC/DESK WORK/BOOK CHAPTER/PROBLEM SOLVING /ASSIGNMENT

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CLASS TEST (2 CLASS TESTS)	20
SEMINARS / CLASS WORK	10
ASSIGNMENT/ OPEN DISCUSSION	10
TOTAL	40

SEMESTER - IV

PRACTICALS - IV

COURSE TITLE	**ANALYTICAL BIOCHEMISTRY**
COURSE CREDITS	**02**
TOTAL CONTACT HOURS	**4 Hours/ Week**
DURATION OF ESA	**03**
FORMATIVE ASSESSMENT MARKS	**25**
SUMMATIVE ASSESSMENT MARKS	**25**

Course Outcome: The Course Objective is to provide experimental practice of analytical techniques in Biochemistry. Upon successful completion, students should develop skills in handling instruments and understand its application in research work.

- Sourcing and handling biological samples.
  Develop skill and proficiency in basic techniques;
- Centrifugation,
- Chromatography,
- Electrophoresis and
- Spectroscopy.

Experiments:

1. Isolation of human lymphocytes using clinical centrifuge.
2. Determination of packed cell volume/ hematocrit.
3. Separation of basic, acidic and aromatic amino acids by ascending/descending and circular paper chromatography.
4. Separation of plant pigments by gel-permeation chromatography.
5. Separation of lipids by thin-layer chromatography.
6. Determination of void volume of a gel-filtration column.
7. Recording the absorption spectrum of riboflavin and determination of l_{max}.
8. Colorimetric estimation of glucose by DNS method.
9. Estimation of DNA by diphenylamine method.
10. Electrophoretic separation of plasma proteins.

REFERENCES :

1. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer ,2011
2. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology 8th Edn.Andreas Hoffman and Samuel Clockie, Ed., Cambridge University Press, 2018.
3. Biochemistry and Molecular Biology; 5th Edn. D. Papachristodoulou, A. Snape, W.H. Elliott, and D. C. Elliott, Oxford University Press ,2014

PEDAGOGY: MOOC/DESK WORK/BOOK CHAPTER/PROBLEM SOLVING /ASSIGNMENT

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CONTINUOUS EVALUATION AND CLASS TEST	15
RECORD / VIVA VOCE	10
TOTAL	25

SEMESTER – IV

OPEN ELECTIVE -1

BIOCHEMICAL TOXICOLOGY

COURSE TITLE	**BIOCHEMICAL TOXICOLOGY**
COURSE CREDITS	**03**
TOTAL CONTACT HOURS	**42**
DURATION OF ESA	**03**
FORMATIVE ASSESSMENT MARKS	**40**
SUMMATIVE ASSESSMENT MARKS	**60**

Course Outcome: This open elective course offered to various streams gives basic idea about biochemical basis of various effects of toxins/ pharmaceuticals and an outline of process involved in toxicity testing and drug dosing.

- Categorize the classes of toxicants/drugs and know specific examples
- State the routes of exposure to toxins/drugs;
- Explain the processes of absorption, metabolism and elimination of toxins/drugs; and
- Explain environmental and physiological factors that affect toxicant metabolism

UNIT – 1 Fundamentals of Toxicology and Dose response 14 hrs

Scope of toxicology; why should we know about toxins/xenobiotics (drugs) and What makes a substance toxic? Grading toxicity, Use of animal studies for toxicity, *in vitro* toxicity, organ toxicity (liver and kidney toxicity). Indicators of toxicity/drug effects; biomarkers. Concentration and site of action, dose response, effect of route of administration, ED_{50}, LD_{50}/TD_{50}. Hazard and risk assessment, risk management, acceptable daily intake (ADI) and tolerable daily intake (TDI).

UNIT – 2 Disposition of Toxins 14 hrs

Outline of ADME process - toxin/drug uptake, entry into cells and systemic circulation. Effect of size,shape, solubility, and charge on their uptake. Major sites of absorption – skin, intestine, and liver. Role of transporters and plasma proteins in distribution. Plasma levels of toxins/drugs, plasma half-life. Excretion - kidney, biliary excretion.

Metabolism - types of metabolic changes of foreign compounds, biotransformation/ detoxification reactions, phase-1 and, phase -2 reactions. Nature of phase-1 and phase 2 enzymes.

UNIT - 3 Targets of toxic damages and Biochemical Mechanism of toxicity 14 hrs

Damage caused by toxins/drugs on liver, kidney, gall bladder and lungs. Methods of identifying the damages.Mechanism of biochemical toxicity; chemical carcinogens - benzo[a] pyrene, tamoxifen.
Liver necrosis: carbon tetrachloride, valproic Acid, and iproniazid,
Kidney damage: chloroform, antibiotics- gentamycin,
Lung damage: 4-Ipomeanol,
Neurotoxicity: isoniazid, parquet, primaquine, cyclophosphamide.

REFERENCES:

1. Biopharmaceuticals Biochemistry and Biotechnology 2nd Edn. Gary Walsh, John Wiley & Sons, Ltd, England , 2003.
2. Fundamentals of Experimental Pharmacology, Ghosh,M.N. 2nd Edition, Scientific Book Agency, Kolkatta , 1984.
3. Introduction to Biochemical Toxicology, 3rd Edn., Ernest Hodgson , Robert C. Smart; Wiley-Interscience; , 2001
4. Principles of Biochemical Toxicology, John A. Timbrell, 4th Edn. 2009, Taylor & Francis
5. Remington Pharmaceutical Sciences, Lippincott, Williams and Wilkins, 2000

PEDAGOGY: MOOC/DESK WORK/BOOK CHAPTER/PROBLEM SOLVING /ASSIGNMENT

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CLASS TEST (2 CLASS TESTS)	20
SEMINARS / CLASS WORK	10
ASSIGNMENT/ OPEN DISCUSSION	10
TOTAL	40

SEMESTER – IV
OPEN ELECTIVE - 2
PLANT BIOCHEMISTRY

COURSE TITLE	**PLANT BIOCHEMISTRY**
COURSE CREDITS	**03**
TOTAL CONTACT HOURS	**42**
DURATION OF ESA	**03**
FORMATIVE ASSESSMENT MARKS	**40**
SUMMATIVE ASSESSMENT MARKS	**60**

Outcomes:

- Understand the plant cell, photosynthesis, transporters and important primary metabolites.
- Illustrate plant growth regulators, plant's responses to various biotic and abiotic stresses.
- Explain about plant secondary metabolites and their functional importance.

UNIT - 1 14 hrs

Plant cell- structure and molecular components: Cytoskeleton- an overview. Plant cell division, cell cycle. Outlines of energy production in plant cells, Carbon assimilation and nitrogen assimilation.

An overview of photosynthesis; C3, C4 plants and crussulacean acid metabolism (CAM); photorespiration; Phytochromes, cryptochromes and phototropins. Non-protein thiols and sulfur cycle.

Plant cell membranes and membrane transport: Introduction to plant cell membranes and membrane constituents. Organization of transport systems across plant membranes; Different types of transporters in plant cell and organelle membranes; classification and importance of H^+-ATPases. Ion channels-properties and significance; Aquaporins and water transport.

Important primary metabolites of plants: Properties, function and applications of cellulose, starch, sucrose, oligosaccharides; fructans, gums, mucilages, poly unsaturated fatty acids, lignin, suberin, surface waxes, sulfides and sweet proteins.

UNIT - 2 14 hrs

Plant growth regulators: Role of auxins, cytokinins, gibberellins, abscisic acid, ethylene, brassinosteroids, polyamines, jasmonic acid and salicylic acid.

Plant responses to biotic stresses: Introduction; plant pathogens and diseases; plant defense systems - hypersensitive response; systemic acquired resistance; induced systemic resistance; Plant biotic stress response to pathogens and insects.

Plant responses to abiotic stress - Salt stress, drought and heavy metal stress responses; osmotic adjustment and significance of osmotic agents such as proline, sugar alcohols and quaternary ammonium compounds. An overview of oxidative stress and oxidative damage - antioxidant enzymes and stress tolerance.

UNIT - 3 14 hrs

Plant Secondary Metabolites
Introduction and definition. An overview of primary metabolism contribution to secondary metabolites biosynthesis. Classification of plant secondary metabolites.

Alkaloids: General characteristics and classification with examples. Contribution of amino acids for alkaloid biosynthesis. Isolation and purification of alkaloids. (S)-Seticuline-the chemical chameleon.

Phenolics: General characteristics and classification with examples - flavonoids and anthocyanins. Isolation and purification of phenolics.

Terpenoids: General characteristics and classification with examples. Isoprene rule. Isolation and purification of terpenoids.

Applications of secondary metabolites: in plants' defense; in insects' signalling, morphogenesis and defense. Physiologically active secondary metabolites in modern medicine and therapeutic compounds for human ailments.

REFERENCES:

1. Lehninger's Principles of Biochemistry - Nelson & Cox. CBS Publishers & Distributors, 2013
2. Principles of Biochemistry - Moran, Horton, Scrimgeour, Perry. Pearson, 5thEdition , 2011

3. Plant Biochemistry - P.M. Dey & J.B. Harborne. Hart Court Asia Pvt Ltd. 1997
4. Plant Biochemistry and Molecular Biology - P. Lea & Richard C Leegood.,John Wiley & Sons. 1999
5. Introduction to Plant Biochemistry - Goodwin and Mercer. CBS Publisher and Distributors. 2005
6. Biochemistry and Molecular Biology of Plants - Buchanan, Greussem and Jones. American Society of Plant Physiologists. 2000
7. Natural Products from plants. Peter B. Kaufman, Leland J. Cseke, Sara Warber, James A. Duke, Harry L. Brielmann, CRC Press, Boca Raton 1999.
8. Natural Products Targeting Clinically Relevant Enzymes. Paula B. Andrade, Patricia Valentao David M. Pereira. Wiley-VCH Verlag GmbH & Co 2017
9. Plant Cell Tissue and Organ Culture: Fundamental Methods - O.L. Gamborg& G.C. Phillips Narosa Publishers, New Delhi , 1995.
10. Kant R. Sweet proteins – Potential replacement for artificial low calorie sweeteners. Nutrition J. 2005; 4:5 doi:10.1186/1475-2891-4-5.
11. Misaka T. Molecular mechanisms of the action of miraculin, a taste-modifying protein. Seminars Cell Develop Biol. 24:222-225, 2013.
12. Temussi PA. Natural sweet macromolecules: how sweet proteins work. Cell Molec Life Sci CMLS. 63:1876-1888, 2006

PEDAGOGY: MOOC/DESK WORK/BOOK CHAPTER/PROBLEM SOLVING /ASSIGNMENT

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CLASS TEST (2 CLASS TESTS)	20
SEMINARS / CLASS WORK	10
ASSIGNMENT/ OPEN DISCUSSION	10
TOTAL	40

SEMESTER V
DSC BIC – 501T

COURSE TITLE	**Biochemistry of Macromolecules and Human Physiology**
COURSE CREDITS	**04**
TOTAL CONTACT HOURS	**60**
DURATION OF ESA	**2.5**
FORMATIVE ASSESSMENT MARKS	**40**
SUMMATIVE ASSESSMENT MARKS	**60**

Course Outcome:

The course provides fundamental insights on the types of macromolecules; and unique structuralfeatures, chemical properties and biological importance of each.
Describe cell structure and functions, how cells form and divide, and how they differentiate and specialize.
Students will be able to describe the cyclical events of cell division and types of cell divisions.
Student's knowledge with regard to the process of cell death and cell aging will enhance to its core.
Physiology involves the study of how living systems function, from the molecularand cellular level to the system level, and emphasizes an integrative approach to studying the biological functions of the human body.

Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
Aptitude	x	x	x	x								
Critical thinking		x								x		x
Subject clarity	x	x					x				x	x
Analytical Skill	x				x	x				x		

UNIT I: Carbohydrates **10 hours**

Definition, empirical formulae, classification, biological importance. Monosaccharides: Configuration relationship of D-aldoses, D-ketoses. General properties of aldoses and ketoses. Oxidation, reduction, reducing property, formation of glycosides, acylation, methylation, condensation – phenyl hydrazine, addition –HCN. Interconversion of aldoses and ketoses by chemical method. Ascending anddescending series by chemical methods. Stereochemistry of monosaccharides, (+) and(-), D and L, epimers, anomers, and diastreoisomers. Elucidation of open chainstructure and ring structure of glucose. Conformation of glucose (only structures),mutarotation. Structure of galactose, mannose, ribose and fructose. Structure and biological importance of deoxy sugars and sugar acids.

Disaccharides: Establishment of structures of Sucrose and Lactose, Biologicalimportance and structure of Isomaltose, Trehalose and Maltose.
Polysaccharides: Partial structure, occurrence and importance of Starch, Glycogen, Inulin, Cellulose, Chitin, and Pectin.
Glycosaminoglycans: Structure of amino sugars, neuraminic and muramic acid. Occurrence, importance and the structure of the repeating units of heparin, hyaluronic acid, teichoic acid and chondroitin sulphate. Bacterial cell wall polysaccharide, peptidoglycans.

UNIT II: Lipids **10 hours**

Classification and biological role, fatty acids – nomenclature of saturated and unsaturated fatty acids.
Acylglycerols: Mono, di and triacylglycerols. Saponification, saponification value, iodine value, acid value and significance. Rancidity, hydrolysis.
Phosphoglycerides: Structure of lecithin (phosphatidyl choline), cephalins, phosphatidyl inositol, plasmalogens, and cardiolipin. Biological role of phosphoglycerides.
Sphingolipids: Structure and importance of sphingomyelin.
Glycerosphingolipids: Composition and importance of gangliosides and cerebrosides.
Prostaglandins: Types, structure of PGE2, PGI2, PGD2 and PGF2 Alpha. Biological roles of thromboxanes, leukotrienes and prostaglandins.
Plasma lipoproteins: Types and functions.

UNIT III: Amino acids and Proteins **10 hours**

Amino acids: Structure and classification of amino acids based on polarity. Reactionsof the amino groups with HNO_2, $LiAlH_4$. Ninhydrin, Phenyl isothiocyanate, Dansyl Chloride, Flurodinitro benzene. Reaction of carboxyl group – Hydrazine. Zwitterionicproperties. pKa values, Titration curve for glycine.
Peptides: Peptide bond, Geometry and bond parameters, Ramachandran plot and biological importance of glutathione, Valinomycin. Synthetic peptides- polyglutamic acid, polylysine.
Proteins: Classification of proteins based on solubility, structure and functions with examples.
Structural levels of protein: Forces that stabilise the structure of proteins, Primary structure of proteins, methods of determining N- and C- terminal amino acids, amino acid composition, sequencing by Edman's degradation method. Secondary Structure – α helix. β-sheet,
β-bend. Tertiary and quaternary structures- hemoglobin, denaturation and renaturation of proteins. Anfinsen's experiment.

UNIT IV: **10 hours**

Basic body plan in humans and location of organs.

Nervous System: Brief outline of nervous system, Neurons – types, structure of multipolar neuron, mechanism of nerve impulse transmission- along axon, across synapse. Action

potential & resting potential. Neurotransmitters – Excitatory & Inhibitory with examples.

Respiratory system: Anatomy, structure and functions of lungs, mechanism ofrespiration (pulmonary ventilation), gas exchange mechanism, biochemical events in the transport of gases & factors affecting, role of lungs in acid-base balance. Hypoxia, emphysema.

Cardio-vascular system: Structure and functions of heart. Blood vessels – types, Overview & functions: Cardiac cycle, cardiac output, regulation of CVS, blood pressure, heart rate, ECG. Body fluids – blood (composition, structure & functionsof blood cells), blood clotting mechanism, Lymph and CSF.

Muscular System: Types of muscles and their structure. Ultrastructure of skeletal muscle. Contractile & regulatory proteins of muscle. Sliding filament model of skeletal muscle contraction.

UNIT V: 10 hours

Bone and Cartilage: Structure and types of bone and cartilage. Long bone – Composition, structure, growth & remodeling, factors affecting.
Digestive System and GIT: Anatomy of GIT and accessory organs, Digestion, absorption & transport of carbohydrates, lipids and proteins. Role of various enzymes involved in digestive process.
Hepatic System: Structure of a liver lobule. Role of liver in metabolic, storage and detoxification.
Excretory System: Brief outline of excretory system, formation of urine – Glomerular filtration, tubular reabsorption & secretions. Role of kidney in acid-basebalance. Regulation of kidney function.

UNIT VI: 10 hours

Endocrine System: Brief outline of various endocrine glands and their secretions. Dynamic balance and regulation of hormonal secretions. Classification of hormonesbased on structure and site of production. Physiological role of hormones of hypothalamus, pituitary, adrenal, thyroid, pancreas and gonads. Regulation of their secretion.
General mechanism of hormone action in brief - peptide and steroid hormones. membrane receptors and secondary messengers (cAMP, DAG, IP3). Signal transduction pathway for steroidal and non-steroidal hormones.

REFERENCES :

1. Harper's Illustrated Biochemistry, Victor W Rodwell, et.al,31st edition, McGraw HillEducation Lange ® 2018.
2. Biochemistry , Lubert Stryer 5th edition 2015
3. Chatterjee C C, Human physiology, Medical allied Agency. New Delhi 2020
4. Gerard J Tortora, Bryan H Derrickson. Principles of anatomy and physiology, 13th edition, John Wiley& Sons 2000
5. Gyton and Hall, Textbook of medical physiology, 10th edition, Elsevier Health Sciences 2015
6. Sembulingam K & Prema Sembulingam, Essentials of medical physiology, 3rd edition, Jaypee Brothers, 2019
7. Thomas D. Pollard, William C. Earnshaw, Jennifer Lippincott-Schwartz and Graham T. Johnson, CellBiology, 3rd edition, Elsevier 2017
8. Lodish, Berk, Kaiser, Krieger et al, Molecular Cell Biology, 6th edition, 2010
9. Bruce Alberts, Hopkin, Johnson Morgan, Raff, Roberts, and Walter, Essential Cell Biology, 5thedition, W.W. Norton & Company, 2019
10. Principles of Biochemistry, Donald Voet, Judith G Voet, Charlotte W. Pratt, 4thEdition, John Wiley and Sons Inc, 2012
11. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications 2012
12. Biochemistry- the chemical reactions of living cells, David E Metzler, 2nd Edition, Elsevier Academic Press,
13. Fundamentals of Biochemistry, Jain, J.L, S.Chand publication 6th Edition, 2005.
14. Biochemistry, Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, Freeman andcompany, 7th Edition, 2010

PEDAGOGY: MOOC/DESKWORKBOOK CHAPTERR/PROBLEM SOLVING /ASSIGNMENT

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CLASS TEST (2 CLASS TEST)	**20**
SEMINARS/CLASS WORK	**10**
ASSIGNMENT/ OPEN DISCUSSION	**10**
TOTAL	**40**

SEMESTER V

DSC B IC 501P: PRACTICAL

COURSE TITLE	**Qualitative analysis of macromolecules and Physiological Chemistry**
COURSE CREDITS	**02**
CONTACT HOURS	**4 Hours/ Week**
DURATION OF ESA	**04**
FORMATIVE ASSESSMENT MARKS	**25**
SUMMATIVE ASSESSMENT MARKS	**25**

Course outcome:

The practical course will enable the students to learn the principles of reactions pertaining to different macromolecules. They will be able to qualitatively identify the presence of specific macromolecules carbohydrate or amino acids when provided with solution of a mixture of biomolecules.
To determining the blood grouping and other physiological parameters.
Demonstrate the principle and working of instruments used in cell biology.

Experiments:

1. **Qualitative analysis of Carbohydrates**- Monosaccharides (glucose, fructose, galactose) disaccarides (lactose, maltose, sucrose) and polysaccharides (starch, glycogen), ribose, deoxy ribose- Molisch Test, Iodine Test, Benedict's Test, Barfoed's Test, Seliwanoff's test, Bial's test, DPA Test, Tollen's Test, Fehling's Test, Picric Acid Test, Osazone Test.

2.**Qualitative analysis of Proteins**-Biuret Test, Ninhydrin Test, Precipitation reactions of proteins- Precipitation by salts (half-saturation test), precipitation by organic solvents,precipitation by acidic reagents, precipitation by heavy metal ion (cadmium & lead), precipitation by heat; colour reactions of proteins (gelatin and albumin)

3.**Qualitative analysis of aminoacids**- Color reactions of any five amino acids (tryptophan, tyrosine, cysteine, methionine, arginine, proline and histidine)- Xanthoproteic test, Millon's Test, Sakaguchi Test, Hopkins- Cole Test, Lead acetate test, Sullivan and McCarthy's Test, Isatin Test, Pauly's Diazo Test.

4. **Qualitative analysis of Lipids and nucleic acids**

Lipids- solubility, acrolein test, Salkowski test, Lieberman-Burchard test.

Nucleic acids: diphenylamine test, orcinol test

5. Determination of ABO blood grouping and Determination of Blood clotting time

6. Enumeration of RBC and WBC count using Haemocytometer, Separation of Serum and Plasma

from Blood

7. Estimation of haemoglobin content in blood

8. Study of pulmonary function test using spirometer and Determination of blood pressure

REFERENCES:

1. Practical Biochemistry, Geetha Damodaran, Jaypee, 2011
2. Biochemical methods, S. Sadasivam , A. Manickam, 3 rd Edition, New Age International Pvt Ltd, 2007
3. An Introduction to Practical Biochemistry, David Plummer , 3rd edition 2017
4. Laboratory manual in Biochemistry , J. Jayaraman 2011
5. Essentials of Medical Physiology , K. Sembulingam and P. Sembulingam. Jaypee brothers medical publishers, New Delhi., 2019
6. Text book of Medical Physiology- C,Guyton and John.E. Hall. Miamisburg, OH, U.S.A, 12th edition 2011
7. Textbook of Practical Physiology , C.L. Ghai, Jaypee brother's medical publishers, New Delhi, 10th edition 2022

PEDAGOGY: MOOC/ DESK WORK/ BOOK CHAPTER/ PROBLEM SOLVING/ ASSIGNMENT

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CONTINUOUS EVALUATION AND CLASS TEST	**15**
RECORD / VIVA VOCE	**10**
TOTAL	**25**

SEMESTER V
DSC BIC – 502T

COURSE TITLE	**MOLECULAR BIOLOGY**
COURSE CREDITS	**4**
TOTAL CONTACT HOURS	**60**
DURATION OF ESA	**2.5**
FORMATIVE ASSESSMENT MARKS	**40**
SUMMATIVE ASSESSMENT MARKS	**60**

Course outcome:

The course provides fundamental insights on the types of nucleic acids and unique structural features, chemical properties and biological importance of each
These topics will enable students to the molecular mechanisms via which genetic information isstored, expressed and transmitted among generations.

Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
Aptitude	x	x	x									
Critical thinking		x										
Subject clarity	x	x				x					x	x
Analytical Skill	x				x	x				x		

UNIT I: Nucleic acids **10 hours**

Nucleic acids: Composition of DNA and RNA. Nucleosides and Nucleotides. Other functions of nucleotides – source of energy, component of coenzyme and second messengers. Chargaff's rule. Watson and Crick model of DNA. Forms of DNA and their interconversion. Nucleic acid chemistry- UV absorption, Effect of alkali and acid on DNA, Chemical reactions of RNA and DNA. Melting of DNA (Tm). Types of RNA (mRNA, tRNA rRNA and snRNA), Secondary structures of tRNA – clover leaf model. Isolation of nucleic acids and sequencing

UNIT II: Introduction and replication **10 hours**

History: Identification of DNA as genetic material- Experiments of Griffith, Hershey andChase: Overview of structure of DNA.
Introduction to Molecular Biology: Chromosomal organization in prokaryotes and Eukaryotes; Gene and gene concept: cistron, muton, and recon. Central dogma of molecular biology and its modification,
Replication: Types of replication -Conservative, semi conservative and dispersive: Evidence for semi conservative replication- Meselson and Stahl experiment: Mechanism of semi conservative replication- Steps involved in replication, Enzymes and proteins involved in replication, outline of DNA replication in eukaryotes.

UNIT III: DNA damage, repair and mutation **10 hours**

DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair
Mutation: Concept of mutation, Mutagens – chemical and physical, Molecular basis of mutation: spontaneous and induced mutations, effect of HNO_2, alkylating agents, intercalating agents and UV-radiation. Point mutations: Concept of missense, nonsense and frame shift mutations.

UNIT IV: Transcription **10 hours**

Transcription: Types of RNA, RNA polymerases, promoters, enhancers, silencers, role of sigma factor, Structure of mRNA in prokaryotes, Mechanism- initiation, elongation and termination (Rho - dependent and independent), Overview of eukaryotic transcription, post transcriptional processing: capping, splicing and poly adenylation, reverse transcription.

UNIT V: Genetic code and Translation **10 hours**

Genetic code: characteristics of genetic code, wobble hypothesis.
Translation: Mechanism of translation - amino acid activation, charging of tRNA, initiation, elongation, and termination; Post-translational modification; Inhibition of protein synthesis by antibiotics. Outline of translation in eukaryotes.

UNIT VI: Regulation of gene expression **10 hours**

General aspects of regulation, transcriptional regulation - inducible and repressible system, positive regulation, negative regulation: Operon concepts – lactose, tryptophan operons, Regulation of translation. Brief account of Eukaryotic gene expression.

REFERENCES:

1. Harper's Illustrated Biochemistry, Victor W Rodwell, et.al,31st edition, McGraw Hill Education Lange ® 2018. 7.
2. Biochemistry , Lubert Stryer 5th edition 2015
3. Principles of Biochemistry, Donald Voet, Judith G Voet, Charlotte W. Pratt, 4thEdition, John Wiley and Sons Inc, 2012
4. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn.Macmillan Publications 2012
5. Biochemistry, Lubert Stryer 5th edition 2015
6. Molecular Biology - David Friefelder, Narosa Publication- house Pvt. Ltd. NewDelhi,2020
7. A Textbook of Biochemistry: Molecular and Clinical Aspects S. Nagini . 2ndedition . Sci Tech Publ., Chennai, 2007

SEMESTER V

DSC B IC 502 P: PRACTICAL

COURSE TITLE	**Microbiology and Molecular biology**
COURSE CREDITS	**02**
CONTACT HOURS	**4 Hours/ Week**
DURATION OF ESA	**04**
FORMATIVE ASSESSMENT MARKS	**25**
SUMMATIVE ASSESSMENT MARKS	**25**

Course Outcome:

At the completion of this course, it is expected that the students will be able to: Identify of microscopical features of various types of cells and tissues:
Understand the anatomy & Physiology of various systems and Learn the various cells and
Demonstrate the principle and working of instruments used in cell biology.
The course will enable the students to learn the principles of reactions pertaining to nucleic acids. They will be able to isolate and quantitate DNA and RNA from different sources and characterization.

Experiments:

1. Instrumentation- Understanding principle, working & handling of simple microscope, autoclave, biosafety & sterilization techniques
2. Examination of prokaryotic & eukaryotic cells, Study of different stages of mitosis & meiosis in onion root tip - squash preparationmethod
3. Demonstration of preparation of culture media for bacterial cultivation and pure culture techniques – Streak, pour plate and serial dilution
4. Gram staining
5. Isolation of DNA from banana/endosperm of coconut/ bacteria / any other source, checking purity and characterisation by agarose gel electrophoresis.
6. Isolation of RNA from spinach leaves/any other source and checking purity.
7. Isolation of plasmid from E.*coli*
8. DNA analysis by Restriction endonucleases (Demonstration)
9. Western blotting (Demonstration)

REFERENCES

1. A Hand book of practical Microbiology, R. Saravanan , D. Dhachinamoorthi , CH. MM. Prasada Rao , 2019
2. Molecular Biology: A Laboratory Manual by by Ashwani Kumar S.K. Gakhar, Monika Miglani, 2019
3. Wilson And Walkers Principles And Techniques of Biochemistry And Molecular Biology 8th ed (Sae) by Hofmann, 1983
4. Laboratory Manual of Microbiology, Biochemistry and Molecular Biology by J. Saxena, M. Baunthiyal, I. Ravi , 2015
5. Biochemical methods, S. Sadasivam , A. Manickam, 3 rd Edition, New Age International Pvt Ltd, 2007
6. An Introduction to Practical Biochemistry, David Plummer , 3rd edition 2017 6. Laboratory manual in Biochemistry , J. Jayaraman 2011

PEDAGOGY: MOOC/ DESK WORK/ BOOK CHAPTER/ PROBLEM SOLVING / ASSIGNMENT

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CONTINUOUS EVALUATION AND CLASS TEST	**15**
RECORD / VIVA VOCE	**10**
TOTAL	**25**

SEMESTER VI
DSC BIC – 601T

COURSE TITLE	**Enzymology**
COURSE CREDITS	**04**
TOTAL CONTACT HOURS	**60**
DURATION OF ESA	**2.5**
FORMATIVE ASSESSMENT MARKS	**40**
SUMMATIVE ASSESSMENT MARKS	**60**

Course outcome:

These topics will enable students to describe structure, functions and the mechanism of actionof enzymes. Learning kinetics of enzyme catalyzed reactions and enzyme inhibitions and regulatory process, Enzyme activity, Enzyme Units, Specific activity.

Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
Aptitude		X		X								
Critical thinking		X				X						
Subject clarity	X	X					X			X		X
Analytical Skill	X				X	X				X		

UNIT I: **10 hours**

Introduction to enzymes:

Nature of enzymes - protein and non-protein (ribozyme). Cofactor and prosthetic group, apoenzyme, holoenzyme, IUBMB classification of enzymes with examples. International Units of enzyme activity, specific activity.
Monomeric and oligomeric enzymes- Monomeric enzymes, multifunctional enzymes, oligomeric enzymes and multi- enzyme complexes, isoenzymes- lactate dehydrogenase.

Applications of enzymes:
Clinical application of enzymes – SGPT and SGOT, LDH and CPK. Biotechnological and industrial applications of enzymes, Enzyme Immobilization- methods, properties and applications of immobilized enzymes.

UNIT II: **10 hours**

Features of enzyme catalysis:

Catalysis, reaction rates and thermodynamics of reaction. Activation energy and transition state theory, catalytic power and specificity of enzymes (concept of active site), Theories of enzyme catalysis- Fischer’s lock and key hypothesis, Koshland’s induced fit hypothesis.

Mechanism of action of enzymes:
General mechanisms of action - Acid-base and covalent catalysis (carboxypeptidase A, chymotrypsin and lysozyme) Involvement of coenzymes in enzyme catalyzed reactions:
Coenzymes - Definition, structure and role of TPP, NAD and PLP.

UNIT III: 10 hours
Enzyme kinetics of single substrate reactions:

Michaelis-Menten equation, equilibrium constant – mono substrate reactions, relationship between initial velocity and substrate concentration, Factors affecting the rate of chemical reactions - enzyme concentration, substrate concentration- pH, temperature and metal ions. Lineweaver- Burk plot. Determination of Vmax & Km fromL-B plot and their significance, Kcat and turnover number.

UNIT IV: 10 hours
Enzyme inhibition
Reversible inhibition- competitive, uncompetitive, non-competitive with graphical representations using L-B plots, Evaluation of Km and Vmax in presence of inhibitor, mixed and substrate inhibition. Irreversible inhibition- Suicide inhibition -antibiotics as inhibitors- penicillin.

UNIT V: 10 hours
Regulation of enzyme activity:

Control of activities of enzymes - end product inhibition, Allosteric enzymes, feedback inhibition (Aspartate Transcarbamoylase), reversible covalent modification phosphorylation (glycogen phosphorylase). Proteolytic cleavage - Zymogen. Multi-enzyme complex as regulatory enzymes (PDH).

UNIT VI: 10 hours
Isolation and purification of enzymes :
Source, methods of cell disruption, Separation based on: solubility, size or mass, polarity, affinity or ligand based. Enzyme assay, Criteria of purity of enzymes.

REFERENCES:

1. Cox, Michael M. Lehninger principles of biochemistry. Freeman, 2013.
2. Lubert Stryer. Biochemistry, 5th edition , 2006
3. Palmer, Understanding enzymes, 4th edition, Prentice Hall/Ellis Horward, Landon2000
4. Price, Nicholas C., and Lewis Stevens. Fundamentals of Enzymology. Oxford Science Publications. Second edition. New York, 2010
5. Buchholz, Klaus, Volker Kasche, and Uwe Theo Bornscheuer. Biocatalysts andenzyme technology. John Wiley & Sons, 2012.
6. Voet, Donald, Judith G. Voet, and Charlotte W. Pratt. "Fundamentals of
7. biochemistry." New York: John Wiley & Sons 2008.
8. Devlin, Thomas M. Textbook of biochemistry: with clinical correlations. John Wiley& Sons, 2011.

PEDAGOGY: MOOC/ DESK WORK/ BOOK CHAPTER/ PROBLEM SOLVING / ASSIGNMENT

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CLASS TEST (2 CLASS TESTS)	**20**
SEMINARS / CLASS WORK	**10**
ASSIGNMENT/ OPEN DISCUSSION	**10**
TOTAL	**40**

SEMESTER VI

DSC B IC 601P: PRACTICAL

COURSE TITLE	**Enzymology**
COURSE CREDITS	**02**
CONTACT HOURS	**4 Hours/ Week**
DURATION OF ESA	**04**
FORMATIVE ASSESSMENT MARKS	**25**
SUMMATIVE ASSESSMENT MARKS	**25**

Course outcome:

The practical course will enable the students to learn the assay of enzymes from differentsources and they will able to study the kinetics of enzymes.

EXPERIMENTS:

1. Isolation of Urease and demonstration of its activity.
2. Isolation of Acid phosphatase and demonstration of its activity.
3. Salivary amylase/β- amylase
   a) Construction of Maltose/glucose calibration curve by DNS method
   b) Construction of standard protein curve
   c) Determination of activity of amylase
   d) Determination of specific activity of amylase
   e) Determination of pH optimum of amylase.
   f) Determination of Km and Vmax of amylase.
   g) Determination of initial velocity [time kinetics] of amylase.
   h) Determination of optimum temperature of amylase.
   i) Effect of sodium chloride on amylase.
4. Determination of activity of yeast invertase.

REFERENCES:

An introduction to Practical Biochemistry, David Plummer, 3r edition 2017

1. Laboratory manual in Biochemistry, Jayaraman J, New Age Internationalpublications, 2011
2. Practical Manual of Biochemistry, Sattanathan G., Swaminathan P. andBalasubramanian B. Sky fox press, 2020
3. Practical manual of Biochemistry, S.P Singh, 7th edition, CBS publications, 2013
4. Sawhney, S. K., and Randhir Singh. Introductory practical biochemistry. AlphaScience Int'l Ltd., 2000.

PEDAGOGY: MOOC/ DESK WORK/ BOOK CHAPTER/ PROBLEM SOLVING/ ASSIGNMENT

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CONTINUOUS EVALUATION AND CLASS TEST	**15**
RECORD / VIVA VOCE	**10**
TOTAL	**25**

SEMESTER VI
DSC BIC – 602T

COURSE TITLE	**Metabolism and Immunology**
COURSE CREDITS	**04**
TOTAL CONTACT HOURS	**60**
DURATION OF ESA	**03**
FORMATIVE ASSESSMENT MARKS	**40**
SUMMATIVE ASSESSMENT MARKS	**60**

Course Outcome:

At the end of the course the students will be able to:

- Understand the concepts of metabolism, characteristics of metabolic pathways andstrategies used to study these pathways.
- Gain a detailed knowledge of various catabolic and anabolic pathways and itsregulation
- Systematically learn the breakdown and synthesis of amino acids and nucleotides inhumans and recognize its relevance with respect to nutrition and human diseases
- Acknowledge the role of inhibitors of nucleotide metabolism which are potentiallybeing used as chemotherapeutic drugs
- Comprehend how the amino acid and nucleotide metabolism are integrated withcarbohydrate and lipid metabolism
- Defines the concept of immunology, concepts of antigen and antibody
- Explain immune system cells, Discuss active immunity and passiveimmunity
- Explain the cellular immune mechanism

Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Aptitude		**x**		**x**				**x**				
Critical thinking		**x**		**x**		**x**				**X**		
Subject clarity	**x**	**x**				**x**	**x**	**x**	**x**	**X**	**x**	**x**
Analytical Skill	**x**				**x**	**x**				**X**		

UNIT I: **10 hours**

Bioenergetics: Laws of thermodynamics, free energy change, Relationship between equilibrium constant and free energy change, ATP cycle, phosphorylation potential, and phosphoryl group transfers. Chemical basis of high standard energy of hydrolysis of ATP, Oxidative phosphorylation : Proton gradient generation, redox loop, Q cycle, Proton pumping. The electron transport chain -Peter Mitchell's Chemiosmotic hypothesis and Proton motive force. Fo-F1 ATP synthase, structure and mechanism of ATP synthesis- binding chain mechanism.

UNIT II: **10hours**

Metabolism : Anabolism and catabolism, compartmentalization of metabolic pathways.
Metabolism of Carbohydrates: Reactions and energetics of glycolysis, entry of fructose, galactose, mannose and lactose into glycolytic pathway. Fates of pyruvate - conversion of pyruvate to lactate, alcohol and acetyl CoA.
Reactions and energetics of TCA cycle, amphibolic and integrating roles of TCA cycle. Anaplerotic reactions. Regulatory steps of glycolysis and TCA cycle, Gluconeogenesis and glycogenolysis. Cori's cycle. Pentose phosphate pathway and its significance.

Metabolism of Lipids: Introduction, hydrolysis of triacylglycerols, transport of fatty acids into mitochondria, β- oxidation of saturated and unsaturated fatty acids, ATP yield from fatty acid oxidation. Biosynthesis of saturated and unsaturated fatty acids. Fatty Acid Synthase complex, Lipogenesis (Denovo synthesis of Fatty acid), Elongation of Fatty acid (Mitochondrial elongation). Biosynthesis of TAG, Phospholipids (Lecithin and Cephalin). Cholesterol metabolism.

UNIT III: **10 hours**

Metabolism of Amino acids: General mechanism of amino acid metabolism: Deamination- oxidative and non–oxidative deamination, transamination, decarboxylation (biologically important amines) and desulphuration. Catabolism of carbon skeleton of amino acids, glycogenic and ketogenic amino acids. Urea cycle and its significance. Synthesis and catabolism of alanine, serine and cysteine.

Nucleic Acid metabolism: De novo biosynthetic pathways of purine and pyrimidine nucleotides. Conversion of ribonucleotides to deoxyribonucleotides. Salvage pathways.
Degradation of nucleic acids, action of nucleases-DNase I and II, RNase and phosphodiesterases. Catabolism of purines and pyrimidines.

UNIT IV: **10 hours**

Organs of the immune system: Anatomy and functions of lymphoid tissues, Cellular components of the immune system - Hematopoiesis, stem cells, granulocytes- Neutrophil, eosinophil, basophil and Mast cell, Mononuclear cells- Lymphocytes, Monocytes, Macrophages, NK cells and Dendritic cells.

Antigen: Concept of antigenic determinants and immunogens, factors that influence immunogenicity, Classes of antigen, Epitopes, Haptens.
Antibody: Immunoglobulin genes, Molecular Structure - general features , light and heavy chains, Hyper variable and constant regions, Different isotypes and subtypes of immunoglobulins, Allotypes and idiotypes, Synthesis, Assembly and Expression of Ig molecules, Immunoglobulin superfamily.

UNIT V: **10 hours**
Innate immunity
Anatomical and physiological barriers, Soluble factors, inflammation characteristics, initiation of the inflammatory response, Recruitment of phagocytic cells, recognition by receptors, adhesion molecules, Chemotaxis, Phagocytosis, Acute inflammatory response, Role of innate immunity. Noncellular components of the immune system -Lipid mediators, Cytokines, Complement system, Acute phase proteins, and Kinin system. Hypersensitivity Type-I and Type-I

UNIT VI: **10 hours**

Adaptive immunity

MHC molecules: genes, different classes, structure and function, Antigen processing and presentation: Endogenous and exogenous pathways.

Humoral Immunity – B cell development and selection, B-cell receptor, B-Cell maturation, Activation, Differentiation, generation of plasma cells and memory B cells.

Cell-mediated immunity :T cell development, Structural organization of T cell receptors, T-cell maturation, Activation, Differentiation, Proliferation , B cell – T cell interaction, The germinal center reactions, Class switch recombination, generation of CD4+and CD8+ cell responses, secondary immune responses, regulation of the adaptive immune response.

REFERENCES

1. Principles of Biochemistry, Donald Voet, Judith G Voet, Charlotte W. Pratt, 4th Edition, John Wiley and Sons Inc, 2012
2. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications 2012
3. Biochemistry- the chemical reactions of living cells, David E Metzler, 2nd Edition, Elsevier Academic Press,
4. Fundamentals of Biochemistry, Jain, J.L, S.Chand publication 6th Edition, 2005.
5. Biochemistry, Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, Freeman and company, 7th Edition, 2010.
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7. Cox, Michael M. Lehninger principles of biochemistry. Freeman, 2013.
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9. Owen, Judith A., Jenni Punt, and Sharon A. Stranford. Kuby immunology. New York: WH Freeman, 2013.
10. Delves, Peter J., Seamus J. Martin, Dennis R. Burton, and Ivan M. Roitt. & Roitt's essential immunology. Vol. 20. John Wiley & Sons, 2011.

PEDAGOGY: MOOC/ DESK WORK/ BOOK CHAPTER/ PROBLEM SOLVING/ ASSIGNMENT

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CLASS TEST (2 CLASS TEST)	**20**
SEMINARS/CLASS WORK	**10**
ASSIGNMENT/ OPEN DISCUSSION	**10**
TOTAL	**40**

SEMESTER VI

DSC B IC 602P: PRACTICAL

COURSE TITLE	**Quantitative Analysis of Macromolecules and lmmunology**
COURSE CREDITS	**02**
CONTACT HOURS	**4 Hours/ Week**
DURATION OF ESA	**04**
FORMATIVE ASSESSMENT MARKS	**25**
SUMMATIVE ASSESSMENT MARKS	**25**

Course Outcome:

The practical course will enable the students to learn the estimation of blood substances which tell how well the organs/kidneys are functioning, and glucose, which indicates whether there is a normal amount of sugar in the blood. Blood urea nitrogen is a measure of how well the kidneys are working.
Competently perform serological diagnosis
Analyze components of human sera by performing electrophoresis experiments

Experiments:

1. Estimation of Urea
2. Estimation of Uric acid
3. Estimation of creatinine
4. Estimation of cholesterol
5. Counting and seeding of cells
6. Hemagglutination inhibition test
7. WIDAL test
8. ELISA test/assay
9. Isolation of antibodies
10. Differential leucocyte count
11. Radial immune diffusion test
12. Agglutination reactions
13. Serum electrophoresis

REFERENCES:

1. Practical Biochemistry, Geetha Damodaran, Jaypee, 2011
2. Biochemical methods, S. Sadasivam, A. Manickam, 3 rd Edition, New Age International Pvt Ltd, 2007
3. An Introduction to Practical Biochemistry, David Plummer, 3rd edition 2017
4. Laboratory manual in Biochemistry, J. Jayaraman 2011
5. A handbook of practical and clinical immunology, 2017 G.P Talwar and S.K Gupta
6. Practical Immunology,2000, Frank C Hey, Publisher: John Wiley and Sons Ltd
7. An Introduction to Practical Biochemistry, David Plummer, 3rd edition 2017
8. Laboratory manual in Biochemistry, J. Jayaraman 2011

PEDAGOGY: MOOC/ DESK WORK/ BOOK CHAPTER/ PROBLEMSOLVING/ ASSIGNMENT

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CONTINUOUS EVALUATION AND CLASS TEST	**15**
RECORD / VIVA VOCE	**10**
TOTAL	**25**