ESTD : 1880

ST ALOYSIUS

(DEEMED TO BE **UNIVERSITY**)

MANGALURU

Course structure and syllabus of

OF

M.Sc. Biochemistry

CHOICE BASED CREDIT SYSTEM (CBCS)

(2024 -25 BATCH ONWARDS)

PREAMBLE

Biochemistry is the study of the structure, composition, and chemical reactions of substances in living systems, aptly ‘Chemistry of Life’. Biochemistry emerged as a separate discipline when scientists combined biology with inorganic, organic and physical chemistry and began to study how living things obtain energy from food, the chemical basis of heredity, and fundamental changes that occur in diseases. Biochemistry includes the sciences of molecular biology, cell biology, immunology, toxicology, genomics, neurochemistry, bioinorganic, bioorganic and biophysical chemistry

It is a practical laboratory science that applies the molecular approaches of chemistry to study the structure and behaviour of the complex biomolecules and the ways these biomolecules interact to form cells, tissues, organs and whole organisms. Biochemistry seeks to unravel the complex chemical reactions that occur in a wide variety of life forms, and thus provides the quintessential basis for advances in medicine, biotechnology, and agriculture. The study of Biochemistry has resulted in valuable contributions to medicine, industry and society in general. This knowledge has been used in fighting illness and improving quality of life. This has made Biochemistry interesting, challenging, rewarding and full of opportunities. This is a very exciting time to be studying biochemistry because so many important discoveries are being made each day. There is a large demand for scientists - the Government wants more scientists and technologists in all walks of life to take advantage of recent advances in knowledge. A Masters in Biochemistry can prepare one for diverse careers including teaching and research in hospitals and medical fields, in the food and drink industries, in agriculture and in industry.

Recognizing the tremendous opportunities, the science offers, St. Aloysius College ventured into the field of Biochemistry as the first college in Dakshina Kannada District to start an undergraduate course in the year 1999. When autonomy status was awarded to St. Aloysius College, one of the major steps taken was to start the M.Sc. Biochemistry course affiliated to Mangalore University in the year 2008.

M.Sc. in the subject Biochemistry

1. Introduction

The framework for the postgraduate program in Biochemistry is intended to provide an academic base that caters to the need of the students to gain comprehensive understanding of Biochemistry and its ever-evolving nature of applications. The curriculum design is aimed at attaining snd maintaining standard of achievement with respect to knowledge, skills and the technical know-how to apply the knowledge gained to progress discovery, invention and application in the field.

The curriculum also aims at fostering scientific attitudes such as rational reasoning, critical thinking, problem solving and values such as ethics, social and environmental concern. The curriculum finally aims at excellence on par with the standard Higher Education Institutions.

2. Learning Outcomes based approach to Curriculum planning

The learning outcome-based approach, has been designed to identify the minimum learning outcome from a student after completing each course. This entire outcome is substantiated by the practical components.

The scheme of syllabus, instruction, examination, evaluation etc., has been prepared with the following objectives in mind.

- To empower students to understand the concepts in the field of Biochemistry
- To facilitate students to acquire theoretical and practical skills for a successful career in academia, industry and research.
- To encourage innovation and creativity among students and to foster the spirit of research and entrepreneurship to contribute positively to the progress of the society

3. Nature and extent of the Post Graduate program in Biochemistry

The two-year full time M.Sc. program in Biochemistry endeavors to provide students with excellent training in Biochemistry highlighting on providing a strong foundation of basic concepts as well as rapidly evolving advancement in the field. The theoretical knowledge, will be substantiated by providing hands on experience in the basic and advanced techniques of

Biochemistry and linked subjects through practical training in masters' laboratory in both the years. A valuable feature of the program is the augmentation of Practical Skills in Research through a Research project that will allow students to get hands-on-experience in tools and methods used in in research. This is followed by dissertation/ project thesis carried out on a research topic under the supervision of a mentor. The idea is to familiarize students to the different aspects of research including research methodology, scientific reading, critical review of the scientific literature, organizational capability, analytical ability, experimental design and execution and research ethics.

4. Post Graduate Attributes

It is expected that at the end of the program, each student acquires knowledge, skills, attitudes and values that will make them independent and confident in in their chosen career and playing a constructive role as a responsible citizen in the society. The students are expected to be able to apply biochemical principles to understand various complex processes in life sciences and provide solutions to combat various human diseases. The characteristics attributes of postgraduates in Biochemistry Program include:

i. **Disciplinary Knowledge and Skills -** Capable of demonstrating
    a. comprehensive knowledge and understanding of basic and advanced concepts, theoretical principles and research findings in Biochemistry and its different subfields like Enzymology, bioenergetics, toxicology, immunology, Physiology, genetics, molecular biology, genetic engineering, microbiology, bioinformatics etc.
    b. ability to use modern instrumentation and laboratory techniques to design and perform experiments in Biochemistry and related subjects.
ii. **Communication Skills**: Ability to speak and write clearly in English and to listen to and follow scientific viewpoints and debate.
iii. **Critical Thinking and scientific reasoning**: Ability to make logical conclusions based on evidence and logically apply methods to evaluate hypotheses.
iv. **Problem Solving**: Ability to conduct an experiment, including stating a hypothesis raising appropriate questions, identifying and controlling variables, and interpreting by applying lateral thinking and analytical skills.

v. **Digital Literacy*:*** Competency in using e-resources and software for analysis of data. Ability to use bioinformatic tools to locate, retrieve, evaluate and apply biological information

vi. **Teamwork and Time Management**: Ability to participate constructively in class room discussions, to contribute to group work and meet deadlines.

vii. **Moral and Ethical awareness:** Ability to evaluate one's own ethical values, and to be aware of ethical to refrain from unethical practices.

viii. **Life-long Learning**: Ability to retain and build on generic and critical thinking skills by consistently reading, reviewing and researching about technological advancement through self-directed learning.

5. Qualification descriptors for PG program in Biochemistry

The key qualification descriptor for Post -Graduate Biochemistry shall be coherent knowledge of concepts, experimentation, communication as well as critical thinking and ethical awareness. Each postgraduate in Biochemistry should be able to •

- Demonstrate

  (i) a systematic, extensive and coherent knowledge and understanding of the academic field of study as a whole and its applications, and links to related disciplinary areas/subjects of study.

  (i) procedural knowledge that creates different types of professionals related to the subject area of Biochemistry, including research and development, teaching and government and public service;

- Demonstrate skills in identifying information needs, collection of relevant quantitative and/or qualitative data from around the world, analysis and interpretation of data using methodologies as appropriate to the subject of Biochemistry and related subjects

- Use knowledge, understanding and skills in Biochemistry for critical assessment of a wide range of ideas and complex problems and issues relating to the various subfields of Biochemistry

- Communicate ideas, opinions and values—both scientific themes and values of life, in order to extend the knowledge of the subject from the classroom/laboratory to

industry and society.

- Demonstrate the skill to share the results of academic and disciplinary learning through various forms of communication such as reports, dissertations, essays, seminars, publications, etc., on different platforms of communication.

6. M.Sc. Biochemistry Program: Learning outcomes

A two-year program will lead to the award of a M.Sc. degree in Biochemistry. Students will be offered advanced level theory and practical courses in subjects like biomolecules, physiology and nutrition, biochemical techniques, organic and physical chemistry, cell biochemistry, biotechnology, immunology, genetic engineering, biostatistics, research methodology, ethics, bioinformatics, metabolism and other related concepts that will help students gain comprehensive knowledge in the field. Other feature of the program is seminars (in all four semesters) that students are required to present in open forum for collective evaluation by the departmental faculty members aimed at fostering skills like habit of scientific reading, analytical ability, leadership organizational capability, independent thinking, basic professional skills, generic and technical skills, ethical values, integrity and honesty. Additionally, during the program particular emphasis will be given to attaining research experience; this includes work by students in research laboratories to carry out projects under the supervision of faculty members. The department strives to achieve the following

Program outcomes:

PO1: Comprehensive knowledge of Biochemistry with inter-disciplinary perspective of other branches of life sciences

PO2: Competence to use modern biochemical and molecular techniques to perform experiments to test scientific hypotheses, analyze data, trouble -shoot and draw conclusions from the experimental data in labs.

PO3: Ability to write research thesis, and present and defend their findings to scientific audiences at regional or national levels.

PO4: Capacity to work independently, while still promoting teamwork and collaboration skills.

Program Specific Outcomes:

A student upon completion of this post-graduate program in Biochemistry should be able to demonstrate:

PSO 1: **Fundamental understanding of Biochemistry**, structure and function of biological molecule, mechanisms of biological processes and bioenergetics.

PSO 2: Competence to understand theories and methods that can be used **to link Biochemistry to related subjects** such as biotechnology, molecular biology, genetics, pharmacology, immunology, genetic engineering and Biostatistics and informatics

PSO 3: Ability to make quantitative measurements of parameters that are routinely encountered in **practical/ experimental biochemistry** and apply a range of techniques that are commonly used in biomolecule analysis.

PSO 4: Ability to a**nalyse and interpret biochemical data** acquired from the experimental procedures and demonstrates analytical and problem-solving skills with regard to biochemical principles of life processes.

PSO 5: Competence in **research and innovation** in Biochemistry and in related field of specialization and the ability to critically review scientific literature for development of new theories and testable hypothesis.

PSO 6: **Basic professional skills** pertaining to biochemical analysis, and the ability to use these skills in specific areas such as technology development, industrial production and skills that are relevant to biochemistry-related jobs and employment opportunities

PSO 7: Skill of **articulation of ideas, scientific writing**, authentic reporting, scientific conversation and writing, capacity for decision making with regard to scientific progress, personal development and career choice.

PSO 8: **Entrepreneurial and social competence,** the ability to plan and manage projects in order to achieve objectives

PSO 9: **Leadership and organizational skills**, ability to work independently, while still promoting team work and collaboration skills.

PSO 10: Ability to **translate knowledge of biochemistry to address environment issues** including, waste disposal management, safety and security issues, nature conservation, sustainability development etc.

PSO 11: Relevant **generic and technical skills** including communication skills effective interaction with others, listening, speaking, observational skills, utilization of e-resources and ICT.

PSO 12: Professional behavior with respect to attribute like **ethical values**, **integrity, honesty,** and sense of responsibility

Programme Learning Outcomes

Hard Core courses

S. No.		PH.511.1	PH.512.1	PH.513.1P	PH.511.2	PH.512.2	PH.513.2P	PH.511.3	PH.512.3	PH.513.3P	PH.514.3P	PH.511.4	PH.512.4	PH.513.4P
1.	Fundamental understanding of Biochemistry	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2.	Link Biochemistry to related subjects	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3.	Practical/ procedural biochemistry			✓			✓			✓	✓			✓
4.	Analyse and interpret biochemical data		✓	✓			✓			✓	✓			✓
5.	Research and innovation	✓	✓		✓	✓		✓	✓			✓	✓	✓
6.	Articulation of ideas, scientific writing	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7.	Basic professional skills			✓			✓			✓	✓			✓
8.	Entrepreneurial and social competence			✓			✓			✓	✓			✓
9.	Leadership and organizational skills			✓			✓			✓	✓			✓
10.	Translate knowledge of biochemistry to address environment issues			✓			✓		✓	✓	✓			✓
11.	Generic and technical skills- communication and ICT skills.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

1 2.	Attributes like ethical values, integrity, honesty, and sense of responsibility.			✓			✓			✓	✓			✓

Program Learning Outcomes

Soft Core courses

S. No.		PS. 514.1	PS. 515.1	PS. 516.1	PS. 517.1P	PS. 518.1P	PS. 514.2	PS. 515.2	PS. 516.2	PS. 517.2P	PS. 518.2P	PS. 515.3	PS. 516.3	PS. 514.4	PS. 515.4	PS. 516.4	PS. 517.4P	PS. 518.4P
1.	Fundamental understanding of Biochemistry	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2.	Link Biochemistry to related subjects	✓	✓	✓			✓	✓	✓			✓	✓	✓	✓	✓		
3.	practical/ procedural biochemistry				✓	✓				✓	✓						✓	✓
4.	analyse and interpret biochemical data	✓			✓	✓				✓	✓						✓	✓
5.	Research and innovation				✓	✓				✓	✓						✓	✓
6.	Articulation of ideas, scientific writing	✓	✓	✓			✓	✓	✓			✓	✓	✓	✓	✓		
7.	Basic professional skills				✓	✓				✓	✓						✓	✓
8.	Entrepreneurial and social competence						✓	✓		✓							✓	
9.	Leadership and organizational skills				✓	✓				✓	✓						✓	✓
10.	Translate knowledge of biochemistry to address environment issues				✓	✓				✓	✓						✓	✓

11.	Generic and technical skills- communication and ICT skills.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
12.	Attributes like ethical values, integrity, honesty, and sense of responsibility.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Program Learning Outcomes

Open elective courses

S. No.		PO. 519. 2	PO. 517. 3
1.	Fundamental understanding of Biochemistry	✓	✓
2.	Link Biochemistry to related subjects	✓	✓
3.	Practical/ procedural biochemistry		
4.	analyse and interpret biochemical data	✓	✓
5.	Research and innovation	✓	✓
6.	Articulation of ideas, scientific writing	✓	✓
7.	Basic professional skills	✓	✓
8.	Entrepreneurial and social competence	✓	✓
9.	Leadership and organizational skills	✓	✓
10.	Translate knowledge of biochemistry to address environment issues	✓	✓
11.	Generic and technical skills- communication and ICT skills.	✓	✓
12.	Attributes like ethical values, integrity, honesty, and sense of responsibility.	✓	✓

7. Program Structure:

The Master's program is a two-year course divided into four semesters. A student is required to complete 92 credits for the completion of course and the award of degree.

First Year: Semester I and Semester II
Second Year: Semester III and Semester IV

The Choice Based Credit System (CBCS) comprises courses in the form of Hard Core, Soft Core for Biochemistry Students and Open Elective course for students other than Biochemistry. Following shall be the minimum and maximum courses per semester.

The credit pattern is Lecture (L); Tutorial (T); Practical (P); (L:T:P) Pattern.

Lecture: One hour session of theory class per week in a semester is 1 credit.

Practical: Two-hour session of tutorial or practical per week in a semester is 1 credit.

One semester period is 16 weeks of teaching and learning.

Duration of semester is 20 weeks that includes semester end examinations.

Credit Pattern of courses:

Semester	Hard core credits		Soft core credits		Open elective credits (O)	Total Credits
	Theory	Practical/ Project	Theory	Practical/ Project		
I	9	4	6	3	-	22
II	9	4	6	3	3	25
III	9	8	3	-	3	23
IV	8	5	6	3	-	22
Total	35	21	24	9	6	92

8. CRITERIA FOR ADMISSION

C**andidates who have passed three year B.Sc. degree/equivalent degree/ four year integrated BSc degree in chemistry/ physics/biochemistry/life sciences/ biosciences/ allied health sciences/ agricultural sciences/ veterinary sciences from any recognized University with minimum of 45% (40% for SC/ST/Category-I candidates) marks are eligible* for the program provided they have studied Biology as major / optional / minor Special/subsidiary subject at PUC/ Higher Secondary level.**

***Students pursuing an international curriculum must note that eligibility is according to Association of Indian Universities stipulations/ UGC guidelines.**

9. Pedagogies employed in the M.Sc. program

Class room teaching: include the chalk and black board method, use of power point presentation, inquiry-based learning and group discussions.

E-learning: includes online components, which can be an assessed part of the degree. This includes online lectures, online tests, and assignments.

Laboratory and practical learning: students will perform the experiments in the laboratory, troubleshoot, interpret and present the results

Presentation: Student seminar/research paper presentation in each semester.

Research: includes literature review in the form of Dissertation. And project work on a small research problem.

Talks: includes Webinars, seminars and Invited talks from eminent scientists, Professors and entrepreneurs

Co-curricular activities

Wall journal: Students maintain a wall journal where all important research findings, job opportunities, creativity etc are displayed

Biochemistry association: All the students are members of Biochemistry association- a platform for show casing their talents- curricular and co-curricular.

Rural exposure camp: Students have to undergo compulsory **rural exposure camp** in order to sensitize them to the needs of the society.

M.Sc. Biochemistry							
I Semester (2+1 Hard core and 2+1 soft core paper)							
Code	**Papers**	**Instruction hours/ Week**	**Duration of Exam (hours)**	**Marks**		**Total**	**Credits**
				IA	**End sem**		
PH.511.1	Principles of Biochemistry	5	3	30	70	100	5
PH.512.1	Biochemical Techniques	4	3	30	70	100	4
PH.513.1P	Bioquantitation	8	4	30	70	100	4
PS.514.1	Chemical principles of biochemistry	3	3	30	70	100	3
PS.515.1	Physiology	3	3	30	70	100	3
PS.516.1	Nutrition and nutrigenomics						
PS.517.1P	Analytical Techniques	8	4	30	70	100	3
PS.518.1P	Experimental Physiology						
	Total					**600**	**22**
II Semester (2+2 Hard core and 2+1 Softcore papers and 1 open elective paper)							
PH.511.2	Enzymology	5	3	30	70	100	5
PH.512.2	Metabolism-I	4	3	30	70	100	4
PH.513.2P	Practical Enzymology	8	4	30	70	100	4
PS.514.2	Cell biology	3	3	30	70	100	3
PH.515.2	Genetics	4	3	30	70	100	4
PS.516.2	Neurobiochemistry						
PS.517.2P	Practical Cellular metabolism	8	4	30	70	100	3
PS.518.2P	Experimental Neuro-Biochemistry						
PO.519.2	Biochemistry of Diseases	3	3	30	70	100	3
	Total					**700**	**26**

M.Sc. Biochemistry							
III Semester (2+2 Hard core and 1 Soft core papers and open elective 1 paper							
Code	**Papers**	**Instruction hours/ Week**	**Duration of Exam (hours)**	**Marks**		**Total**	**Credits**
				IA	**End Sem**		
PH.511.3	Molecular Biology	5	3	30	70	100	5
PH.512.3	Immunology	4	3	30	70	100	4
PH.513.3P	Molecular and immunological techniques	8	3	30	70	100	4
PS.514.3P	Tools in biostatistics and bioinformatics	3	3	30	70	100	3
PH515.3	Metabolism -II	4	3	30	70	100	4
PS.516.3	Research methodology and Bioinformatics	3	3	30	70	100	3
PS.517.3	Clinical Biochemistry						
PO.518.3	Evolution and Ecology	3	3	30	70	100	3
	Total					**600**	**22**
IV Semester (2+1 Hard core and 2+1 Soft core papers)							
PH.511.4	Clinical Research and Nanotechnology	4	3	30	70	100	**4**
PH.512.4	Biochemistry of cell signaling	4	3	30	70	100	**4**
PH.513.4P	Project	10	3	30	70	100	**5**
PS.514.4	Genetic Engineering	3	3	30	70	100	**3**
PS.516.4	Food Biochemistry	3	3	30	70	100	**3**
PS.517.4P	Methods in Genetic Engineering and nanotechnology	8	3	30	70	100	**3**
PS.518.4P	Experiments in food science						
						600	**22**
	Grand Total					**2500**	**92**

PH. 511.1. PRINCIPLES OF BIOCHEMISTRY

Total No. of Lectures: 56 hours **Total marks: 70**

No. of Lectures/week: 5 **Credits: 5**

Course Objective

The objective is to enable the students to obtain detailed knowledge about the fundamentals of biochemistry, providing basic concepts of structure and biological function of biomolecules The first unit elaborates on amino acids, peptides and proteins, second unit on carbohydrates , the third unit discusses the classification and biological functions of lipids, while the fourth unit deals with the study of nucleic acids.

Course Learning Outcomes: Upon completion of this course, students will be able to

CO 1:Explain the basic aspects of amino acids, peptides, organization of protein structure,carbohydrates, lipids and nucleic acids
CO 2:Describe the structure - function relationship of proteins and nucleic acids.
CO 3:State the role of various biomolecules in health and disease.
CO 4:Interpret the different structures of biomolecules and their implications on different disease states.
CO 5:Explain classification and properties of various biomolecules.

Unit - I **14 L**

Amino acids and Proteins: Classification, Structure and Physicochemical properties; Peptide bond, Peptides of biological importance (Peptide antibiotics-Bacitracin, actinomycin-D,Glutathione), Chemical synthesis of peptides – Solid phase peptide synthesis; Proteins – Classification, Isolation, Purification and Characterization of proteins, Criteria of homogeneity; Protein sequencing; Structural organization of Proteins – Ramachandran plots; Denaturation of proteins.Protein folding – Anfinsen's studies on ribonuclease. Thermodynamics of protein folding:molten globule model, Chemical modification of proteins.(Methylation, Phosphorylation, Glycosylation and lipidation)

Unit – II **14L**

Carbohydrates: Classification, Monosaccharides- classification with structures.(Pentoses, hexoses, ketosis) Sugar derivatives - alcohols, acids, amino sugars, deoxysugars, glycosides

Oligosaccharides- structure and linkages in lactose, maltose, and sucrose, raffinose series oligosaccharides, Polysaccharides- Homo and heteropolysaccharides, glycosaminoglycans, bacterial cell wall peptidoglycans. Glycoconjugates- structural features and biological functions of Proteoglycans and Glycoproteins (O-linked, N-linked and GPI-linked).Cyclic structures of monosaccharides; Haworth projection, boat and chair forms, anomers and mutarotation, glycosides.

Unit- III **12L**

Lipids: Classification; Structure, Properties and Biological roles of Phospholipids and Sphingolipids; Fatty acids and their physicochemical properties;ω-3 and ω-6, Fats and Waxes - Physicochemical properties and characterization of fats and oils; Structure, Properties and functions of Eicosanoids - Prostaglandins, Prostacyclins, Thromboxanes, Leukotrienes; Chemistry and Properties of Sterols and Steroids – Bile acids and Bile salts; Salient features of Bacterial and Plant lipids.

Unit – IV **16 L**

Nucleic acids: Nomenclature, Structure and properties of pyrimidine and purine bases, nucleosides and nucleotides of nucleic acids, Conformation of nucleotides, Nucleic acids- classes and their functions. Physico-chemical properties DNA and RNA- base composition and primary structure of single- stranded DNA and RNA, Shorthand notation of polynucleotide structure. Chargaff's rules, Structure and function of DNA-Watson-Crick, Forces stabilizing structure of DNA. Denaturation - hypochromic and hyperchromic effect; melting temperature. Renaturation kinetics- effect of salts and complexity(Cot curve). Hybridization and its significance.Different class of RNAs - mRNA, rRNA, tRNA. Primary, secondary and tertiary structure of tRNA. Determination of primary structure (sequencing) of DNA using Maxam-Gilbert method and limitations. Sanger and Coulson’s method, advantages and drawbacks.

References:

- "Lehninger Principles of Biochemistry" by David L. Nelson and Michael M. Cox (Publisher: W. H. Freeman; Latest Edition: 2020)
- "Biochemistry" by Jeremy M. Berg, John L. Tymoczko, and Gregory J. Gatto Jr. (Publisher: W. H. Freeman; Latest Edition: 2019)
- "Biochemistry" by Donald Voet, Judith G. Voet, and Charlotte W. Pratt (Publisher: Wiley; Latest Edition: 2016)
- "Principles of Biochemistry" by Albert L. Lehninger, David L. Nelson, and Michael M. Cox (Publisher: W. H. Freeman; Latest Edition: 2017)
- "Biochemistry: A Short Course" by John L. Tymoczko, Jeremy M. Berg, and Lubert Stryer (Publisher: W. H. Freeman; Latest Edition: 2018)
- "Harper's Illustrated Biochemistry" by Victor W. Rodwell, David Bender, Kathleen M. Botham, Peter J. Kennelly, and P. Anthony Weil (Publisher: McGraw-Hill Education; Latest Edition: 2020)
- "Biochemistry" by Lubert Stryer, Jeremy M. Berg, and John L. Tymoczko (Publisher: W. H. Freeman; Latest Edition: 2015)
- "Biochemistry: The Molecular Basis of Life" by Trudy McKee and James R. McKee (Publisher: Oxford University Press; Latest Edition: 2020)

PH. 512.1 BIOCHEMICAL TECHNIQUES

Total No. of Lectures: 56 hours **Total marks: 70**

No. of Lectures/week: 4 **Credits: 4**

Course Objective:

This paper deals with the principle, construction, and application of various techniques used by Biochemists to understand the life processes.The first unit deals with basic techniques for cell fractionation, isolation and chromatographic separation of biomolecules. The second and third unit emphasizes on the physical methods of determining size, shape and structure of biomolecules. The fourth unit introduces the various spectroscopic techniques.

Course Learning Outcomes: Upon completion of this course, students will be able to

CO 1: List the basic instruments used in analytical biochemistry and state their applications.

CO 2: Explain the principles and applications of important techniques used in isolation, purification and characterization of various biomolecules.

CO 3: Interpret the various molecular spectrum obtained from different spectral techniques.

CO 4: Explain preparation and analysis of different biological samples to be subjected to various analytical techniques.

CO 5: Gain technical competency in different advanced techniques with a comprehensive understanding of their principle, instrumentation and applications.

Unit-I **14L**

Preliminary Techniques in Biochemistry – Mechanical and non-mechanical methods of Cell disruption, Cell Fractionation Techniques, Concentration - Ultrafiltration, precipitation by organic solvents and Salting out, lyophilization; Dialysis; Chromatographic Techniques – Principle and Applications of Paper, TLC, column chromatography based on Adsorption, Ion exchange, Gel filtration, Affinity and HPLC- principle, instrumentation, different columns and detectors, their application and FPLC. Gas Liquid Chromatography- instrumentation, detectors.

Unit-II **16L**

Physical methods of determining size, shape and structure of molecules

Electrophoretic Techniques for Biomolecules separation – native Polyacrylamide gel electrophoresis, SDS-PAGE, Agarose gel Electrophoresis, Isoelectric focusing, pulsed field electrophoresis, High voltage electrophoresis, Capillary Electrophoresis, Visualization by staining. Centrifugation: Ultra Centrifugation –Preparative and analytical ultracentrifuge – Instrumentation, principle and application, Svedberg's constant, Sedimentation velocity, Sedimentation equilibrium and Schlieren Optics, Magnetic Resonance spectroscopy– NMR: nature of NMR absorption, chemical shift, spin-spin splitting, ^{13}C and ^{1}H NMR spectra for suitable biomolecules, ESR – Principle and Applications.

Unit-III **12L**

Methods to determine biopolymers structure- Mass spectrometry- theory, instrumentation, ionization, fragmentation, m/e, typical bar graph of mass spectrum, interpretation mass spectra, time of flight, MALDI, GC-MS, and ESI. X-ray Crystallography – Protein crystals, Bragg's law, unit cell, Isomorphous replacement, Fiber pattern of DNA

Microscopy-Review of light microscopy, application of different stains, phase contrast, fluorescence, Confocal microscopy, scanning and transmission electron microscopy, FACS

Unit-IV **14L**

Spectroscopic Techniques – Beer-Lambert's Law, application and Limitation, light absorption and its transmittance, determination and application of Extinction Coefficient, UV-Visible Spectroscopic techniques- Instrumentation and applications of Turbidometry (Platelet aggregometer), Flame photometry, Vibration Spectra – IR- Principle, applications and characteristic IR absorptions of some functional groups and Raman spectroscopy– Principle and applications, Principle, instrumentation and applications of Atomic spectroscopy, fluorescence and emission spectroscopy: uses. Polarized Light – plane and circularly polarized light, CD/ORD spectroscopy and its applications.

References:

1. Principles and techniques of biochemistry and molecular biology. Wilson, K. and J. M. Walker (2010,7th edn). Cambridge ; New York, Cambridge University Press.

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3. Biophysical chemistry-Principles and techniques- Upadhay, Upadhyay and Nath(2010) Himalaya publishing house
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7. The tools of biochemistry. Cooper, T. G. (1977). New York London, Wiley.
8. Physical chemistry for the biological sciences. Hammes, G. G. and S. Hammes-Schiffer(2015) Wiley New York
9. Molecular and cellular biophysics. Jackson, M. B. (2006). Cambridge, Cambridge University Press.
10. Proteomics: a Cold Spring Harbor Laboratory course manual. Link, A. J., J. LaBaer, et al. (2009).Cold Spring Harbor, N.Y., Cold Spring Harbor Laboratory Press.
11. Proteomics: from protein sequence to function. Pennington, S. R. and M. J. Dunn (2001). Oxford, BIOS.
12. Protein purification techniques: a practical approach. Roe, S. (2001). Oxford ; New York, Oxford University Press.
13. Physical biochemistry: principles and applications. Sheehan, D. (2009). Chichester, UK ; Hoboken, NJ, Wiley-Blackwell.
14. Recent Advances in Electron Microscopy- Part-A; B.V. Venkartarmaprasad, and Steve Ludtke, Academic Press (2010).
15. Recent Advances in Electron Microscopy- Part-B; B.V. Venkartarmaprasad, and Steve Ludtke, Academic Press (2011).
16. Introduction to Electron Microscopy for Biologists; Terry Allen, Academic Press (2008).
17. Fluorescence Microscopy; Anda Carnea and P. Michael Conn; Academic Press (2014).

PH.513.1P BIO QUANTITATION

Total Marks: 70

Practical: 8hr/wk **Credits : 4**

Course objective

The objective is to enable students to develop skills in the practical components, learn good laboratory practices, preparations of various solutions and estimation of biomolecules using different methods.

Course Learning Outcomes: Upon completion of this course, students will be able to

CO 1: Learn good laboratory practices and be able to prepare basics of solutions

CO 2: Perform and explain the principle of colorimetric analysis of various biomolecules.

CO 3: Interpret and present scientific and technical information derived from laboratory experiments.

1. Quantitative estimation of reducing sugars by DNS Method
2. Estimation of total sugar by Phenol sulphuric acid/Anthrone method
3. Quantitative estimation of Proteins by UV absorption method and by Lowry's method
4. Quantitative estimation of proteins by biuret method
5. Quantitative estimation of DNA by Diphenylamine method
6. Quantitative estimation of RNA by Orcinol method
7. Quantitative estimation of ascorbic acid
8. Quantitative estimation of total phenol by using Folin-Ciocalteu reagent.
9. Qualitative analysis of some common food adulterants in milk, turmeric, tea powder, honey, Oil, Ghee and grains
10. Estimation of iron content
11. Estimation of calcium in biological samples.
12. Lipid Analysis
    a. Iodine number
    b. saponification value
    c. acid value
    d. peroxide value.

PS. 514.1 Chemical principles of Biochemistry

Total No. of Lectures: 42 hours **Total marks: 70**

No. of Lectures/week: 3 **Credits: 3**

Course objective:

The objective is to enable the students to understand the structure and reaction mechanisms of organic molecules and water; application of thermodynamics and radioisotopes in biochemistry. The first unit discusses the basics of bonding and stereochemistry and its importance in understanding biochemical reactions. Second unit explains the physical properties of water and thermodynamic law and its application in biology. Third unit elaborates on Radioisotopes in Biology.

Course Learning Outcomes: At the completion of this course, students will be able to

CO 1: Explain the basic concepts of different types of chemical bonds that can be useful to understand the chemical nature of biomolecules.

CO 2: Describe the thermodynamic parameters and their variations in homeostasis of cells and its biomolecules and their interaction with water.

CO 3: Acquire knowledge about preparation of radioisotopes, their applications in studying the cellular metabolic processes.

CO 4: Display skills in problem solving, critical thinking and analytical reasoning as applied to problems in chemical aspects of biochemistry

Unit-I **16 L**

Bioorganic chemistry

Atoms and atomic orbitals, molecular orbital (hydrogen molecule), Covalent bond; coordinate bond; Isomerism- structural isomerism, stereoisomerism, geometric isomerism. optical isomerism: optical activity, chirality, enantiomers, diastereomers, meso-compound, Fischer projection, threo-erythro notation, DL, RS configuration (in sugars and amino acids).

Types of organic reactions- substitution, addition, elimination, rearrangement, condensation and polymerization.

Heterocyclic Compounds – Numbering of the ring, properties and biological occurrence of furan, pyran, indole, thiazole, pteridine, isoalloxazine, pyrrole, quinone, purine and pyrimidine rings.

Free radicals in biological systems: Oxygen as a free radical in the auto- oxidation of fats. and antioxidants

Unit-II **12 L**

Thermodynamics in Chemistry and biochemistry – open, closed and isolated system, Laws of thermodynamics- I law, II law and III law, applications of thermodynamic laws in understanding energies in the living system. Chemical potential and equilibrium constant.

Oxidation and redox reactions- characteristics, half reactions, spontaneous and non-spontaneous redox reactions.

Water-Physical properties and structure of water, hydrogen bonding and hydrophobic interactions. ionization of water, pH scale, Acids and bases, Henderson- Hasselbalch equation, buffers, buffer capacity, ionic strength, buffer solutions and their action. Importance of buffers in biological systems (cytosol and blood).

Unit-III **14 L**

Radioisotopes in Biology –Heavy isotopes and radioisotopes, Nature of radioactivity, Types of Radiation, properties of α, β, γ-rays, Units of radioactivity, (RAD, REM, CURIE and BECQUEREL) Nature of radiation sources, Techniques used to measure radioactivity– GM counter and scintillation counter, solid and liquid scintillation, autoradiography. isotopes commonly used in biochemical studies- ^{3}H, ^{14}C, ^{32}P, ^{131}I, ^{35}S, ^{60}Co their biological application- *invivo* and *invitro* labeling techniques, quenching, concept of half-life, decay constant, Specific activity, Cerenkov radiation, Synthesis of Isotopically labeled glucose and ATP (α, γ). Biological hazards of radiation and safety measures in handling radioisotopes.

References:

1. Organic Chemistry by Jonathan Clayden, Nick Greeves, and Stuart Warren (2012) Publisher: Oxford University Press
2. Organic Chemistry by Paula Yurkanis Bruice (2016) Publisher: Pearson
3. Principles of Organic Chemistry by Robert J. Ouellette and J. David Rawn (2015) Publisher: Cengage Learning
4. Principles of Physical Biochemistry by Kensal E. van Holde, W. Curtis Johnson, P. Shing Ho (2005) Publisher: Pearson
5. Physical Biology of the Cell, 2nd Edn. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
6. Roberts, J. D., and Caserio, M. C. (1977). *Basic principles of organic chemistry*. WA Benjamin, Inc.
7. Bahl, B. S., and Bahl, A. (2019). *A textbook of organic chemistry*. S. Chand Publishing.
8. Finar, I. L. (1956). *Organic Chemistry, Volume 2: Stereochemistry And The Chemistry Natural Products, 5/E*. Pearson Education India.
9. Mosher, M. (1992). Organic Chemistry. (Morrison, Robert Thornton; Boyd, Robert Neilson).
10. Eliel, E. L., and Wilen, S. H. (1994). *Stereochemistry of organic compounds*. John Wiley and Sons..
11. Organic Chemistry. Vol. I. Fundamental principles. I. L .Finar. 6th Edn. ELBS
12. Bioinorganic Chemistry; Ei-Ichiro Ochiai, Elsevier (2008).

PS. 515.1 HUMAN PHYSIOLOGY

Total No. of Lectures: 42 hours **Total marks: 70**

No. of Lectures/week: 3 **Credits: 3**

Course objective

The objective is to offer knowledge about the physiology and function of different organs of the human body and the nutritional aspects essential for the maintenance of health.

The first unit deals with circulatory, respiratory, hepatobiliary, excretory and gastrointestinal system. The second unit deals with the endocrine and reproductive system. The third unit elaborates on macro and micronutrients.

Course Learning Outcomes: At the completion of this course, students will be able to

CO 1: Explain the functions of important physiological systems including the cardio-respiratory, reproductive renal, and metabolic systems

CO 2: Explain the integration of the different endocrine organs and their hormones in maintaining homeostasis

CO 3: Discuss nerve physiology and muscle physiology.

Unit-I **16L**

Introduction to Human body, Organs and organ systems.

Blood: Composition of Blood, Plasma; composition and function, Blood cells; Hematopoiesis, RBC-erythropoiesis, life cycle and function-types and functions, platelets and their functions. Blood coagulation (hemostasis and thrombosis), anticoagulants, and fibrinolysis. Buffer systems of plasma, total and differential blood count.

Body fluids-CSF and Lymph- composition and functions.

Cardiac Physiology: Cardiac conduction system, Cardiac cycle, Cardiac Output, Blood pressure, ECG.

Respiratory System – Lungs structure and functions. Gas exchange, oxygen binding by hemoglobin, factors affecting oxygenation.

Excretory System; Kidney– Ultra structure of the nephron, mechanism of glomerular filtration and formation of urine. Role of kidney in acid-base balance. Kidney function test.

Hepatobiliary System – Anatomy of the liver, blood supply, cells – hepatocytes, endothelial cells and Kupffer cells. Secretory and excretory function-formation of bile, composition, Secretion of bile and enterohepatic circulation, Liver function test.

Gall bladder and its functions

Pancreas- Anatomy, its exocrine and endocrine activities. Target tissues and biological functions of insulin and glucagon.

Gastrointestinal System– Physiology and biochemistry of digestion and absorption of food. Mechanism of HCl production in the stomach, Gastro-intestinal hormones and their role.

Unit-II **12L**

Endocrine system- Endocrine organs in man, The target cell concept, major groups of hormones- lipophilic and hydrophilic hormones -their general features.

Structure, anatomy and control of hypothalamus - hormones produced and their role.

Hypothalamic- hypophysiotropic hormones- biological role. The hypothalamo-Pituitary axes with major feedback loops.

Adenohypophysial- tropic hormones, lipotropin, endorphins and enkephalins-their biological action. Neurohypophysial.hormones- their biological action. ANF (atrial natri uretic factor).

Thyroid gland, thymus and adrenal gland- hormones and their biological functons. renal hormones: Functions; Renin-angiotensin system. Pineal gland-melatonin, its role in circadian rhythm and aging.

Hormones of Gonads: Anatomy of testes and ovaries, their endocrine functions, Hormone synthesis, storage, secretion and regulation, their physiological and biochemical aspects - hormonal control of puberty, hormonal regulation of menstrual cycle, Oral contraceptives.

Unit-III **14L**

Nerve physiology-Structure of neuron and synapse- excitability- action potential conduction of never impulse-synaptic transmission- neurotransmitter systems, Glial cells: Structure and function of glial cells, Different types of glial cells: astrocytes, oligodendrocytes and Schwann cells, Types of astrocytes – type I and II astrocytes, fibrous and protoplasmic astrocytes, Importance of astrocytes in glutamate metabolism

and blood brain barrier.

Muscle physiology- Structure and organization of muscle cells, types of muscles -striated muscle, cardiac and smooth muscle. Molecular organization of contractile systems (actin, myosin, tropomyosin, troponin, α-actinin, nebulin, dystrophin, Molecular mechanism of contraction and relaxation of muscle - Role of calcium, troponin C, calmodulin and nitric oxide.

References:

1. Murray, R. K., Granner, D. K., Mayes, P. A., and Rodwell, V. W. (2023). *Harper's illustrated biochemistry*. Mcgraw-hill.
2. Devlin, T. M. (Ed.). (2022). Textbook of biochemistry: with clinical correlations.
3. Vasudevan, D. M., Sreekumari, S., and Vaidyanathan, K. (2016). *Textbook of biochemistry for medical students*. JP Medical Ltd.
4. Guyton, A., and Hall, J. (2020). Textbook of medical physiology.
5. Sembulingam, K., and Sembulingam, P. (2012). *Essentials of medical physiology*. JP Medical Ltd.
6. Khurana, I., Khurana, A., and Kowlgi, N. G. (2019). *Textbook of Medical Physiology_-E- book*. Elsevier Health Sciences.
7. Jenkins, G., and Tortora, G. J. (2017). *Anatomy and physiology*. John Wiley and Sons.

PS. 517.1 Nutrition and Nutrigenomics

Total No. of Lectures: 42 hours **Total marks: 70**

No. of Lectures/week: 3 **Credits 3**

Course objective:

The objective of this course is to provide exposure to the students of basic concept of food, nutrients, nutraceutical's and food microbiology

The first unit deals with the basic properties of water, protein, carbohydrate, lipids, minerals, vitamins, and phytochemicals and their roles in food systems. The second unit introduces the concept of nutraceuticals and their role in disease treatment and prevention. The third unit elaborates on the aspects of food microbiology, their applications and harmful effects.

Course Learning Outcomes: Upon completion of this course, students will be able to

CO 1: Discuss the concept of food and nutrition

CO 2: Enlist macro- and micronutrients, their sources and functions in the human body.

CO 3: Explain the concept of nutraceuticals and their role in treatment and prevention of various disease conditions

CO 4: to explore the intricate interplay between genetics, nutrition, and health, examining how gene variants, nutrient intake, and epigenetic mechanisms collectively influence individual susceptibility to diseases

Unit I 14L

Basic food biochemistry: basic concept of food, nutrients, nutrition

Classification of food constituents; Carbohydrates- sources, daily requirements, functions. chemical reactions, functional properties of sugars and polysaccharides, modified starch, dietary fibre.

Lipids- estimation and physiochemical properties of lipids in food, rancidity, hydrogenation and winterization, vegetable and animal fat, margarine, lad and butters.

Protein-classification and properties, egg proteins, milk proteins,meat proteins, oil seed proteins and cereal proteins.

Vitamins and minerals- role, effect of various processing treatments, fortification.

Role of water in food, water activity and shelf life of food. significance of natural pigments in food- chlorophylls, carotenoids, anthocyanins, flavonoids and tannins, natural antioxidants, Browning reactions in foods.

Unit II 14L

Nutraceuticals

Introduction to nutraceuticals: definitions, synonymous terms, basis of claims for a compound as a nutraceutical, regulatory issues for nutraceuticals including CODEX. Nutraceuticals for cardiovascular diseases, cancer, diabetes, cholesterol management, obesity, joint pain, immune enhancement, age-related macular degeneration, endurance performance and mood disorders.

Manufacturing aspects of selected nutraceuticals such as lycopene, isoflavonoids, prebiotics and probiotics, glucosamine, phytosterols.

Unit III 14L

Nutrigenomics: Definition, Nutrigenetics: - response of gene Variants on nutrients difference between nutrigenetics and nutrigenomics. Gene variants, SNPs, disease risk modified by nutrients

Effects of nutrients on gene expression: Interaction between genes and nutrients. Food intake and the risk of obesity, and metabolic syndrome. PPARs and nutrient regulation of gene expression, effect of phytochemicals on gene expression. Example EGCG and Her-2/neu receptor,

Epigenetics and nutrients; Example Alcohol addiction

Effects of gene variants on nutrient metabolism. Example: LPH gene polymorphism and Lactose intolerance, Glutathione peroxidase polymorphism, selenium and risk of cancer. Methylenetetrahydrofolate gene polymorphism on folate metabolism and homocysteine levels in heart diseases. Apolipoprotein E variants, lipid diet and risk of heart diseases. Effect of food on health and health on food.

References

1. "Food Chemistry" by Owen R. Fennema (Publisher: CRC Press; Latest Edition: 2019)
2. "Food Chemistry" by H.-D. Belitz, Werner Grosch, and Peter Schieberle (Publisher: Springer; Latest Edition: 2009)
3. "Food Biochemistry and Food Processing" by Benjamin K. Simpson (Publisher: Wiley-Blackwell; Latest Edition: 2012)
4. "Food Analysis" by S. Suzanne Nielsen (Publisher: Springer; Latest Edition: 2010)
5. "Nutraceuticals: Efficacy, Safety and Toxicity" edited by Ramesh C. Gupta (Publisher: Elsevier; Latest Edition: 2016)
6. "Nutraceutical and Functional Food Processing Technology" edited by Joyce I. Boye and Yves Arcand (Publisher: Wiley-Blackwell; Latest Edition: 2014)

7. "Nutrigenomics and Nutrigenetics in Functional Foods and Personalized Nutrition" edited by Lynnette R. Ferguson (Publisher: CRC Press; Latest Edition: 2013)
8. "Epigenetics, Nutrition and Health" edited by Emily Ho, Frederick Domann, and David Williams (Publisher: CRC Press; Latest Edition: 2015)
9. "Nutritional Genomics: Discovering the Path to Personalized Nutrition" by Jim Kaput and Raymond L. Rodriguez (Publisher: Wiley; Latest Edition: 2006)
10. "The Gene Smart Diet" by Floyd H. Chilton and Laura Tucker (Publisher: Wiley; Latest Edition: 2009)

PS.518.1P ANALYTICAL TECHNIQUES

Total marks: 70

Practical: 8hr/wk **Credits: 3**

Course Objective:

This practical course deals with basic techniques that are used to analyse biomolecules. It includes all types of chromatographic, electrophoretic and extraction techniques to extract and analyse biomolecules.

Course Learning Outcomes: At the completion of this course, students will be able to

CO 1: Get hands on training for different types of chromatographic techniques

CO 2: Perform different types of electrophoretic techniques used to separate proteins and analyse the results.

CO 3: Perform various extraction procedures used to extract different molecules from biological samples.

1. Applications of Beer's law- Determination of optimum absorption wavelength for any dye and verification of Beer Lambert law.
2. Determination of pKa of amino acids.
3. Separation of amino acids by
    a) circular
    b) 2D-paper chromatography
4. Descending paper chromatography of sugars
5. TLC Sheet preparation and Separation of lipids
6. Flame Photometry
7. Paper Electrophoresis.
8. Column chromatography for plant pigment separation
9. Quantitative estimation of amino acid by Formal titration
10. Extraction of casein from milk by isoelectric precipitation
11. Extraction of cholesterol and phospholipids from egg yolk
    a. Quantitative estimation of cholesterol
    b. Quantitative estimation of phospholipids

PS.519.1P EXPERIMENTAL PHYSIOLOGY

Total Marks: 70

Practical: 8hr/wk **Credits: 3**

Course Objective:

The objective of this practical course is to provide hands-on-experience in aseptic techniques, microbial culture, staining procedure and skills in microscopy.

Course Learning Outcomes: At the completion of this course, students will be able to

CO 1: Analyse the components of urine and blood.
CO 2: Perform the quantitation of various components of blood and urine.
CO 3: Interpret the results after the estimation of various components.

1. Qualitative analysis of urine (Normal and abnormal)
2. Estimation of titrable acidity and titrable ammonia
3. Quantitative estimation of uric acid in blood
4. Estimation of urea in blood and urine
5. Estimation of glucose in blood
6. Estimation of creatinine in blood and urine.
7. Estimation of bilirubin in blood
8. Estimation of HDL and LDL cholesterol
9. Estimation of hemoglobin
10. Estimation of A/G ratio

PH. 511.2 ENZYMOLOGY

Total No. of Lectures: 56 hours **Total marks: 70**

No. of Lectures/week: 5 **Credits: 5**

Course Objective:

The objective is to offer in-depth knowledge about enzymes, which catalyse the diverse biochemical reactions in life processes, providing basic concepts of their kinetics mechanism of action, regulation, inhibition, and wide-ranging applications.

The first unit introduces the student to the basic concepts in enzymology. It deals with nomenclature of enzymes. The second unit discusses enzyme assay, isolation and purification. The third unit focuses on the kinetics of enzyme action and its inhibitors. The fourth unit deals with nature and mechanism of enzyme catalysis. The fifth unit deals with protein ligand interaction, metabolic regulation of enzymes as well as application of enzymes.

Course Learning Outcomes: Upon completion of this course, students will be able to

CO 1: Classify and explain the general properties of enzymes

CO 2: Describe and use the equations of enzyme kinetics.

CO 3: Describe the catalytic mechanisms of most well-characterized enzymes

CO 4: Describe the mechanisms of enzyme regulation

CO 5: Explain the applications of enzymes in diagnosis, monitoring, and therapy.

Unit-I **7L**

General Aspects of Enzymes– History, Nomenclature and IUB classification of enzymes, significance of numbering system. General characteristics of enzymes, nature of enzyme, enzyme specificity and enzyme active site. Holoenzyme, apoenzyme, cofactors, isoenzymes, multifunctional enzymes, metalloenzymes, metal activated enzymes, coenzymes, monomeric enzymes, oligomeric enzymes and multi-enzyme complexes, - with suitable example. Factors affecting enzyme activity- enzyme concentration, substrate concentration, pH, temperature, activators and inhibitors. Significance of energy of activation.

Unit-II **7L**

Purification, Measurement and expression of enzyme activity- Units of enzyme activity- definition of IU, Katal and specific activity, Enzyme localization, isolation, purification and

characterization of enzymes. Criteria of purity of enzymes. Enzyme assay methods- end point and kinetic assay, continuous assay. Coupled assay and its application in quantification of enzyme assays.

Unit-III **14L**

Enzymes Kinetics – Rate of a reaction, order and molecularity. Derivation of Michaelis Menten equation for unisubstrate reactions- Equilibrium and steady state approach. Significance of Vmax, Km, Turnover number (K_{cat}/K_m). Linear transformation of Michaelis Menten equation – Lineweaver Burk plot, Eadie-Hofstee, Haynes-Wolf and Cornish-Bowden plot.

Bi- substrate Reactions – Cleland's notation with examples for ordered, Ping-Pong, Theorell-Chance and random mechanism, their general rate equations.

Fast Reaction kinetics –Characteristics and applications, Methods: Stopped flow, temperature jump.

Active site structure determination- Methods of determining active site structure –isolation of ES complex, affinity labelling and chemical modification studies.

Inhibition kinetics –Competitive, non competitive, uncompetitive, mixed and product inhibition. Irreversible inhibition – suicide inhibition and its significance, transition state analogs- their application. Determination of K_i and it's significance. Primary and secondary plots in enzyme kinetics. Enzyme immobilization techniques and their applications.

Unit-IV **10 L**

Nature of Enzyme Catalysis –.

Nature of Enzyme Catalysis: Collision theory and transition state theory, Mechanism of catalysis-acid base catalysis, covalent catalysis, nucleophilic and electrophilic catalysis, proximity and orientation and metal ion catalysis

Mechanisms of Action of Specific Enzymes – Serine proteases- Classes, Mechanism of Chymotrypsin, Lysozyme, RNA as enzyme.

Coenzymic action of NAD^+, FAD, PLP, Folic acid

Unit-V **18L**

Protein- ligand binding – Binding of ligands to macromolecules – Hill and scatchard plot, cooperativity, positive and negative cooperativity. Oxygen binding to hemoglobin. Homotropic and heterotropic effectors, aspartyl transcarbamoylase as an allosteric enzyme. Sigmoidal kinetics and their physiological significance, Symmetric (MWC) and sequential models (KNF) for action of allosteric enzymes and their significance.

Metabolic Regulation of Enzyme Activity – General mechanisms- Zymogen activation (in digestive enzymes- chymotrypsin), reversible and irreversible covalent modifications of enzymes with suitable examples. Designer enzymes- abzymes, synzymes. Enzymes as therapeutic agents-Collagenase, Uricas, streptokinase, L-asparaginase. Application of enzymes in industry- Industrial application of rennin, lipases, lactases, invertase, pectinases, papain.

Enzyme application in clinical biochemistry- Aminotransferases, Creatine Kinase, α-amylase, Glucose phosphate dehydrogenase, Cholinesterase; Isoenzymes of lactate dehydrogenase, alkaline phosphatase in diagnosis and monitoring of disorders.

References:

1. Palmer, T., and Bonner, P. L. (2007). *Enzymes: biochemistry, biotechnology, clinical chemistry*. Elsevier.
2. Eisenthal, R., and Danson, M. J. (Eds.). (2002). *Enzyme assays: a practical approach* (Vol. 257). Practical Approach (Paperback)..
3. Taylor, K. B. (2002). *Enzyme kinetics and mechanisms*. Springer Science and Business Media..
4. Pandey, A., Webb, C., Soccol, C. R., and Larroche, C. (Eds.). (2006). *Enzyme technology*. Springer Science and Business Media..
5. Shanmugam, S. (2009). *Enzyme technology*. IK International Pvt Ltd..
6. Devasana (T), 2010, Enzymology, Oxford University Press.
7. Fundamentals of Enzymology, 3rd edition, 2003, Price NC and Stevens L; Oxford University Press, New York
8. Voet's Biochemistry, Adapted ed, 2011, Voet, D and Voet JG; Wiley, India
9. Lehninger Principles of Biochemistry, 8th edition, 2021, Nelson DL and Cox MM; WH Freeman and Co, New York
10. Biochemistry, Berg JM, Stryer L, Gatto, G, 8th ed, 2015; WH Freeman and Co., New York.
11. Enzyme Kinetics and Mechanism – 2007 by Paul F. Cook and W. W. Cleland; Publisher:Garland Science.

PH. 512.2 METABOLISM -I

Total No. of Lectures: 56 hours **Total marks: 70**
No. of Lectures/week: 4 **Credits: 4**

Objective:

The objective is to enable students to understand the basic concept of bioenergetics. This paper elaborates on the metabolic pathway of carbohydrates and lipids.
The first unit explores the metabolism of carbohydrates. The second unit deals with the respiratory chain and electron transport in mitochondria. The third unit explains the general lipid metabolism. The fourth unit discusses the various types of metabolic disorders and integration of metabolism.

Course Learning Outcomes: Upon completion of this course, students will be able to

CO 1: Describe the metabolism of carbohydrates, and its regulation
CO 2: Describe the metabolism of lipids and its regulation
CO 3: Explain the importance of high energy compounds, electron transport chain, and synthesis of ATP.
CO 4: Explain the integration of carbohydrate and lipid metabolism
CO 5: Correlate synthesis and breakdown of biomolecules with various metabolic disorders

Unit -I **14L**

Introduction – Catabolism, anabolism, catabolic, anabolic and amphibolic pathways. **Carbohydrates** – Glycolysis, energetics and regulation. Pathways of utilization of pyruvate – lactate and ethanol fermentation, Pasteur's effect, gluconeogenesis and regulation, futile cycle.Cori cycle and its significance. Citric acid cycle-reactions, regulation, energetic and role as amphibolic pathway. Anaplerotic reactions, glyoxylate cycle and significance. HMP shunt pathway, its physiological significance. Biosynthesis of sucrose, and starch. Glycogenesis and Glycogenolysis- their regulation. Entry of reducing equivalents for oxidation into mitochondria- malate–aspartate shuttle and glycerol phosphate shuttle,

Unit -II **6L**

Mitochondrial electron transport –. Organization of respiratory chain complexes, structure and function of the components – Fe-S proteins, cytochromes, sequence of electron carriers based on redox potentials, Q cycle, P/O ratio, oxidative phosphorylation, uncouplers and inhibitors of

oxidative phosphorylation. Models to explain oxidative phosphorylation-Mitchell's hypothesis and proofs and drawbacks. proton motive force, structure of ATP synthase complex, binding change mechanism and mechanism of ATP synthesis.

Unit -III **14L**

Lipids – Degradation of triacylglycerols and phospholipids – lipases, hormone sensitive lipase, phospholipases. Transport of fatty acids into mitochondria, Fatty acid degradation- β- oxidation of even chain fatty acids and as a source of metabolic water and ATP yield. β- oxidation of odd chain and unsaturated fatty acids, α and ω-oxidation. Biosynthesis of saturated and unsaturated FA and chain elongation reactions. Desaturation Fatty acid synthase, Regulation of fatty acid biosynthesis and oxidation. Biosynthesis of triglycerides. Metabolism of ketone bodies-synthesis and degradation. Pathways in plants and animals -conversion of linoleate to arachidonate (scheme only).

Cholesterol Biosynthesis, Degradation, excretion and regulation. Metabolism of circulating lipids – Chylomicrons, HDL, LDL, VLDL and free fatty acids. Reverse cholesterol transport by HDL.

Phospholipid Biosynthesis – *Denovo* pathway and interconversion, biosynthesis of sphingolipids, ether lipids and glycolipids. Degradation and biosynthesis of gangliosides and cerebrosides. Biosynthesis of prostaglandins, thromboxane and leukotrienes.

Unit -IV **8L**

Metabolic Diseases – Disorders of carbohydrate metabolism – Diabetes mellitus, classification, etiology and its management, laboratory investigations – GTT, Hb analysis (glycohemoglobin)**.** Inborn errors of carbohydrate metabolism – glycogen storage diseases, galactosemia, lactose intolerance, pentosuria.

Disorders of Lipid Metabolism: Hyperlipidemia, Familial Hypercholesterolemia (FH) Tangier Disease. Inherited human diseases with membrane lipid accumulation- Tay-Sachs disease, Nieman-Pick disease, Fabry's disease. **Cardiovascular Disorders** – Major Cardiovascular diseases – Atherosclerosis – risk factors, pathogenesis, Diagnosis and prognosis.
Integration of carbohydrate and lipid metabolism, glucose paradox

References:

1. "Biochemistry" by Jeremy M. Berg, John L. Tymoczko, and Gregory J. Gatto Jr. (Publisher: W. H. Freeman; Latest Edition: 2019)
2. "Lehninger Principles of Biochemistry" by David L. Nelson and Michael M. Cox (Publisher: W. H. Freeman; Latest Edition: 2020)
3. "Biochemical Pathways: An Atlas of Biochemistry and Molecular Biology" by Gerhard Michal and Dietmar Schomburg (Publisher: Wiley-Blackwell; Latest Edition: 2012)
4. "Harper's Illustrated Biochemistry" by Victor W. Rodwell, David Bender, Kathleen M. Botham, Peter J. Kennelly, and P. Anthony Weil (Publisher: McGraw-Hill Education; Latest Edition: 2020)
5. "Biochemistry" by Donald Voet, Judith G. Voet, and Charlotte W. Pratt (Publisher: Wiley; Latest Edition: 2016)
6. "Lippincott's Illustrated Reviews: Biochemistry" by Denise R. Ferrier (Publisher: Lippincott

Williams and Wilkins; Latest Edition: 2017)
7. "Textbook of Biochemistry for Medical Students" by D.M. Vasudevan, S. Sreekumari, and Kannan Vaidyanathan (Publisher: Jaypee Brothers Medical Publishers; Latest Edition: 2020)
8. "Medical Biochemistry" by John W. Baynes and Marek H. Dominiczak (Publisher: Elsevier; Latest Edition: 2019)
9. "Advanced Nutrition and Human Metabolism" by Sareen S. Gropper, Jack L. Smith, and Timothy P. Carr (Publisher: Cengage Learning; Latest Edition: 2016)
10. "Biochemistry and Molecular Biology of Plants" by Bob B. Buchanan, Wilhelm Gruissem, and Russell L. Jones (Publisher: Wiley-Blackwell; Latest Edition: 2015)

PH. 513.2. GENETICS

Total No. of Lectures: 56 hours **Total marks: 70**

No. of Lectures/week: 4 **Credits: 4**

Course Objective:

The objective of this course to provide knowledge about the structure and function of nucleic acids, basic processes that regulate expression of genetic information, biological processes that direct inheritance of genetic information, and an overview of cancer genetics

The first unit deals with basic principles of Mendelism and population genetics. The second unit discusses the genome organization, gene linkage and mapping of the genes. The third unit deals with mutations and DNA repair mechanism and also discusses some hereditary diseases. The fourth unit deals with evolutionary genetics

Course Learning Outcomes: Upon completion of this course, students will be able to

CO 1: Describe basic concepts of classical Genetics, Mendelian inheritance, extrachromosomal inheritance, sex-linked inheritance and population genetics
CO 2: Elaborate on the concept of gene, genome organization, linkage and genetic mapping and recombination.
CO 3: Discuss the different organisms used as models for studies in genetics
CO 4: Comparing and contrasting different mutation and DNA repair mechanisms and relate variations in chromosome structure and number to phenotypic variation.
CO 5: Describe the relationship between evolution and genetics, basic theories of evolution.

Unit-I **14L**

Classical genetics – Mendelian principles: dominance, segregation, independent assortment,

deviation from Mendelian inheritance.

Extensions of Mendelian principles - incomplete dominance, codominance, epistasis, simple gene interaction (eg. Comb shape in chickens), polygenic inheritance, penetrance and expressivity, sex limited and sex influenced characters.

Extra chromosomal inheritance: Inheritance of mitochondria (e.g. Male sterility in plants), and chloroplast genes (e.g. Variegation in four O'clock plant), maternal inheritance (e.g. Shell Coiling in snails).

Population Genetics: Speciation (allopatricity and sympatricity). Hardy Weinberg genetic equilibrium, random genetic drift, coevolution, convergent evolution, Pedigree analysis,

Unit-II **16L**

Genome size and evolutionary complexity, C-value paradox

Structure of bacterial chromosome, structure of eukaryotic chromosome, nucleosome organization, arrangement of chromatin fibers in a chromosome. Polytene chromosomes, centromere and telomere structure.

Concept of gene: Allele, multiple alleles, pseudo allele, complementation tests. Transposons and their types

Gene Linkage and Chromosome – Linkage and crossing over, sex linkage, linkage, recombination of genes in a chromosome, crossing over, map unit.

Gene mapping methods: Linkage maps, three-point test cross, tetrad analysis, Recombination-types – homologous, site-specific, somatic recombination. E.coli rec system. Holliday model of recombination.

Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, plaque formation and lytic cycle

Unit-III

Mutation and repair **14L**

Models for genetic studies: Rat/Mice, Drosophila, yeast, Arabidopsis thaliana, zebra fish and E.coli.

Mutation– Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants. Mutation rates. Chemical mutagens-affecting replicating and non-replicating DNA, radiation induced mutation, reverse mutations

and suppressor mutations – intergenic and intragenic suppression, reversion as a means of detecting mutagens – Ames test.

Repair Mechanism – photoreactivation, excision repair, repair of alkylation, E.coli- rec system (SOS repair).

Chromosomal abnormalities: Deletion, duplication, inversion, translocation, ploidy and their genetic implications. Human genetics: lod score for linkage testing, karyotypes, Genetic counselling.

Unit-IV **12L**

Evolutionary genetics:

Emergence of evolutionary thoughts: Lamarck; Basis for Darwin's theory–concepts of variation, adaptation, struggle, fitness and natural selection.

Origin of cells and unicellular evolution: Origin of basic biological molecules; abiotic synthesis of organic monomers and polymers; concept of Oparin and Haldane; experiment of Miller (1953); Molecular divergence and molecular clocks, Geological time scale. current controversies concerning theory of evolution, Hoaxes and falsification of data.

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3. Hartl, D. L., and Jones, E. (2021). Genetics: Analysis Of Genes And Genomes (11th ed.). Jones and Bartlett, Boston.
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5. Krebs, J. E., Goldstein, E. S., and Kilpatrick, S. T. (2012). Lewin's Essential GENES (Biological Science) (3rd ed.). Jones and Bartlett Learning.
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7. Miesfeld, R. L. (2002). Applied Molecular Genetics (1st ed.). Wiley-Liss inc.
8. Pierce, B. A. (2013). Genetics: A Conceptual Approach, 5th Edition (4th ed.). W. H. Freeman.
9. Snustad, P. D., and Simmons, M. J. (2022). Principles of Genetics (6th ed.). Wiley.
10. Snyder, L., Peters, J. E., Henkin, T. M., and Champness, W. (2013). Molecular Genetics of Bacteria, 5th Edition (ASM Books) (4th ed.). ASM Press.
11. Watson, J. D. (2003). Molecular Biology of the Gene (5th ed.). Cold Spring Harbor Laboratory Press.

PH.514.2P Practical Enzymology

Total Marks: 70

Practical:8hr/wk **Total Marks:70**

Credits: 4

Course Objective:

This course aims at understanding practical aspects of kinetic reactions catalysed by enzymes with one or more than one substrate. The course covers various aspects of isolation, purification and characterization of enzymes using their kinetic reactions.

Course Learning Outcomes: Upon completion of this course, students will be able to

CO 1: Demonstrate practical understanding of enzyme kinetics and its applications.

CO 2: Demonstrate practical applications of unisubstrate and bisubstrate assays and an overall understanding of using various biochemical kinetic reactions for isolating and purifying specific analytes.

CO 3: Isolate and purify enzymes using downstream processing CO

4: Conduct quantitative assay of clinically important enzymes

1. Enzyme assay and Kinetic studies of enzyme Salivary amylase
    a. specific activity
    b. effect of pH
    c. effect of temperature
    d. energy of activation,
    e. effect of substrate,
    f. Km and Vmax determination with MM plot, LB plot, Eadie-Hoftee plot *etc.*
2. Assay of invertase from Calatropis/ Yeast
3. Assay of protease from papaya,
4. Assay of acid/alkaline phosphatase
5. Bisubstrate enzyme assay (minimum one kinetic assay)
    a. SGOT
    b. SGPT
    c. LDH
6. Isolation of enzymes from biological sources.
7. Inoculum preparation and scale up of Inoculum
8. Extraction of Enzyme
9. Downstream processing by
    a. ammonium sulphate precipitation
    b. Ion exchange chromatography
    c. Fold purity calculation
    d. Native PAGE

SDS-PAGE and molecular weight determination

PS.515.2 CELL BIOLOGY

Total No. of Lectures: 42 hours **Total marks: 70**

No. of Lectures/week: 3 **Credits: 3**

Course Objective:

This paper offers basic aspects of microbial technology, fermentation, products of fermentation, introduction and application of animal cell culture, plant tissue culture and their role in agriculture and environmental pollution control.

The first unit elaborates on microbial technology- basic aspects of fermentation bioprocess. The second unit elaborates on animal cell culture techniques and its applications. The third unit elaborates on Plant Biotechnology and concepts of Environmental Biotechnology.

Course Learning Outcomes: Upon completion of this course, students will be able to

CO 1: Explain cell organelles, structure and functions, membrane biochemistry and membrane transport mechanism.

CO 2: Demonstrate an understanding of animal cell culture, cell lines, application in tissue engineering and hybridoma technology.

CO 3: Explain basic concepts od Plant Biotechnology and its applications in agriculture like micro-propagation, haploid plants, embryo culture, hybrids

Unit -I **16L**

Structural organization and function of intracellular organelles: Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, Endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure and function of cytoskeleton and its role in motility.

Biomembranes - Composition and Architecture of membrane: structural lipids in membranes, membrane bound proteins - structure, properties, and function, Lipid raft.. Lipid aggregates: micelles, bilayers and liposomes- structure, types, preparation, characterization, and therapeutic applications of liposomes. Membrane Dynamics: lipid movements, flippase, floppase, scramblase. Models of Membrane, Gorter and Grendel's experiment, bilayer structure, Danielle – Davson model of membrane, Singer and Nicolson's model and Newer models. Study of

membranes -FRAP, FRET.

Membrane Transport – Laws of diffusion across membranes, simple diffusion, facilitated diffusion, osmosis and cell volume regulation. Mechanisms of endocytosis, receptor mediated endocytosis, and exocytosis, Ion channels, aquaporin channel, ionophores. Active transport systems, (Na^+ K^+ ATPase, mammalian MDR proteins) secondary active transport (Na^+ glucose transporters).

Unit -II 14 L

Animal Cell Culture – Culture techniques, aseptic conditions, Equipment and materials for animal cell culture. Different constituents of culture medium, types of media and their application. Basic techniques of mammalian cell culture in vitro; disaggregation of tissue and primary culture. Cell lines-characteristics and routine maintenance.Cell viability and cytotoxicity assays. Characterization of the cultured cells- measuring parameters of growth. Cell synchronization, Somatic cell fusion, Cell cloning and cryopreservation. Applications of animal cell culture- Organ and histotypic cultures. Differentiated cells in culture and its application. Tissue engineering (e.g. Skin). Adult and embryonic stem cells and their applications.

Unit -III **12L**

Plant cell culture

Plant cell culture; Laboratory design, aseptic conditions, methodology, media. Techniques of callus cultures, meristem cultures, anther culture, embryo culture, protoplast culture, micropropagation, somatic embryogenesis and soma clonal variation, synthetic seeds; germplasm conservation and its application.

References

1. "Molecular Biology of the Cell" by Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, and Peter Walter (Publisher: Garland Science; Latest Edition: 2019)
2. "Cell Biology" by Thomas D. Pollard, William C. Earnshaw, and Jennifer Lippincott-Schwartz (Publisher: Elsevier; Latest Edition: 2016)
3. "Cell and Molecular Biology: Concepts and Experiments" by Gerald Karp (Publisher: Wiley; Latest Edition: 2020)
4. "Biochemistry" by Lubert Stryer, Jeremy M. Berg, and John L. Tymoczko (Publisher: W. H. Freeman; Latest Edition: 2015)
5. "Essential Cell Biology" by Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander D. Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter (Publisher: Garland Science; Latest Edition: 2019)
6. "Molecular Biology of the Gene" by James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, and Richard Losick (Publisher: Cold Spring Harbor Laboratory Press; Latest Edition: 2020)
7. "Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications" by R. Ian Freshney (Publisher: Wiley; Latest Edition: 2016)
8. "Plant Cell and Tissue Culture" by Jennifer A. Veale and Trudy A. Tortorello (Publisher: CABI; Latest Edition: 2021)

9. "Plant Tissue Culture: Theory and Practice" by S.S. Bhojwani and M.K. Razdan (Publisher: Elsevier; Latest Edition: 2015)
10. "Principles of Tissue Engineering" by Robert Lanza, Robert Langer, Joseph P. Vacanti, and Antonios G. Mikos (Publisher: Academic Press; Latest Edition: 2020).

PS. 516.2. NEUROBIOCHEMISTRY

Total No. of Lectures: 42 hours **Total marks: 70**

No. of Lectures/week: 3 **Credits: 3**

Course Objective:

The aim of this paper is to provide the students with the basic understanding in Biochemistry of the developing nervous system, nature of neurotransmitters and their potential role in the vast majority of neurological diseases.

The first unit introduces the nervous system and its components. The second unit elaborates on the neurotransmission. The third unit deals with neurological diseases.

Course Learning Outcomes: Upon completion of this course, students will be able to

CO 1: Demonstrate basic understanding of the nervous system and its functions.

CO 2: Explain basic concepts of physiology and structure of nervous system

CO 3: Describe the nature of neurotransmitters and its role in neuronal signal transmission

CO 4: Demonstrate concrete understanding of neuronal processes that involves key aspects of learning and memory.

Unit-I **14L**

Neurons: Introduction to neurons, components of neurons, classification and types of neurons, cytology of neurons, dendrite's structure and function, axon's structure and functional aspects, ultrastructure, myelination and synapses. Sensory system, Glial cells: Structure and function of glial cells, Different types of glial cells: astrocytes, oligodendrocytes and Schwann cells, Types of astrocytes – type I and II astrocytes, fibrous and protoplasmic astrocytes, Importance of astrocytes in glutamate metabolism and blood brain barrier.

Unit II **14L**

Neurotransmission- voltage-Gated Ion Channels, action Potentials, neurotransmitters and their

Receptors, Role of voltage-gated and ligand-gated ion channels in neural transmission, ion channels and signaling in nerve cells, neurotransmitter synthesis and metabolic mechanisms at the synapse, release and re-uptake/degradation of classical neurotransmitters and peptide transmitters. Acetylcholine synthesis, storage and release. Nicotinic and muscarinic receptors; Catecholamine: Biosynthesis, storage and release; dopamine, adrenergic receptors. Serotonin synthesis, action and distribution, role of serotonin receptors in behaviour, molecular sites and action in the CNS; GABA and glycine: synthesis, uptake and release; receptors of GABA and glycine.

Unit III **14L**

Neurochemical and molecular mechanisms of peripheral neuropathy; diseases involving myelin; Multiple sclerosis and other demyelinated disorders; Genetic disorders of Lipid, glycoprotein, and Mucopolysaccharide metabolism; Epileptic seizures; Genetics and diagnosis of Huntington disease and other triplet repeat disorders; Alzheimer's disease: Molecular, genetic, immunological aspects and diagnostics Alzheimer's disease and Parkinson's disease and Prion Diseases.

References:

1. David L. Nelson and Michael M. Cox. (2011). Lehninger Principles of Biochemistry, 5th Edition, W.H. Freeman and company.
2. Lubert Stryer, Jeremy M. Berg, John L. Tymoczko,. (2002). Biochemistry, 5th Ed., Freeman and co, New York.
3. Robert K. Murray, Daryl K. Grammer, Peter A. Mayer, Victor W. Rodwell (2009). Harper's Biochemistry, 28th Ed., Tata mcgraw- Hill publishing company limited, New Delhi.
4. Donald Voet, Judith G. Voet, Charlotte W. Pratt (2011). Fundamentals of Biochemistry, Life at the molecular level. 4th Ed., John wileyand sons, Inc.
5. Alberts B, Bray D, Lewis J, Raff M, Roberts K, Watson J. D. (2008). Molecular Biology of the cell. 4th edn, Garland Publishing, Inc., New York.
6. Cooper, Geoffrey M (2007). The Cell-A Molecular Approach, 2nd ed., Sunderland (MA): Sinauer Associates, Inc
7. Siegel, (2006). Basic Neurochemistry (7th Edition) Academic Press.
8. Verkhratsky, (2007). Glial Neurobiology, A Text Book, Wiley.
9. Kendel (2013), Principles of Neural Science (5th edition), McGraw Hill,
10. Squire (2013), Fundamental Neuroscience (4th Edition), Elsevier.

PS. 518.2P Experimental Neurobiochemistry

Total marks-70

Practical:8hr/wk **Credits 3**

Course Objective

The objective of this paper is to enable the students to attain practical knowledge in neurobiochemistry, including analysis of behavioural parameters, effects of drugs/toxins on the brain. This practical paper also focuses on the tissue preparations for various biochemical and cytogenetic assays.

Course Learning Outcomes: Upon completion of this course, students will be able to

CO 1: Quantify and analyse the effect of drugs/toxins on brain tissue

CO 2: Prepare tissue homogenates required for various biological assays and perform biochemical and histological assays to understand neuronal activity

CO 3: Evaluate the behavioural changes that take place under conditions of stress and anxiety and apply the information obtained

1. Isolation and preparation of brain tissue homogenates
2. Effect of various psychotic drugs on brain tissue
3. Cytotoxicity of heavy metals (Lead, cadmium) on brain cells
4. Evaluation of memory and learning using radial maze test
5. Study of brain development in chick embryo
6. Behavioural analysis software tools and analysis
7. Study of blood-brain barrier models for drug transport
8. Assessment of bioavailability of toxicants/drugs in brain tissue
9. Acetyl choline esterase activity in brain cells
10. Measurement of anxiety and antidepressant activity using elevated plus maze

PS 517.2P Practical cellular metabolism

Total Marks: 70

Practical:8hr/wk **Credits 3**

Course Objective

The objective of this paper is to enable the students to attain practical knowledge in neurobiochemistry, including analysis of behavioural parameters, effects of drugs/toxins on the brain. This practical paper also focuses on the tissue preparations for various biochemical and cytogenetic assays.

Course Learning Outcomes: Upon completion of this course, students will be able to

CO1: Evaluate and apply knowledge of modern techniques in cellular biology for observation and identification of tissues and cells

CO 2: Extract DNA, RNA and perform their analysis at molecular level.

CO 3: Learn the different phases of cell division using molecular techniques.

CO 4: Handle, maintain Drosophila melanogaster and perform experiments related to the model organism

1. Micronucleus test
2. Study of mitosis in onion root tips and determination of mitotic index and inhibition ofmitosis by mitotic inhibitors
3. Study of plasmolysis in cells of Rheo leaves
4. Preparation of erythrocyte membranes
5. Salient feature of *Drosophila melanogaster*, Maintenance of *Drosophila melanogaster* cultures.
6. Study of mutants of *Drosophila melanogaster*
7. Demonstration of sex chromatin/ Barr bodies.
8. Eye pigment isolation of *Drosophila melanogaster*.
9. Mounting of salivary gland chromosome of *Drosophila melanogaster*.
10. Glycogen extraction and quantification from fed and fasting mice liver and muscle.
11. Estimation of pyruvate/lactate/ alpha ketoglutarate (Keto acids)
12. Estimation of amount of chlorophyll present in the leaf tissue

PO.519.2. Biochemistry of Health and Diseases

(Open Elective-I)

Total No. of Lectures: 42 hours **Total marks: 70**

No. of Lectures/week: 3 **Credits 3**

Course objective:

The objective of this paper is to enable the students to understand basic health, common diseases, general check-ups and medical diagnostic tests.

The first unit gives information about anatomy of the human body, healthy diet, and general check-ups. The second unit deals with some common infectious disease, tests to diagnose them and antidote therapy. The third unit elaborates on systemic pharmacology and drugs used for various diseases.

Course Learning Outcomes: Upon completion of this course, students will be able to

CO 1: Demonstrate an understanding of the mechanisms of diseases- cause, transmission, detection, treatment and prevention.

CO 2: Understand general health check-ups, diagnosis and samples for disease analysis.

CO 3: Understand the nutraceuticals, types of diets, benefits and functional foods.

CO 4: Acquire know-how to health research and develop new tools for their management.

Unit I **12L**

Introduction -Introduction on Concepts of macro and micro nutrients, healthy diet, Atkins diet, mediterranean diet, essential nutrients and their classification. General health, syndrome and common diseases – communicable and non- communicable diseases. General check-up: Blood group, Hb, height and weight, waist to hip ratio, electrocardiogram. Samples for analysis: Blood, urine and cerebrospinal.

Professional hazards: High risk groups (farmers, heavy duty machine workers, corporate workers, athletes).

Unit II **16 L**

Nutraceuticals; use of nutraceuticals in traditional health sciences. Role of omega-3 fatty acids, carotenoids, dietary fiber, phytoestrogens; glucosinolates; organosulfur compounds in health and disease.

Prebiotics and probiotics: Mechanics and usefulness of probiotics and prebiotics in gastrointestinal health and other benefits. Beneficiary microbes; prebiotic ingredients in foods; types of prebiotics and their effects on gut microbes.

Functional foods: Definition, development of functional foods, benefits and sources of functional foods in Indian diet. Food additives: Definitions, functions and uses in processed food products, salts and chelating/sequestering agents, leavening agents, antioxidants, emulsifying and stabilizing agents, anti-caking agents, thickeners, firming agents, flour bleaching agents and bread improvers.

Sweetening agents: Artificial sweeteners, composition, uses. Natural and synthetic colors, food Flavors, Spices and flavoring constituents, flavors in food industries.

Unit III **14 L**

Infectious diseases: Cause, Symptoms and treatment/prevention- Bacterial infections (Tuberculosis, Salmonella, Cholera), Viral infections (Hepatitis, H1N1, chikungunya, Dengue), STDs (Chlamydia, Syphilis, Gonorrhea, HIV) Parasitic diseases (Malaria) . Pregnancy and infections.

Antidotal therapy: types of antidotes: universal, simple and multiple antidotes: definition and examples. Antidotal procedures: decrease absorption of toxicants by emetics and chelating agents.

Adverse effect of Drugs: - Paracetamol, Aspirin, Solvent toxicity -Methanol and Chemotherapeutic drugs.

References:

1. Tripathi, K. D. (2013). Essentials of medical pharmacology. JP Medical Ltd.
2. Hodgson, E. (Ed.). (2004). A textbook of modern toxicology. John Wiley and Sons.
3. Thomas, L. (6^{th} Ed), (2008). Foyes principles of medicinal chemistry. Wolter Klu

Publishers.

4. Advanced Nutrition and Human Metabolism 7th Edn. Sareen S Gropper, Jack L Smith, and Timothy P Carr, Cenage Learning (2018).
5. Introduction to Human Nutrition, 2nd Edn. Michael J. Gibney, Susan A. Lanham-New, Aedin Cassidy, Hester H. Vorster, Wiley-Blackwell (2009).
6. Modern Nutrition in Health and Disease, 10 Ed. Shills et al;, Lippincott Williams and Wilkins (2006). 7. Nutrition: Everyday Choices, 1st Edition; Mary B. Grosvenor, Lori A. Smolin Wiley (2006).
7. Bioactive Food as Dietary Interventions for Liver and Gastrointestinal Disease; Watson Elseveir (2012).
8. Nutrition and Metabolism, 2nd Edn., Lanham S, Mac Donald I and Roche H. The Nutrition Society, London, UK, (2012).
9. Introduction to Human Nutrition, 2nd Edn., Gibney M, Lanham S, Cassidy A and Vorster H.The Nutrition Society, London, UK, (2012).