CENTRAL UNIVERSITY OF HARYANA

DEPARTMENT OF BIOCHEMISTRY

Learning Outcomes based Curriculum Framework (LOCF)

M.Sc. Biochemistry (Two-Year) Programme

Syllabus (2021-22)

(As per National Education Policy 2020)

SCHOOL OF INTERDICIPLINARY AND APPLIED SCIENCES

Table of Contents

1. Background

Biochemistry is one of the most **fascinating subjects** as it deals with the **chemical language of Life**, be it human, animal, plant or microorganism. Biochemistry is one of the most upcoming and highly in demand subject in the Indian as well as the foreign universities. The **basic foundation in Biochemistry is a necessary pre-requisite for any kind of life science, biotechnological, medical, paramedical and biological research activity**. By considering above facts, Department of Biochemistry, Central University of Haryana has been established in July 2015 under the arena of School of Interdisciplinary and Applied Sciences (SIAS). The department envisions imparting high quality teaching and research to its students to engross them in the world of applied and basic sciences. The department is committed to continue its efforts to develop and strengthen infrastructure for research in almost all aspects of biochemistry. The department offers a high quality and interdisciplinary learning environment for post graduate and PhD students. Department offers exciting research opportunities for postgraduate students and highly personalized training to PhD students. The faculty is setting a tradition of excellence in teaching, while their research accomplishments have been well recognized nationally and internationally in the areas of biochemistry, molecular biology and cellular biology, genomics and proteomics research etc. In nutshell, the department has been set up with a major goal of spear heading the applied biology teaching and cutting-edge research with effervescent zeal and dedication. The department is pursuing research in almost all areas of modern biochemistry including plant secondary metabolites, functional genomics, medicinal and aromatic plants, clinical biochemistry, discovery and development of antifungals & antimicrobials, fluoride and drug resistance, cancer biology etc owing to the trained faculties. The Department is equipped with the modern and sophisticated scientific equipment's like Spectrophotometer, PCR, RT-PCR, Gel Doc, rotary evaporator etc. Each year students appear and qualify the National level examinations like CSIR-JRF-NET, GATE. The long-term research goals for the department, are to place Department of Biochemistry as a research laboratory engaged in high quality research on plant molecular biology, cancer and neurobiology, antimicrobials and discovering novel drug molecules and mechanisms for prevention of human diseases including metabolic diseases, cardiovascular diseases, cancer and genetic diseases.

The vision and mission of Department of Biochemistry is to:

- Impart a broad fundamental knowledge for the concept and principles of Biochemistry
- Provide opportunities for hands on training and experience in research-oriented education, & application skills in protein biochemistry, molecular biology, genomics, biochemical assays and molecular diagnostics

Programs and number of seats offered

S. No.	Program	Seats	Admission criteria
1	M.Sc. Biochemistry	31	Admission to M.Sc program is through CUCET entrance examination that is based on the CUCET score. A candidate having a bachelor degree under 10+2+3 system, recognized by the university, or a degree recognized as its equivalent is admissible to master program.

Four categories of courses will be offered to the admitted students:

Core Courses:

Include theoretical as well as practical courses and seminars

Discipline Centric Elective Course:

- Include theoretical as well as practical learning through Department specific courses.
- Student must opt for two out of four or more courses offered by the Department)

Generic Elective courses (GEC):

- In 1st and 3rd semester students will opt for any one of the open elective courses offered by other departments of the University.

Skill Enhancement Course:

- A separate project training-based course that leads to a dissertation worth of twenty credits. This course is also included as among one of the Core Courses

A student is required to accumulate a total of <u>100 credits</u> to fulfill the requirements for a Master of Science degree in Biochemistry.

2. Program Outcome:

- **Basic and applied knowledge:** Interdisciplinary knowledge to find solution for the complex biological problems
- **Problem analysis:** Ability to analyse society related/ applied research problem, design and execute experiments to find relevant solutions
- **Advanced Usage of Technology**: Apply advanced instrumentation tools, online resources with an understanding of the troubleshooting and limitations
- **Ethics:** Commitment towards professional ethics and responsibilities as a social endeavor to bring harmony with nature
- **Lifelong learning:** Scientific skills for industrial applications and entrepreneurship

PO1: An ability to apply knowledge of Biochemistry to all branches of Life Science understanding and applications.

PO2: An ability to design and conduct experiments in biochemistry, as well as to analyze and interpret data.

PO3: A broad education necessary to understand the impact of biochemistry in a global, economic, environmental and societal context.

3. Program Specific Outcome

PSO1: Acquire deep scientific knowledge in the subjects like cell and molecular biology, plant biochemistry, metabolism, immunology etc

PSO2: Gain skill-oriented and innovative capabilities in the field of Biochemistry in general, clinical biochemistry and molecular diagnostics in particular to meet competitive research requirements.

PSO3: Develop effective means of communicating biochemical concepts / methods; both orally as well as in writing.

PSO4: Gain proficiency in laboratory techniques of various aspects of biochemistry and also be able to apply processes of experimentation and hypothesis testing to biochemical methods

PSO5: Develop special industrial oriented skills to establish and perform macromolecules based scaled-up industrial process.

PSO6: Demonstrate analytical and problem-solving skills to combat human diseases and resolve problems in the field of agriculture.

PS07: Develop understanding and applications of modern state of art computational tools and statistical methods in biological sciences

PSO8: Learn to work independently and as a team for retrieving information from various e-resources, carry out research investigations and result interpretations.

PSO9: Effectively work and lead in a team in professional environment, demonstrate professional integrity with value-based learnings and be able to serve with responsibility towards society and country with knowledge and understanding of fundamental science

4. Postgraduate Attributes

- Disciplinary knowledge
- Creative and critical thinking
- Reflective thinking
- Problem solving
- Analytical reasoning
- Communication skills
- Research skills
- Life skills

- Multicultural competence
- Moral and ethical values
- Lifelong learning
- Global competence

The purpose of study Biochemistry is to **understand structure, composition, signaling, energy flow and biochemical processes** that give rise to the **complexity of life**. Students who opt the Biochemistry course will have the basic and advanced knowledge about the metabolic processes, their mechanism, and diagnosis of different biological activities taking place inside the human body. It compressively deals with the biochemical aspect of environmental pollutants' effect on human health with their prevention and control. It unveils the chemical basis of life in all living organisms including plants, animals and microorganisms. Biochemistry has contributed enormously to the growth of modern medical and health science and agriculture. Biochemistry has applications in clinical diagnosis, understanding pathology of diseases, treatment of diseases, designing of drugs and understanding their metabolism and manufacture of various biological products like amino acids, proteins, antibiotics, hormones, enzymes, nutrients, etc. Understanding the biochemical basis of vital processes of plants such as photosynthesis, respiration, hormonal regulation, nutrient assimilation have helped in developing superior varieties of crop plants with better growth attributes and yield. The learning outcomes of Biochemistry course is to understand the objectives of Biochemistry i.e. analyze, appreciate, understand the concepts of biochemical reactions occur in living systems, which enable them to understand the various perspectives of applied sciences that benefit mankind.

Biochemistry is a career oriented, high demand fundamental course with applications in all biological research, be it plants, animal, human and microbes. It provides opportunity to students to develop their career in the following areas:

- Healthcare industry
- Diagnostics research
- Food and packaging industries
- Medical Instrument companies
- Research Companies and Laboratories
- Drug manufacturing industries
- Public Health Entities
- Blood research and Services
- Industrial Laboratories
- Cancer research institutes

- Research Departments
- Educational Institutes
- Environmental Pollution Control
- Agriculture and fisheries
- Forensic Science
- Hospitals
- Public Health Laboratories
- Cosmetic Industries etc.
- Genomics Industries
- Diagnostics and testing Industries

Students passionate about their job to study structures and functions of proteins, carbohydrates, fats, lipids, process of metabolism, molecular basis of the action of genes, biochemical pathways, and diagnosis of different ailments can make a career in the Biochemistry field after pursuing this course.

5. Structure of Master's Course

Credit Summary of Courses Offered by Department of Biochemistry

(Academic Session 2021-22)

Total Credits: 100

Semester	**Credits**				**Total credits**
	Core courses	**Skill enhancement core course**	**Elective courses**		
			DCEC (For Department of Biochemistry students)	**GEC (For other Department students)**	
I	21	-	-	4	**25**
II	21	-	4	-	**25**
III	17	-	4	4	**25**
IV	-	22+3	-	-	**25**
Total	**59**	**25**	**8**	**8**	**100**

6. Learning Outcome Index

Core Courses

PSO	CC-1	CC-2	CC-3	CC-4	CC-5	CC-6	CC-7	CC-8	CC-9	CC-10	CC-11	CC-12	CC-13	CC-14	CC-15	CC-16
PSO-1	X	X		X	X		X	X	X	X	X		X	X	X	X
PSO-2		X	X	X	X	X	X	X		X		X			X	
PSO-3	X	X	X	X		X	X			X	X	X	X	X	X	X
PSO-4	X	X	X		X	X		X	X	X	X			X	X	X
PSO-5	X		X	X	X	X	X	X	X	X	X	X	X	X		X
PSO-6	X	X	X		X		X	X				X	X	X	X	X
PSO-7		X	X	X	X	X			X	X	X			X		X
PSO-8	X	X		X	X		X	X	X		X	X	X		X	X
PSO-9	X	X	X		X		X	X				X	X	X	X	X

Learning Outcome Index, Elective Courses

PSO	EC-1	EC-2	EC-3	EC-4	EC-5	EC-6	EC-7
PSO-1	X	X		X			X
PSO-2	X	X	X	X	X		X
PSO-3		X		X		X	X
PSO-4	X	X	X		X	X	
PSO-5	X	X	X	X	X		
PSO-6	X	X	X	X	X	X	X
PSO-7			X		X	X	X
PSO-8	X	X		X	X	X	X
PSO-9	X	X	X	X	X	X	X

7. Semester-wise Courses and Credit Distribution

Semester-I (Total credits 25)

Course code	Course title	L	T	P	Type of course	Credit
SIAS BC 11 01 C 4004	Cell and Molecular Biology	4	0	0	Core (CC-1)	4
SIAS BC 11 02 C 4004	Biomolecules and Metabolism	4	0	0	Core (2)	4
SIAS BC 11 03 C 3104	Analytical Biochemistry	3	1	0	Core (3)	4
SIAS BC 11 04 C 3104	Protein Biochemistry	3	1	0	Core (4)	4
SIAS BC 11 05 C 00105	Practical Skills in Basic Biochemistry	0	0	10	Core (5)	5
	Generic Elective Course (to be opted from other Department)	4	0	0	GEC	4

Semester-II (Total credits 25)

Course Code	Course Title	L	T	P	Type of Course	Credit
SIAS BC 12 01 C 4004	Enzymology & Enzyme technology	4	0	0	Core (6)	4
SIAS BC 12 02 C 4004	Immunology	4	0	0	Core (7)	4
SIAS BC 12 03 C 4004	Recombinant DNA Technology	4	0	0	Core (8)	4
SIAS BC 12 04 C 3104	Bioinformatics	3	1	0	Core (9)	4
SIAS BC 12 05 C 00105	Practical Skills in Biochemical Techniques	0	0	10	Core (10)	5
SIAS BC 12 01 DCEC 4004	Cell Culture Technology	4	0	0	DCEC (EC-1)	4
SIAS BC 12 02 DCEC 4004	Biochemical Toxicology	4	0	0	DCEC (2)	4
SIAS BC 12 03 DCEC 3104	Biostatistics	3	1	0	DCEC (3)	4

8. One of the courses will be opted by the student from DCEC.

Semester-III (Total credits 25)

Course Code	Course title	L	T	P	Type of course	Credit
SIAS BC 13 01 C 3104	Genomics and Proteomics	3	1	0	Core (11)	4
SIAS BC 13 02 C 4004	Clinical Biochemistry	4	0	0	Core (12)	4
SIAS BC 13 03 C 4004	Plant Biochemistry	4	0	0	Core (13)	4
SIAS BC 13 04 C 00105	Practical Skills in Advanced Biochemistry	0	0	10	Core (14)	5
SIAS BC 13 01 DCEC 4004	Cancer Biology	4	0	0	DCEC (4)	4
SIAS BC 13 02 DCEC 4004	Molecular Diagnostics	4	0	0	DCEC (5)	4
SIAS BC 13 03 DCEC 3104	Computational Biology	3	1	0	DCEC (6)	4
SIAS BC 13 04 DCEC 4004	Human Health and Disease	4	0	0	DCEC (7)	
	Generic Elective Course (to be opted from other Department)	4	0	0	GEC	4

One of the courses will be opted by the student from DCEC**.**

Semester-IV (Total credits 25)

Course code	Course title	Type of course	Credit
SIAS BC 1 4 01 SEC 0003	Presentation and Research Skills	Core (15)	3
SIAS BC 1 4 02 SEC 0020	Dissertation	Core (16)	22
	Total credits of the Program		**100**

Note: In general, 40 % of each course will be covered through online mode while rest 60% will be covered by offline mode

Generic Elective Course: Offered by Department of Biochemistry to students from other Departments of the University.

Semester	Type of course	Course code	Course title	Credit
I	GEC	SIAS BC 1 1 01 GEC 4004	Fundamental of Biochemistry	4
		SIAS BC 1 1 02 GEC 4004	Biochemical and Environmental Toxicology	
III	GEC	SIAS BC 1 3 01 GEC 4004	Clinical Biochemistry	4
		SIAS BC 1 3 02 GEC 4004	Analytical Techniques	

8. Course Level Learning Outcomes

SEMESTER-I

SEMESTER-I

Course title: Cell and Molecular Biology **Credit: 4**
Course code: SIAS BC 11 02 C 3104 **Lecture: 60**

Course objectives:
The focus of Cell and Molecular Biology is the study of the fine structure and function of the cell. In this course we will emphasize on Eukaryotic cell biology and will cover topics such as membrane structure and composition, transport, and trafficking, the cytoskeleton and cell movement. We also cover important cellular processes including DNA replication, transcription, and translation.

Student learning outcomes:
Upon completion of this course, the student will be able to:

- Describe the fundamental principles of cellular biology
- Have a conceptual understanding of the molecular basis of various cellular processes
- Know how cell function and structure are related
- Be able to think critically and interpret hypothetical experimental observations based on class concepts.

Unit-I
Introduction to Cell Biology, Membranes and Cell Architecture, Nucleus architecture, Membrane Transport, Membrane Trafficking, Vesicular Traffic, Secretion, and Endocytosis Glycosylation & COP-Mediated Vesicular Transport, Moving proteins into membranes and organelles.

Unit-II
Cellular Organization and Movement, Cytoskeleton-Microfilaments and Intermediate Filaments, Microtubules, Microtubule-Based Movement - Intracellular Transport, Motile Appendages, Cell-Cell Organization and the Extracellular Space, the Extracellular Matrix (ECM), Integrating Cells into Tissues.

Unit-III
DNA: Structure and function, Chromosome and chromatin, DNA replication and its regulation (prokaryotes and eukaryotes), DNA polymerases of Prokaryotes. Mechanism of replication in prokaryotes. Eukaryotic DNA polymerases. Mechanism of replication in eukaryotes. DNA damage and repair, DNA Mutation, Types of mutations, Genetic system of Mitochondria and plastids, Gene recombination Homologous and site-specific recombination.

Unit-IV
Transcription and its regulation (prokaryotes and eukaryotes), Prokaryotic RNA polymerase. Nature of prokaryotic promoters. Mechanism of prokaryotic transcription. Eukaryotic RNA polymerases. Nature of eukaryotic promoters, Mechanism of eukaryotic transcription. Inhibitors of transcription. Translation and its regulation (prokaryotes and eukaryotes), adapter role of RNA in protein synthesis; genetic code; wobble hypothesis; ribosomes, activation of amino acids; initiation, elongation, and termination of protein synthesis in prokaryotes and eukaryotes. Control of translation: role of guanine nucleotides; translational control of gene expression

Suggested reading:

1. Essential Cell Biology, 4th edition, Alberts, Bray, Hopkin, Johnson, Lewis, Raff, Roberts, and Walter.
2. Essentials of Stem Cell biology (2013) 3rd ed., Lanza RP and Anthony A, Elsevier Academic Press,
3. Molecular Cell Biology. Seventh Edition. Lodish et. al. Freeman Press. (ISBN-13: 978-1-4292-3413-9)

4. The Cell: A Molecular Approach (2018) 8th ed., Cooper, GM, Oxford University Press.
5. Molecular Biology of the Gene (2017) 7th ed., Watson JD, Tania B, Stephen PB, Alexander G, Michael L and Richard L, Pearson Education.

SEMESTER-I

Course title: Biomolecules and Metabolism **Credit: 4**
Course code: SIAS BC 11 02 C 3104 **Lecture: 60**

Course objectives: The course is aimed to give students an exposure of chemical interactions inside the cell. It provides deeper insight into structures, properties and functions of major bio-molecules and metabolic pathways in the living systems.

Learning outcomes:
Upon completion of this course, the student will be able to:

- Evaluate the structure of carbohydrates and their functions
- Acquire knowledge on the building blocks of lipids, classification and their properties
- Understand the various orders of structure, classification, properties and biological importance of proteins
- Evaluate the structure and hierarchical organization of nucleic acids with their biological functions

Unit I
Carbohydrates: Brief review of configurational and conformational aspects of carbohydrates. Structure, properties and importance of structural (cellulose and chitin) and storage polysaccharides (starch and glycogen), Structure elucidation of polysaccharides (starch, glycogen and cellulose). Glycoproteins- structure and functions. Lipoproteins. Glycolysis, citric acid cycle, pentose phosphate pathway and its regulation. Gluconeogenesis, glycogenesis and glycogenolysis.

Unit II
Lipids: Building blocks of lipids - fatty acids, glycerol. Storage lipids - triacylglycerol and waxes. Structural lipids in membranes- Phospholipids, glycerophospholipids, galactolipids, sulpholipids, sphingolipids and sterols. Oxidation of odd and even number of fatty acids. Fatty acid biosynthesis.

Unit III
Amino acids and Proteins: Review of classification and structure of amino acids, acid – base properties of amino acids. Ionic properties of peptides and proteins. Primary, secondary, tertiary and quaternary structure of proteins. General reactions of amino acid metabolism - Transamination, decarboxylation, oxidative and non-oxidative deamination of amino acids. Urea cycle and its regulation.

Unit IV
Nucleic acids: Nomenclature, classification and structure of Nucleotides and Nucleic Acids, structure of nitrogenous bases, nucleosides and nucleotide, The Chemical Structures of DNA and RNA, Double Helical DNA, The Watson– Crick Structure: B-DNA, Denaturation and Renaturation. Biosynthesis and degradation of purine and pyrimidine nucleotides and its regulation.

Suggested readings:

1. Lehninger: Principles of Biochemistry (2017) 7th ed., Nelson DL and Cox MM, WH Freeman and Company (New York), ISBN:978-1319108243.

2. Voet's Principles of Biochemistry (2018) Global ed., Voet D, Voet JG and Pratt CW, John Wiley and Sons, ISBN:978-1119451662.
3. Biochemistry (2015) 8th ed., Berg JM, Stryer L and Tymoczko JL, WH Freemanand Company (New York), ISBN: 9781464126109
4. Textbook of Biochemistry with Clinical Correlations (2011)7th ed., Devlin TM, JohnWiley & Sons, Inc, ISBN 13:978-0470281734.
5. Harper's Illustrated Biochemistry (2018) 7thed., Rodwell VW, Bender DA, Botham KM, Kennelly PJ and Weil PA, McGraw-Hill, ISBN 13:978-1259837937.

SEMESTER-I

Course title: Analytical Biochemistry **Credit: 4**
Course code: SIAS BC 11 04 C 4004 **Lecture: 60**

Course objective: To provide basic and advance understanding of the core principles and working mechanism of various tools and techniques used in biological experiments.

Learning outcomes:

Upon completion of this course, the student will be able to:

- Understand the biochemical techniques used in research and industry
- Demonstrate principles of various basic and advanced techniques used in biological experiments
- Critically analyze and interpret the results obtained from biological experiments
- Relate the principles and applications of spectroscopic, electrochemical and mass spectrometric detection at quantitative and qualitative analysis in the area of bioanalysis

Unit-I

Microscopy; principle, resolving, magnification power, Lens defects, application of compound microscopy, Factors affecting resolution, Fluorescence microscopy, phase contrast microscopy, confocal microscopy, atomic force microscopy (AFM) and electron microscopy (SEM, TEM and STEM). Sample preparation for SEM and TEM.

Unit-II

Agarose gel electrophoresis, polyacrylamide gel electrophoresis (native and SDS-PAGE), Blotting (Western, Southern, Northern), iso-electric focusing (IEF), 2-Dimensional gel electrophoresis, pulse field electrophoresis, principle and applications of centrifugation, Rotor types, differential centrifugation, density gradient centrifugation (rate zonal and isopycnic), and ultracentrifugation.

Unit-III

Principle and types of Chromatography; Planner chromatography (paper, Thin layer chromatography, column chromatography (gel filtration, ion exchange, affinity), principle and application of High performance liquid chromatography (HPLC) and gas chromatography (GC). Radioactivity; Geiger-Müller and, Scintillation counter, autoradiography, non-radiolabeling, Safety measures of radioisotopes handling.

Unit-IV

Beer-Lambert's Law, principle and instrumentation of UV-visible, infrared (IR), Florescence, AAS, NMR spectroscopy, Mass spectrometry (MS), electrospray ionization mass spectrometry (ESI-MS), MALDI, tandem MS for protein identification, Circular Dichroism (CD), flow cytometry, and ELISA. SDS-PAGE

Suggested readings:

1. Principles and Techniques of Biochemistry and Molecular Biology (2018) 8th ed. Wilson K and Walker J, Cambridge University Press, ISBN No. 131661476X.
2. Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D., Wiley Blackwell (West Sussex), ISBN: 978-0-470-85602-4 / ISBN: 978-0-470-85603-1.
3. Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982) 2nd ed., Freifelder D, W.H. Freeman and Company (New York), ISBN:0-7167-1315-2 /ISBN:0-7167-1444-2.
4. Principles of Instrumental Analysis (2018) 7th ed., Douglous A. Skoog, F. James Holler, Stanley R Crouch, Singapore: Cengage Learning Asia Pte Ltd.

SEMESTER –I

Course title: Protein Biochemistry **Credit: 4**
Course code: SIAS BC 11 04 C 3104 **Lecture: 60**

Course Objectives:
The objective is to offer detailed knowledge about proteins, the dynamic biomolecules that sustain life through innumerable diverse functions, providing basic concepts of structures of proteins, their mechanism of folding and methods to engineer them for various applications.

Learning outcomes:
Upon completion of this course, the student will be able to:

- Acquire insight into levels of protein structures – their basic constituents, forces that stabilize protein structures, their various modules and arrangements.
- Learn how proteins fold during and following translation and consequences of improper folding.
- Acquire insight into protein structure-function relationship learning the significance of protein structures in their ability to perform various functions.
- Learn about the types, methods and strategies of protein engineering and examples of successful protein engineering in various applications.

Unit I:
Introduction: Importance and Significance of proteins; Functional diversity, Classes and Dynamism; Structure-function relationship; Key Features. Amino acids as constituents: Ways of representation, Classification, Stereochemistry, Chemical and structural features. Physico-chemical interactions in biological systems: Covalent & non-covalent interactions, Importance of weak interactions in protein structures.

Unit II:
Levels of protein structure: *Primary structure*: Flexibility and conformational restrictions, Characteristics of peptide bond, Ramachandran plot. *Secondary structure*: Diversity in alpha-helices, Helix capping, Beta-stand and sheet, Turns and loops, Importance of loops. *Super secondary structure*: Domains and motifs. *Tertiary structure*: General properties and characteristics. *Quaternary structure*: Concept of subunits and promoters and their association, Importance of quaternary structure, various examples, Myoglobin and Haemoglobin structures and their relation to cooperativity and allostery.

Unit III:

Protein Folding and its biotechnological applications: problems in protein folding; Anfinsen's classical experiment; Folding curves and transitions; Assisted protein folding (Chaperones), Misfolding and diseases, Mechanism of sickle-cell disease, Industrial and medical applications.

Unit IV:
Fibrous and Globular proteins, Structural Features of Membrane proteins, Basics of Mass Spectrometry, Ionization mechanisms. Protein Engineering: Basic principles, Types and Methods, Applications and case studies. Sequencing and amino acid composition of peptides and proteins, artificial peptide synthesis and their applications.

Suggested Readings:

1. Introduction to Protein Structure (2nd Ed.), C. Branden, T. Tooze. 1999, Garland Science, Taylor and Francis Group, New York, USA. ISBN: 978-0-8153-2305-1.
2. Proteins: Structures and Molecular Properties (3rd Ed.), T.E. Creighton. 2002, W.H. Freeman and Company, New York, USA. ISBN 978-0716770305.
3. Mechanisms of Protein Folding, R. H. Pain. 2000. Oxford University Press, Oxford, England. ISBN 978-0716770305.
4. Protein Engineering Handbook, S. Lutz, U. T. Bornscheuer. 2008. Wiley-VCH, Weinheim, Germany. ISBN: 978-3-527-31850-6.
5. Protein Misfolding, Aggregation and Conformational Diseases: Part A: Protein Aggregation and Conformational Diseases (Protein Reviews), V. N. Uversky, A.L. Fink. 2006. Springer, New York, USA. ISBN: 978-1-4419-3851-0.

SEMESTER -I

Course Title: Practical Skills in Basic Biochemistry **Credit: 5**
Course Code: SIAL BC 1 1 02C 00105 **Lecture: 150**

Course Objectives: To analyse and estimate biomolecules

Learning outcomes:
Upon completion of this course, the student will be able to:

- Students will learn about various good lab practices, working in labs and use of Instruments
- The course will provide better understanding of the art of design, execution and analysis of experiments
- Learn how to standardize various biomolecules
- Quantify and identify different biomolecules like amino acid, sugar, lipid based on their physiochemical properties

1. Introduction to laboratory safety precautions, personal hygiene, Glass wares, pipetting & weighing, Instruments (Centrifuge, pH meter, Colorimeter, Spectrophotometer, UV & VIS Spectrophotometer, Ultra Centrifuge, Electronic Balance)
2. Preparation of buffers and measurement of pH, Determination/calculation of normality and molarity of solutions.
3. Qualitative estimation of carbohydrates by Molish test
4. Qualitative estimation of reducing sugars by Fehling solutions.
5. To determine presence of starch by Iodine test.
6. Qualitative estimation of aromatic amino acids by Xanthoproteic test
7. To detect the presence of Tyrosine by Millon's test
8. Detection of glycerol by Acrolein test for detection of

9. Estimation of total protein content by Lowry's method
10. Fractionation of serum on gel filtration chromatography

Suggested readings:

1. An introduction to practical Biochemistry, 3rd Edition (2017), David T. Plummer, Tata Mc Graw Hill Co. Ltd., Bombay. ISBN- 9780070994874
2. Introductory Practical Biochemistry (2001). 2nd Edition. S.K. Sawhney and Randhir Singh. Narosa Publishing House, ISBN- 8173193029
3. Practical Biochemistry, 3rd Edition, 2018, Sadasivam and Manickam. New Age International Pvt Ltd Publishers; Third edition, ISBN- 8122421407
4. Practical Biochemistry, Principles and Techniques (1995). 8th Edition. Keith Wilson and John Walker. Cambridge University Press, ISBN- 131661476X

SEMESTER -I

Course title: Fundamentals of Biochemistry **Credit: 4**

Course code: SIAS BC 1 1 01 GEC 4004 **Lecture: 60**

Course Objectives: To understand the structure and functions of biomolecules.

Learning outcomes:

- Appreciate the hierarchical organization of various biomolecules.
- Evaluate the structure of carbohydrates and their functions
- Acquire knowledge on the building blocks of lipids, classification and properties as well as lipoprotein and composition of membranes.
- Understand the various orders of protein structure, classification, properties and biological importance of proteins.
- Evaluate the structure and hierarchical organization of nucleic acids with their biological functions.

Unit I

Carbohydrates: Brief review of configurational and conformational aspects of carbohydrates. Structure, properties and importance of structural (cellulose and chitin) and storage polysaccharides (starch and glycogen), glycosaminoglycans, cardioglycosides and bacterial cell wall polysaccharides. Structure elucidation of polysaccharides (starch, glycogen and cellulose). Glycoproteins-structure and functions. Lipoproteins.

Unit II

Lipids: Building blocks of lipids - fatty acids, glycerol, ceramide. Storage lipids - triacyl glycerol and waxes. Structural lipids in membranes- Phospholipids, glycerophospholipids, galactolipids, sulpholipids, sphingolipids and sterols.

UNIT III

Amino acids and Proteins: Review of classification and structure of amino acids, acid – base properties of amino acids. Non – standard, non–protein and biologically active amino acids. Ionic properties of peptides and proteins. Naturally occurring peptides. Primary structure: Elucidation of primary structure of proteins – Determination of amino acid composition, end group analysis, cleavage by enzymes and chemicals. Secondary structure: Peptide bond – structure and conformation, Ramachandran plot. α – helix, β – pleated sheet, loops and triple helical structures. Tertiary structure: Forces stabilizing tertiary structure of proteins. Protein denaturation and renaturation. Quaternary structure and symmetry: Structure and function of myoglobin and hemoglobin.

Unit IV

Nucleic acids: Nomenclature, classification and structure of Nucleotides and Nucleic Acids, structure of nitrogenous bases, nucleosides and nucleotide, The Chemical Structures of DNA and RNA, Double Helical DNA, The Watson– Crick Structure: B-DNA, Denaturation and Renaturation, Ionization of the bases, effect of chemicals and radiations, detection of nucleic acids.

Suggested readings:

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292- 3414-8.
2. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.

3. Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J.L. and Stryer, L., W.H Freeman and Company (New York), ISBN: 13:978-1-4292-7635-1.

SEMESTER -I

Course title: Biochemical and Environmental Toxicology **Credit: 4**
Course code: SIAL BC 1 1 02 GEC 4004 **Lectures: 60**

Course objective: To study the fundamental concepts, methods, approaches of Biochemical and environmental toxicology.

Learning outcomes:

- Identifying a variety of environmental toxicants in terms of their occurrence and toxic effects
- Understanding the fate and transport of toxicants in the environment and how these processes affect their toxicity
- Understanding the toxicological effects of biochemical and environmental toxicants on humans

Unit –I

Definition and scope of toxicology**,** eco-toxicology and its environmental significance. Toxic effect: Basis for general classification & nature. Dose – Response relationship: synergism and antagonism, determination of ED_{50}&LC_{50}/$LD_{50,}$ minimum effective dose (MED), minimum tolerance dose (MTD). Acute and chronic exposures. Factors influencing toxicity.

Unit-II

Xenobiotic metabolism: absorption & distribution. Phase I reaction. Oxidation, reduction, hydrolysis and hydration. Phase II reaction/conjugation: methylation, glutathione, glucouronic acid and amino acid conjugation. Detoxification. Biochemical basis of toxicity: distribution of Excitable membrane function. Altered calcium homeostasis. Covalent binding to cellular macromolecules & genotoxicity. Tissue specificity of toxicity. Toxicity testing: in-vitro test systems- bacterial mutation test: reversion test, Ames test, fluctuation tests. Comet assay. Chromosome damage tests.

Unit-III

Food Toxicology: role of diet in cardio-vascular disease and cancer. Toxicology of food additives. Metal toxicity: Toxicology of arsenic, mercury, lead and calcium. Environmental factors affecting metal toxicity – effect of light, temperature and pH.

Unit-IV

Diagnosis of toxic changes in liver and kidneys: metabolism of haloalkanes, haloalkenes and paracetamol with their toxic effects on tissues. Air pollution: common air pollutant & their sources. Air pollution and ozone. Air pollution due to chlorofluorocarbons (CFCS) and asbestos. Water pollution; major water pollutants. Effects of selected pollutions on fresh water flora & fauna. Effect of UV radiation on human health.

Suggested readings:

1. Introduction to Environmental Toxicology: Molecular Substructures to Ecological Landscapes (2017) 5th ed., Landis WG, Sofield RM and Yu MH, CRC Press, ISBN: 978- 1498750424.
2. Environmental Toxicology: Biological and Health Effects of Pollutants (2011) 3rd ed., Yu MH, Tsunoda H and Tsunoda M, CRC Press, ISBN: 978-1439840382.
3. Environmental Toxicology Current Developments (2014) 1st ed., Rose J, Taylor and Francis, ISBN: 0203-30551-5.
4. An Introduction to Environmental Toxicology (2018) 4th ed., Dong MH, Create space Independent Publishing platform, ISBN: 1979904510.
5. Foodborne Microbial Pathogens: Mechanisms and Pathogenesis (2018) 2nd ed., Bhunia AK, Springer Nature, ISBN: 978-1493973477.

SEMESTER-II

SEMESTER-II

Course title: Enzymology and Enzyme technology **Credit: 4**
Course code: SIAS BC 12 01 C 3104 **Lectures: 60**

Course objective: To provide a deeper insight into the fundamentals of enzyme structure and function and kinetics of soluble and immobilized enzymes.

Learning outcomes:
Upon successful completion of this course, students should be able to:

- Distinguish the fundamentals of enzyme properties, nomenclatures, characteristics and mechanisms.
- Understanding how enzymes are able to increase speed of a biochemical reaction in sense of thermodynamics, kinetics and molecular interactions
- Interpreting and explaining significant mechanisms of regulation of enzymatic action
- Analyzing options for applying enzymes and their inhibitors in medicine and various industries

Unit-I

Enzymes; general characteristics, Classification and Nomenclature, Coenzymes and Cofactors, metallo-enzymes, isozymes, ribozymes, Criteria of purity of enzymes; Specific activity, Enzyme units-Katal and IU, proximity, orientation effect, Strain & distortion theory. Factors affecting rate of chemical reactions, collision theory, activation energy and transition state theory, determination of activation energy. Fischer's lock and key hypothesis, Koshland's induced fit hypothesis.

Unit-II

Initial velocity and substrate concentration relationship, derivation of Michaelis- Menten equation, Significance of Km, Vmax, Kcat, and Kcat/Km. Different plots (Lineweaver-Burk plot, Eadie-Hofstee and Hanes plot). Effect of pH, temperature and metal ions on enzyme activity. Reversible inhibition (competitive, uncompetitive, non- competitive, Mixed), Suicide inhibitor.

Unit-III

Mechanism of enzyme catalysis-General acid-base catalysis, electrostatic catalysis, covalent catalysis. Enzyme regulation; reversible (glutamine synthase & phosphorylase) and Irreversible (proteases), covalent modifications of enzymes, Feedback inhibition and feed forward stimulation, Allosteric enzymes, co-operatively, and sigmoidal kinetics: MWC and KNF models. Significance of sigmoidal behavior, Study of ATCase and pyruvate dehydrogenase allosteric enzyme.

Unit-IV

Application of enzyme in diagnostics (SGPT, SGOT, Creatine kinase, alkaline and acid phosphatases, LDH, glucose-6-phosphate dehydrogenase (G6PD)), enzyme therapy (Streptokinase, Angiotensin-converting enzyme (ACE) inhibitor), immobilized enzymes, Biotransformation, Scope of enzymes in industries.

Suggested readings:

1. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry (2007) 2nd Edition. Palmer T, and Bonner PL, Woodhead Publishing, ISBN: 978-1904275275.
2. Fundamentals of Enzyme Kinetics (2017) 3rd Edition. Bowden AC, Medtech, ISBN:978-9385998508.
3. Lehninger: Principles of Biochemistry (2017) 7th Edition. Nelson DL and Cox MM, WH Freeman and Company (New York), ISBN:978-1319108243.
4. Essentials of Enzymology (2016) 1st Edition. Herald J, Syrawood Publishing House, ISBN:978-16182862285.
5. Biochemistry (2015) 8th Edition. Berg JM, Stryer L and Tymoczko JL, WH Freeman and Company (New York), ISBN: 9781464126109.
6. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis (2000). Robert A. Copeland, 2nd ed., Wiley-VCH, Inc. ISBNs: 0-471-35929-7 (Hardback); 0-471-22063-9.

SEMESTER-II

Course title: Immunology **Credit: 4**
Course code: SIAS BC 12 02 C 3104 **Lectures: 60**

Course Objective

This course is designed to teach basic and advanced concepts of immunology. This course includes various case studies that help the learner to understand and identify the appropriate immunogenic situation.

Learning Outcome:

Upon completion of this course, the student will be able to:

- Develop broad core knowledge in immunology
- Develop a working knowledge of innate and adaptive immune responses, how these responses can be protective, and how they contribute to disease
- Develop skills in analytical and critical thinking related to immunological research
- Discuss the classification of immunity, cell mediated immune response, humoral immune response.

Unit-I

Immune system and the cell types involved in defense mechanisms of the body. Gross features, functions, development and histogenesis of various primary and secondary lymphoid organs in the body. Immunity in invertebrates and vertebrates. Cells, receptors, molecules and other components of innate immunity. Development, characteristics and function of innate immune cells. Antigens and haptens, factors that dictate immunogenicity. Case Study/Applied Aspect: Pathogens (Microbes, Viruses), Infections and disease development (Microbial and Viral Infections0, Immunity Breakdown.

Unit-II

B cell development and function, antibody formation, structure and effector function. T cell development and function, cytokines and their essential functions, and effects on the immune system. Connections between Innate and Adaptive Immunity. B and T cell epitopes. Structure and distribution of classes and subclasses of immunoglobulins (Ig), Ig fold, effector functions of antibody, antigenic determinants on Ig and Ig super family. Multigene organization of Ig locus, mechanism of VDJ genomic rearrangement, ways of antibody diversification.

Case Study/ Applied Aspect: Use of antibodies in immunological techniques and the principle for a few common immunological techniques- Immunohistochemistry, Immunocytochemistry and privileged sites.

Unit-III

Complement activation by classical, alternate and MB lectin pathway. General organization and inheritance of MHC, structure, distribution and role of MHC class I and class II proteins, pathways of

antigen processing and presentation. Structure and role of T cell receptor, and co receptor, T cell development, generation of receptor diversity, selection and differentiation. General properties of effector T cells, cytotoxic T cells (Tc), natural killer cells; NKT cells and antibody dependent cellular cytotoxicity (ADCC).
Case Study/Applied Aspect: Immunological basis of graft rejection, clinical manifestations, immunosuppressive therapy.

Unit-IV
Mechanism of tolerance, Organ specific and systemic autoimmune diseases, possible mechanisms of induction of autoimmunity, IgE mediated (Type I) hypersensitivity, antibody mediated cytotoxic (Type II) hypersensitivity, immune complex mediated (type III) hypersensitivity and delayed type (Type IV) hypersensitivity.
Case Study/Applied Aspect: Vaccines, Importance and Types of vaccines, active and passive immunization, and Vaccine Development. Strategies in Vaccine development.

Suggested readings:

1. Kuby immunology, Eighth edition.: Punt, Jenni; Owen, Judith A.; Stranford, Sharon A.; Jones, Patricia P.; Kuby, Janis. New York: W.H. Freeman/Macmillan Learning, 2019.
2. Janeway's Immunobiology (2017) 9th ed., Murphy KM and Beaver C, WW Norton and Company, ISBN: 978-0815345510.
3. Roitt's Essential Immunology (2017) 13th ed., Delvis PJ, Martin SJ, Burton DR and Roitt, IM, Wiley-Blackwell, ISBN: 978-1118415771.
4. Textbook of Immunology, 2nd Edition, Mohanty Sunil Kumar, Jaypee Brothers Medical Publishers.

SEMESTER-II

Course title: Recombinant DNA Technology and Applications in Biotechnology Credit: 4
Course code: SIAS BC 13 01 C 3104 Lectures: 60

Course Objective:
The Genetic Engineering helps the students to understand about the cloning strategies, expression pattern, and various techniques involved and their applications in the advancement of Biotechnology

Learning outcomes:

Upon completion of this course, the student will be able to:
- To understand the concept of recombinant DNA technology
- Biology of plasmids, and phages and their uses in different cloning systems
- Different types of DNA libraries and their application to isolate genes
- Designing expression vectors for prokaryotic expression and fundamentals of eukaryotic expression systems

Unit-I
Restriction and Modification systems in *E. coli* and their use in recombinant library constructions-Basic techniques for RDT including Agarose gel electrophoresis, PAGE, Pulse field electrophoresis-Basic Biology of plasmids including their replication, copy number, Incompatibility of Plasmids, and development of Plasmid Vectors. Development of phage and phagemid vectors-Biology of bacteriophage lambda, phage assembly and *in vitro* packaging and development of vectors for different types of Libraries.

Unit-II

Vectors for cloning large fragments of DNA, (Cosmid, PAC, YAC and BAC) and strategies for cloning large DNA Fragments. PCR and its application including cloning of PCR amplified fragments, mutagenesis and construction of Libraries. Basic DNA sequencing methods, Maxam and Gilbert's chemical and Sanger's chain termination methods, and automated DNA sequencing, Introduction to next generation sequencing (NGS)-Polymerase chain reaction and its application in research. Oligonucleotide synthesis, purification, and its application in screening of libraries, cloning and mutagenesis. Real time/quantitative PCR and its applications

Unit-III

Strategies for constructing cDNA libraries and screening using Nucleic acid and antibody probes. Subtractive Libraries, Expression based strategies for cloning of functional genes, Differential mRNA Display-Strategies for constructing Genomic libraries and screening using nucleic acid probes, Gene Expression analysis by Microarray.

Unit-IV

Understanding of Operons Lac, Trp, Arabinose, Tetracycline and their applications in studying biological processes and development of Vectors. Use of Tags to aid solubility and Purification-Vectors and strategies for expressing heterogeneous proteins in *E. coli*, Yeast and mammalian Cells.

Suggested readings:

1. Molecular cloning, A Laboratory Manual Vol. I-III. (Fourth edition), M.R.Green and J. Sambrook (2012) Cold Spring Harbor Laboratory Press.
2. Current Protocols in Molecular Biology. Fred M. Ausubel*et al.* (2015), John Wiley and Sons, Inc.
3. Recombinant DNA: Genes and Genomes: A Short Course. (Third edition), J.D.Watson, (2007) W.H.Freeman and Company.
4. Recombinant DNA, Genes and Genomes – A Short Course (3rd edition). James D. Watson, Richard M. Myers, Amy A. Caudy and Jan Witkowski. (2007). Cold Spring Harbor Laboratory Press.
5. Principles of Genome Analysis and Genomics. (7th edition) S.B. Primrose and R.M. Twyman. (2006) Blackwell Publishing.
6. Gene Cloning and DNA Analysis. T.A. Brown. (2010) Wiley-Blackwell publishing (Oxford, UK).

SEMESTER-II

Course title: Bioinformatics **Credit: 4**
Course code: SIAS BC 12 04 C 3104 **Lectures: 60**

Course objective:

The aim of the course is to enable students to get familiar with a significant number of bioinformatics tools and databases, understand the computational methods behind them, be able to exploit in-depth the capabilities of the tools, implement and competently interpret and present the results of a wide range of bioinformatics analyses, critically discuss the current limitations and design the next generation of tools.

Learning Outcomes

Upon completion of this course, the student will be able to:

- Understand and choose appropriate bioinformatics tools and databases for their investigation
- Perform sequence/structural/functional analysis of biomolecules
- Analyze and interpret omics data
- Get familiar with modelling and simulations in Biology

Unit-1
Introduction to Bioinformatics: Bioinformatics Overview, Bioinformatics Concepts: - Functional Genomics, Comparative genomics, Structural biology, classification of protein structure, Medical information, Objectives of Bioinformatics. Applications, Challenges in Molecular biology, Careers in Bioinformatics, Major databases & tools.

Unit-2
Genomics: Data Mining –ORF, Pubmed, Phylogenetic Analysis, MSA, Gen BANK, COG Cluster, OMIM, Gene Mapping, Sequence Assembly & Expression, Alignment of MS. Proteomics: Visualization & prediction of Protein Structure, Methods used in protein structure prediction, PROSITE, DNA Micro array (DNA chip).

Unit-3
Tools in Bioinformatics: Web based Bioinformatics Applications, Desktop based software, Online Analysis Tools & Servers, PDB, SWISS-PROT, CATH, Annotation Systems-DAS, Homology Tools – BLAST, FASTA, Multiple Alignment-CLUSTALW, Molecular visualization software-Swiss pdb viewer, Rasmol Gene Prediction Software: Genescan, Protein Modelling software-SWISSMODEL.

Unit-4
Computational Biology: Genetic Algorithms, HMMR, Dynamic Programming Algorithm. Local & Global Alignment Algorithm, Needleman- Wunsch Algorithm, Heuristic Algorithm like BLAST, FASTA-Multiple Segment Alignment Algorithm, Protein secondary structure prediction Algorithm.

Suggested Readings:

1. Essential Bioinformatics (2006) 1st ed., Xiong J, Cambridge University Press, ISBN 13: 978-0521600828.
2. Fundamental concepts of Bioinformatics (2003) Krane DE and Raymer ML Pearson, ISBN:978-8177587579.
3. An Introduction to Bioinformatics (2017)1sted., KnightR, Larsen and Keller Education, ISBN:978-635490459.
4. Concepts of Bioinformatics and Genomics (2016) 1st ed., Momand J, McCardy A, Heubah, S and Warter-Perez N, Oxford University Press, ISBN:978-0199936991
5. Introduction to MATLAB for biologists (2019)., Webb, Cerian Ruth, Domijan, Mirela. Springer. ISBN-978-3-030-21337-4

SEMESTER-II

Course title: Practical Skills in Biochemical Techniques **Credit: 5**
Course code: SIAS BC 12 05 SEC 00105 **Lectures: 150**

Course objective: To train students a variety of experimental concept designed to complement the lectures different courses of the semester.

Learning Outcomes

Upon completion of this course, the student will be able to:

- Get hands on training for bacterial cell culture
- learn polyacrylamide gel electrophoresis for detection of proteins, their visualization by different staining methods
- Separate amino acids by paper and thin layer chromatography

- Get hand on training on plant tissue culture technology

Experiments:

1. Determination of Km and Vmax using Lineweaver-Burk graph.
2. Separation of amino acids/ protein by column/ paper chromatography.
3. Ammonium sulphate fractionation and enzymatic assay of purified enzyme.
4. SDS-PAGE analysis of proteins.
5. Western blot / ELISA analysis of the proteins using antibodies
6. To prepare bacterial competent cells using $CaCl_2$ method.
7. To isolate pure colony of bacteria from soil sample by serial dilution and spreading method.
8. Determine the Gram stain of bacterial sample.
9. Preparation of MS (Murashige& Skoog) medium and inoculation of explant.
10. Live and dead cell assay by trypan blue method.
11. Here we should include plasmid isolation and expression of proteins in E.coli.

Suggested readings:

1. An Introduction to Practical Biochemistry (2017) 3rd ed., Plummer D, Tata McGraw Hill Education ISBN:978-0070994874.
2. WilsonandWalker'sPrinciplesandTechniquesofBiochemistryandMolecularBiology (2018) 8th ed., Hoffmann A and Clokie S, Cambridge University Press, ISBN: 978- 1108716987.
3. Physical Biochemistry: Principles and Applications (2016) 2nded., Sheehan, D, Wiley India, ISBN:978-8126564842.
4. Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1983)2nd ed., Freifelder D, WH Freeman and Company (New York), ISBN: 978-0716714446.
5. Biophysical Chemistry: Principles and Techniques (2016) 4thed., Upadhyay A Upadhyay K and Nath N, Himalaya Publishing House, ISBN:978-9351422273.

SEMESTER –II

Course title: Cell Culture Technology **Credit: 4**
Course code: SIAS BC 12 01 DCEC 3104 **Lecture: 60**

Course objectives: Objective of this course is to familiarize the student with concepts of cell and tissue culture technology in both animals and plants.

Learning outcomes:

Upon completion of this course, the student will be able to:

- Understand the basics of plant and animal cell culture
- Get an in-depth knowledge about growing the animal cells *in vitro* to get cell mass, tissues, and their applicability examples
- learn the mass propagate the plants *in vitro* and how to raise virus free, pest resistance, new variety of plants etc.
- Understand application of cell culture in industries and research labs

Unit-I

Animal cell culture: History, biology of cultured cells, culture media-composition, preparation and development, cell isolation, establishment and evaluation of cell culture, sterilization techniques for ATC lab. Animal cell lines: Establishment, properties and use of cell lines, cultures of tumor cells; Cryopreservation of animal cells.
Culture and scale up: Monolayer culture-surface requirements, gas phase requirements, capillary culture units, suspension culture scale up. Somatic cell fusion: Methods of somatic cell fusion, selection, properties of cell hybrids and their applications.

Unit- II
Animal cloning and embryo transfer: Superovulation, *in vitro* fertilization, embryo transfer technology in animals; Concepts and techniques of cloning.
Applications: Industrial applications of animal cell culture; Stem cell culture and its applications.

Unit- III
Plant tissue culture: History of plant cell culture, culture media-composition, preparation and development, cellular totipotency, cryopreservation. Callus and cell culture: Isolation of cells, growth of single isolated cells. Suspension culture: Regeneration and maintenance of callus, organogenesis and embryogenesis.

Unit-IV
Organ culture: Meristem culture, embryo culture and embryo rescue, anther culture, virus free plant production and haploid plant production, production of synthetic seed, micropropagation. Protoplast culture and fusion: Isolation of protoplasts, culture and regeneration; fusion ofprotoplasts, selection of fusion products of protoplasts; Cybrids. Somaclonal variation, plant transformation-*Agrobacterium* mediated and particle gun mediated, secondary plant metabolites and application of plant biotechnology in crop improvement.

Suggested readings:

1. Culture of animal cells: A manual of Basic Technique, 5th edition (2005). Freshney R. Ian, Willey-Liss Publisher.
2. Tissue Engineering: Essential for Daily Laboratory Works, Minuth W.W., Strehl R., Schumacher K., Willey Publisher (2005).
3. Plant Biotechnology, H. S. Chawla, Oxford and IBH, 2009
4. Plants, Genes and Crop Biotechnology 2nd Edition, Chrispeels, M.J. &Sadava D.E. American Society of Plant Biologists, Jones and Bartlett Publishers, USA (2003).
5. Plant Biotechnology, B D Singh. Kalyani publisher, 2003
6. Agricultural Biotechnology, Arie Altman. Marcel Dekker, Inc. (2001).
7. Biochemistry and Molecular Biology of Plants, Buchanan B.B., Gruissem W, and Jones RL (2000)

SEMESTER –II

Course title: Biochemical Toxicology **Credit: 3**
Course code: SIAS BC 12 02 DCEC 4004 **Lecture: 35**

Course Objective: To acquire knowledge, understand and develop an understanding of the kinds of toxicant interactions, their impact on human health.

Learning outcome:
Upon completion of this course, the student will be able to:
- Understand different types of toxins their biological process and effects on various organs/ systems

of the human body

- Be aware of dose absorption, excretion of the toxic components
- Understand impact of toxin on renal, liver, neural systems
- Identify underlying susceptibility factors which contribute to the ability of chemicals to elicit bio effects which contribute to human disease.

Unit I

Definition and scope of toxicology and Biochemical toxicology, Sources and classes of toxicants; air, water and soil pollutants, food additives and contaminants, Toxic effects of Persistent organic pollutants (POPs), dioxins, drugs and Pesticides and their biochemical mode,

Unit II

Toxicokinetics; absorption, distribution, excretion, and biotransformation of toxicants, Metabolism of toxicants; xenobiotic metabolism and biological consequences of Phase I and Phase II reactions, role of cytochrome P450 in Phase I monooxygenations and types of Phase II metabolic conjugations,

Unit III

Factors affecting metabolism of toxicants; Chemical, physiological and environmental, Different routes of elimination of toxication; exhalation (lung), renal and hepatic routes. Hepato and renal toxicology; basic principles and specific examples.

Unit IV

Genetic poisons; DNA damage agents, chemical carcinogenesis and trace element toxicity and their toxic mechanism, Bone marrow toxicity: benzene as a case study, Neurotoxicology, Metal toxicology: mercury, cadmium, Nanoparticle toxicology.

Suggested Readings:

1. Molecular and Biochemical Toxicology. Robert C. Smart, Ernest Hodgson (2018) Wiley publications.
2. Introduction to toxicology. John A. Timbrell (1889) Taylor and Francis.
3. Principles of Biochemical Toxicology. John A. Timbrell (4th Edition) CRC Press.
4. Introduction to Biochemical Toxicology. Ernest Hodgson, Robert C. Smart (3rd Edition) Wiley inter-science.

SEMESTER –II

Course title: Biostatistics **Credit: 4**
Course code: SIAS BC 12 03 DCEC 3104 **Lecture: 60**

Course Objective:
To introduces selected important topics in biostatistical concepts and reasoning. Specific topics include tools for describing central tendency and variability in data; methods for performing inference on population means and proportions via sample data; statistical hypothesis testing and its application to group comparisons.

Learning outcome:
Upon completion of this course, the student will be able to:

- Recognize and give examples of different types of data arising in public health and clinical studies.
- Interpret differences in data distributions via visual displays.

- Calculate and interpret confidence intervals for population means and proportions.
- Understand and interpret results from Analysis of Variance (ANOVA), a technique used to compare means amongst more than two independent populations

Unit-1

Looking at your data, Types of Data, Tables & Graphs, Central tendency & dispersion Probability, Bayes Theorem, Sensitivity &Specificity, Odds Ratio & Relative Risk

Unit-2

Distributions: Binomial distribution, Poisson distribution, Normal distribution, Central Limit Theorem, Standard scores/z-scores, Statistical inference: Samples and populations, Power, Confidence intervals, p-values, Type I & II error, One and two groups (continuous outcomes): One-sample population mean, Paired sample t-test, Independent samples t-test

Unit-3

Contingency Tables, comparing more than two groups (continuous outcomes): One-way ANOVA, Two-way ANOVA, Comparing two groups (categorical outcomes): Chi-square test, McNemar'stest.

Unit-4

Correlation, Linear Regression, Multiple predictor variables, multiple regression, Logistic regression, Non-parametric Tests, Sign test, Wilcoxon test, Kruskal-Wallis test, Rank correlation, Survival Analysis: Common terms, Cox regression analysis, Tree-structure models

Suggested Readings:

1. Understanding advanced statistical methods. Westfall, P., & Henning, K. S. (2013). CRC Press.
2. Biostatistics for the biological and health sciences. Triola, M. M., &Triola, M. F. (2006). Boston: Pearson Addison-Wesley.
3. The analysis of biological data. Whitlock, M. C., & Schluter, D. (2009). Greenwood Village, CO: Roberts and Company Publishers.
4. Applied Biostatistics for Health Sciences, Rossi R.J. (2010). Wiley.
5. Medical Statistics-Principles & Methods, Sundaram, K.R. (2010) BI Publications, New Delhi.

SEMESTER-III

Course title: **Genomics and Proteomics** **Credit: 4**
Course Code: SIAS BC 13 01 C 3104 **Lectures: 60**

Course Objective
This course is designed

- To introduce and teach basic concepts and advanced techniques employed in genomics and proteomics.
- To introduce genomic and proteomics techniques employed in understanding cellular function and also in Industrial application for producing therapeutic molecules.
-

Learning Outcome:

- Upon completion of this course, the student will be able to:
- Understand basic concepts of high throughput genomics and proteomics techniques
- Understand the genomic manipulation techniques and designing recombinant molecules
- Understand different platforms employed in next generation genome sequencing and acquire the ability to perform nucleic acid and peptide sequencing
- Understand the strategies employed for studying protein-protein interactions, protein expression including antibody gene cloning and protein engineering

Unit-I
Concept of Genomics-Mutagenesis, Regulated vectors for controlled expression of multiple genes to study gene function in different hosts. Recombinant DNA strategies to study protein interactions. (Yeast 2-hybrid system, Phage display, Protein fragment complementation). Determining the Function of Individual genes (Gene deletion, over-expression and complementation, Genome-wide insertional mutagenesis).

Unit-II
Fundamentals of Whole-Genome Sequencing. Sequencing of Phage, Viral and Bacterial Genomes, Human Genome sequencing, and comparative genomics. High throughput genome-wide cloning and protein expression strategies and applications. Antibody gene cloning and engineering, humanization and Human antibodies.

Unit-III
Introduction to proteome, proteomics technology, types and kinds of proteomics investigation, importance of proteomics. Principles and applications of the separation technology (Electrophoresis, Centrifugation, Chromatography) in proteomics. Mass spectrometry (Ionizers, analyzers and detectors) technology and its application in proteomics.

General workflow for the 2-D Gel Electrophoreses, sample preparation, evolution of 2D PAGE, experimental details for the 2-D gel and high throughput 2-D PAGE. Application of two-dimension gel electrophoreses in proteomics and biomarker discovery. Importance of 2-D fluorescence difference gel electrophoresis for comparative proteomics.

Unit-IV
Proteomic profiling for host-pathogen interaction. Sample treatment for labeling, 2D LC-MS/MS analysis, database search and relative quantification, analysis and interpretation, quantitative proteomics. Protein-Protein Interaction (PPI) and its application in proteomics. Methods to study PPI. Application of proteomics for drug discovery. Biomarkers and drug targets identification. Validation of drug targets and assessment of its toxicology.

Case Studies /Tutorials:

(i) Strategies for large-scale expression of recombinant proteins in heterogonous hosts. Purification and downstream processing to produce Therapeutic grade recombinant proteins and regulatory aspects.
(ii) Microarray techniques for DNA, Proteins and Antibodies. Global expression profiling
(iii) Cellular Engineering.

Suggested Readings:

1. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010) 4th ed., Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC).
2. Protein-Protein Interactions: A Molecular Cloning Manual. Erica Golemis and Peter D. Adams (2005) Cold Spring Harbor Laboratory Press,
3. Molecular cloning, A Laboratory Manual Vol. I-III. (Fourth edition), M.R.Green and J. Sambrook (2012) Cold Spring Harbor Laboratory Press.
4. Current Protocols in Molecular Biology. Fred M. Ausubel*et al.* (2015) John Wiley and Sons, Inc.
5. Recombinant DNA, Genes and Genomes – A Short Course (3rd edition). James D. Watson, Richard M. Myers, Amy A. Caudy and Jan Witkowski. (2007). Cold Spring Harbor Laboratory Press.
6. Principles of Genome Analysis and Genomics. (7th edition), S.B. Primrose and R.M. Twyman. (2006) Blackwell Publishing.

SEMESTER-III

Course title: Clinical Biochemistry **Credit: 4**
Course code: SIAS BC 13 02 C 3104 **Lectures: 60**

Course objective: The objectives of this course are to demonstrate how basic biochemistry and analytical chemistry can be applied to medical diagnosis, treatment and management.

Learning outcomes:

Upon completion of this course, the student will be able to:

- Clinically assess the laboratory indicators of physiologic conditions and diseases
- Understand the etiology, findings and management of diabetes, phenylketonuria.
- Understanding the biochemical and molecular tools needed to accomplish diagnostic, and therapeutic intervention on hereditary and acquired disorders
- Describe and explain the diseases of the major organs and systems, organ functional tests for diagnosis and management

Unit-I

Introduction to laboratory principles and instrumentation in Clinical Biochemistry. Biological samples - types, collection, processing, stability and storage; phlebotomy; serum and serum separator devices; chemical composition of biological fluids - blood, urine and cerebrospinal fluid; reference ranges. Quality assurance; accuracy and precision; factors influencing the accuracy of results

Unit-II

Disorders of Metabolism: Diabetes mellitus; Ketone bodies; Glycogen storage diseases; Galactosemia. Diagnostic tests for apolipoproteins, HDL cholesterol, LDL-cholesterol and triglycerides disorders. Phenylketonuria, homocystineuria, tyrosinemia and related disorders, aminoacidurias.

Unit-III

Electrolytes, Blood Gases and Acid Base Balance: Electrolytes, blood gases, respiration, acid-base balance and acid-base disorders, respiratory and renal mechanism of acid balance disorders. Disorders of Mineral Metabolism: Hypercalcemia, hypocalcemia, normocalcemia, hypophosphatemia, hyperphosphatemia.

Unit-IV

Organ function tests clinical presentation and diagnosis of the diseases of the liver and kidney; bilirubin metabolism; acid base disorders; Genetic Information about diseases - Oncogenes

and cancer, inborn errors of metabolism.

Suggested readings:

1. Clinical Biochemistry (2018) 6th Edition. Murphy M, Srivastava R and Deans K, Elsevier, ISBN:978-0702072987.
2. Clinical Biochemistry: Metabolic and Clinical Aspects (2014) 3rd Edition. Marshall WJ, Churchill Livingstone, ISBN: 978-0702051401.
3. Clinical Biochemistry (Lecture Notes) (2017) 10th Edition. Rae P, Crane M and Pattenden R, Wiley-Blackwell, ISBN:111924868X.
4. Lecture Notes: Clinical Biochemistry (2010) 8th Edition. Becket G, Walker SW, Race Pand Ashby P, Wiley-Blackwell, ISBN: 978-1405193054.
5. Principles of Medical Biochemistry (2016) 4th Edition. Meisenberg G and Simmons WH, Elsevier, ISBN: 978-03232 96168.
6. Tietz Fundamentals of Clinical chemistry and Molecular diagnostics. (2014) 7th Edition. Burtis CA and Bruns DE, Elsevier, ISBN: 978-8131238851.

SEMESTER-III

Course title: Plant Biochemistry **Credit: 4**
Course code: SIAL BC 1 3 08 C 4004 **Lectures: 60**

Course objective: The course is intended for students in the plant sciences. This course will provide students with fundamental knowledge of biochemistry and specific knowledge of compounds and biochemical pathways that occur in plants.

Learning outcomes:
Upon completion of this course, the student will be able to:

- Understand plant cell structure, organization, and apply specific biochemical functions to all compartments of the plant cell
- Learning the structure, function and biosynthetic pathways of essential biochemical molecules including their key chemical and physical properties
- Describe the biochemistry of plant growth and development
- Understand stress metabolism mechanisms that operate in plants in various stress conditions

Unit-I
Photosynthesis &Carbon Assimilation-Photosynthesis – Light and dark reactions, Emerson effect. Photo systems – mechanism of pigment excitation, types of pigments, Photophosphorylation – Calvin-Benson Cycle, Hatch and Slack pathway, Calvin cycle and regulation; C4 cycle and crassulacean acid metabolism (CAM), photorespiration.

Unit-II
Nitrogen metabolism-Biological nitrogen fixation by free living and in symbiotic association, structure and function of enzyme nitrogenase. Nitrate assimilation: nitrate and nitrite reductase. Primary and secondary ammonia assimilation in plants; ammonia assimilation by glutamine synthetase-glutamine oxoglutarate amino transferase (GS-GOGAT) pathway.

Unit-III
Secondary metabolites-Representative alkaloid group and their amino acid precursors, function of alkaloids, Examples of major phenolic groups; simple phenylpropanoids, coumarins, benzoic acid

derivatives, flavonoids, tannins and lignin, biological role of plant phenolics, classification of terpenoids and representative examples from each class, biological functions of terpenoids.

Unit-IV

Stress physiology-Reactive oxygen species and their generation, enzymic and non-enzymic components of antioxidative defence mechanism. Genetic basis of pathogen resistance, Responses of plants to biotic (pathogen and insect) and abiotic (water, temperature and salt) stresses; mechanism of resistance to abiotic stress.

Suggested readings:

1. Plant Biochemistry: Concepts and Applications (2018), Granger TC, ISBN: 9781632399878.
2. Biochemistry and Molecular Biology of Plant (2015) 2nd ed., Buchanan BB, Gruissem W and RusseL LJ, Wiley-Blackwell. ISBN: 978-0470714218.
3. Plant Biochemistry (2013) 3rd ed., Walter HH, cbspd, ISBN-13: 978-8131200032.
4. Outlines of Biochemistry (2006) 5th ed., Conn EE, Stumpf PK, Bruening G and Roy HD, Wiley, ISBN: 978-8126509300.
5. Fundamentals of Plant Physiology (2018) 6th ed., Taiz L, Zeiger E, Møller IM and Murphy A, Sinauer Associates Inc, ISBN: 978-1605357904.

SEMESTER-III

Course title: Practical Skills in Advanced Biochemistry **Credit: 5**
Course code: SIAS BC 13 05 SEC 00105 **Lectures: 150**

Course objectives: To train students a variety of experimental concept designed to complement the lectures different courses of the semester.

Learning outcomes:

Upon completion of this course, the student will be able to:

- Isolate DNA from various sources – viz plant, microbes and animals
- Quantify RNA and DNA using spectrophotometry
- Isolate and quantify the clinically important molecules like glucose, triglycerides, bilirubin from blood
- Understand the optimal conditions essential for protein/nucleic acid separation and purification

Experiments:

1. Genomic DNA isolation from plant/bacteria/animal
2. Qualitative and quantitative analysis of DNA.
3. Preparation of culture media
4. Bacterial culture: establishing a pure culture; identification of bacteria; staining techniques; antibiotic sensitivity of bacteria
5. Isolation of plasmid DNA
6. Restriction digestion of plasmid by restriction endonucleases and separation of restriction fragments by agarose gel electrophoresis
7. Isolation of RNA and separation on agarose gel
8. Quantitative estimation of RNA.

9. Polymerase chain reaction.
10. Estimation of blood glucose.
12. Estimation of triglycerides, bilirubin and urea in blood serum

Suggested readings:

1. An Introduction to Practical Biochemistry (2017) 3rd ed., Plummer, D, Tata McGraw Hill Education ISBN 13: 978-0070994874.
2. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology (2018) 8th ed., Hoffmann, A and Clokie, S, Cambridge University Press, ISBN 13: 978-1108716987.
3. Physical Biochemistry: Principles and Applications (2016) 2nd ed., Sheehan, D, Wiley India, ISBN 13; 978-8126564842.
4. Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1983) 2nd ed., Freifelder, D, WH Freeman and Company (New York), ISBN 13; 978-0716714446.
5. Biophysical Chemistry: Principles and Techniques (2016) 4th ed., Upadhyay, A Upadhyay, K and Nath N, Himalaya Publishing House, ISBN 13: 978-9351422273

SEMESTER-III

Course title: Cancer Biology **Credit: 4**
Course code: SIAS BC 13 01 DCEC 3104 **Lecture: 60**

Course objectives: To provide an understanding of basic knowledge of cancer

Learning outcome

Upon completion of this course, the student will be able to:

- Have an in depth understanding of the molecular and cellular mechanisms that lead to cancer
- Describe the fundamental mechanistic principles behind cancer diagnosis and prevention
- Know the basic principles behind personalized medicine and therapeutic cancer management
- Have an overview of advanced methodologies used in cancer research

Unit I

Normal vs Cancer cell. Characteristics of cancer and cancer cells. Sign and symptoms of cancers. Risk factors of cancer - Life style and dietary factors. Benign and malignant tumors. Types of cancers. Epidemiology of breast, cervical, oral and lung cancers.

Unit II

Carcinogenesis: Carcinogens and carcinogenesis. Environmental carcinogens. Oxidative stress and Cancer. Concept of tumor suppressor and oncogenes. Pathology: Tumor formation - Initiation, promotion, and progression. Spread of cancer cells. Biology of cell death. Common myths and misconceptions of cancer.

Unit III

Prediction and Diagnosis: Clinical examination - Blood Tests, Pap smear test and Biopsy. Radiological examination - Xrays, CT scan, MRI and Mammography. Applications of Computational tools in cancer prediction.

Unit IV

Prevention and therapy: General principles of cancer therapy. Biomedical applications of nanotechnology

in cancer prevention. Concept of cancer vaccine. Antioxidants and dietary fiber in cancer prevention. Complementary therapy – Yoga and meditation.

Suggested Readings:

1. Molecular Pathology and Diagnostics of Cancer (Cancer Growth and Progression), Domenico Coppola, Springer.
2. An Introduction to Cellular and Molecular Biology of Cancer, Oxford Medical publications.
3. The Biology of Cancer, 2nd Ed. Janice Gabriel, John Wiley & Sons Ltd.,
4. Cancer Biology, 4th Ed. Raymond W. Ruddon, Oxford University Press, Inc.,
5. Introduction to Cancer Biology, Momna Hejmadi, Ventus Publishers.
6. Molecular Biology of Human Cancers, Wolfgang Arthur Schulz, Springer Science, Business Media, Inc.

SEMESTER-III

Course title: Molecular Diagnostics **Credit: 4**
Course code: SIAS BC 13 04 DCEC 3104 **Lectures: 60**

Course Objectives

This course is designed

- To introduce principles and concepts of various equipment's and instruments utilized in molecular diagnosis of various human diseases.
- To teach techniques that improve the ability to diagnose a number of diseases by enabling identification of many human pathogens that had previously been difficult to detect due to their low concentration.

Learning Outcome:

Upon completion of this course, the student will be able to:

- Understand the basic principles and get familiarise with the equipment, instruments commonly used in molecular diagnostics
- Understand basic of macromolecules and techniques employed to detect the levels of nucleic acids and proteins
- Understand the overview of non-infectious diseases like life-style disorders and tumorigenesis and the molecular diagnostic techniques employed to detect and analyze them
- Understand the overview of various infectious diseases caused by bacteria and virus and the molecular diagnostic techniques employed to detect and analyze them

Unit -I

Serological and Molecular diagnostics: Lab management, handling of spectrophotometer, water baths, pipettes, calculation of optimum pH, Temperature, Preparation and handling of reagents for enzyme assay, Overview of serological tests, commonly used serological diagnosis/ and tests, Diagnosis of Blood and Urine samples, Enzyme assays, Benefits of molecular diagnostics over serological diagnostics tests.

Unit -II

Role of molecular diagnostics in present diagnostic area: Basic techniques used in molecular diagnostics, future of molecular diagnostics, Overview of Macromolecules, Polyacrylamide gel electrophoresis (PAGE) and SDS- PAGE, Qualitative and quantitative determination of RNA and DNA, Standard curve preparation of DNA & RNA, Isolation of DNA, Agarose gel electrophoresis, Polymerase chain reaction. Antigen Antibody assay, ELISA tests, Immuno- electrophoresis.

Unit -III

Diagnosis of Non-infectious Diseases: Diagnosis of Lifestyle disorder- Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/Kit

Diagnosis of Tumours-Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray, PET, MRI and CT scan (using photographs). Molecular diagnosis of tumorigenesis types of tumor.

Unit -IV

Diagnosis of Infectious Diseases: Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis Molecular diagnostics of bacterial infections-*Mycobacterium tuberculosis*, Staphylococci, *Schwenella typhus*, Pathogenic *E.coli*, sample preparation and pathogen detection. Prenatal diagnostics of various genetic disorders.

Molecular diagnostic of various viral diseases- HIV type -1, HIV type –II, HPV, Various hepatitis strains, Influenza (H1N1), sample preparation, various steps required for viral infection analysis and Viral load monitoring,

Suggested readings:

1. Preventive and Social Medicine, Park, K. (2007), B.B. Publishers
2. Textbook of Medical Laboratory Technology, II Godkar P.B. and Godkar D.P. Edition, Bhalani Publishing House
3. A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses, Cheesbrough M.,
4. Textbook of Medical Physiology, Guyton A.C. and Hall J.E. Saunders
5. Pathologic Basis of Disease, VIII Edition, Robbins and Cortan, Saunders
6. Lab Manual on Blood Analysis and Medical Diagnostics, Prakash, G. (2012), S. Chand and Co. Ltd.

SEMESTER-III

Course title: Human Health and Diseases **Credit:4**

Course code: SIAS BC 13 04 DCEC 3104 **Lectures:60**

Course objective: To acquire knowledge on different diseases of humans and their management.

Learning outcomes:

Upon completion of this course, the student will be able to:

- Be aware of energy requirements for humans, malnutrition disorders in children and role of vitamins and minerals in maintaining health
- Understanding basic concept of life style disease, hormonal imbalance, autoimmune disease and viral diseases
- Assess pathophysiology, risk factors and clinical manifestation of diseases related to nutrition
- Gain insights about the current lifestyle as a consequence of industrialization

Unit I

Inborn errors of metabolism, Nutritional deficiency based diseases: Alkaptonuria, Phenylketonuria, SCID, Clotting disorders. Kwashiorkar, Marasmus, Beri-beri, Scurvy, Pellagra, Anaemia, Night blindedness, Rickets, Osteomalacia, Osteoporosis, Wilson's disease.

Unit II

Life style diseases, Hormonal Imbalances: Obesity, Cardiovascular diseases, Atherosclerosis, Diabetes mellitus-II. Inflammatory Bowel Disease (IBD). Outline of hormone action and imbalances leading to disease – precociouspuberty, hyper and hypopituitarism. Hyper and hypothyroidism.

Unit III

Autoimmune diseases, Diseases caused due to misfolded proteins: Concepts in immune recognition - self and non-self-discrimination, organ specific autoimmune diseases – Hashimoto's thyroiditis, Grave's disease, Myasthenia Gravis; Systemic diseases - SLE, rheumatoid arthritis; Diabetes Mellitus-I. Alzheimer's, Huntington's disease, Kuru, Creutzfeldt-Jakob disease, Sickle cell anemia, Thalassemia.

Unit IV

Infectious diseases: Viral infection (polio, measles, mumps, influenza, HIV); Bacterial infections (tetanus, diphtheria, tuberculosis, typhoid, cholera); Protozoan (*Plasmodium* and *Trypanosoma*) and parasitic infections. Vaccines against diseases. General strategies in the design and development of vaccines.

Suggested readings:

1. Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
2. Immunology: A Short Course (2009) 6th ed., Coico, R and Sunshine, G., John Wiley& sons, Inc (New Jersey), ISBN: 978-0-470-08158-7
3. Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J.L. and Stryer, L., W.H Freeman and Company (New York), ISBN: 13:978-1-4292-7635-1.
4. Genetics (2012) 6th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2.

SEMESTER-III

Course title: Clinical Biochemistry **Credit:4**
Course code: SIAL BC 1 3 01 GEC 4004 **Lectures: 60**

Course objective: The objectives of this course are to demonstrate how basic biochemistry and analytical chemistry can be applied to medical diagnosis, treatment and management.

Learning outcomes:

Upon completion of this course, the student will be able to:

- Clinically assess the laboratory indicators of physiologic conditions and diseases
- Understanding the biochemical and molecular tools needed to accomplish diagnostic, and therapeutic intervention on hereditary and acquired disorders
- Understanding the importance of quality control and assurance to diagnostic work
- Illustrate, compare and appreciate functions and biochemical attributes of Liver and Implications in Clinical Biochemistry

Unit-I

Clinical Biochemistry - concept, definition and scope; biological samples - types, collection, processing, stability and storage; phlebotomy; chemical composition of biological fluids and its importance - blood, urine and cerebrospinal fluid; reference ranges.

Unit-II

Quality assurance; accuracy and precision; factors influencing the accuracy of results; Levy-Jennings's chart; reliability of a laboratory method; interferents.

Unit-III

Biochemical tests in clinical practice–characteristics and uses of a biochemical test; Investigation of disorders of carbohydrate metabolism- Hypoglycemia, Hyperglycemia. Diabetes mellitus; enzymes as diagnostic tool; advantages and disadvantages of enzyme assays; isozymes and their diagnostic importance; methods for the detection of isoenzymes.

Unit-IV

Organ function tests clinical presentation and diagnosis of the diseases of the liver and kidney; bilirubin metabolism; acid base disorders; Genetic Information about diseases - Oncogenes and cancer, inborn errors of metabolism.

Suggested readings:

1. Clinical Biochemistry (2018) 6thed., Murphy M, Srivastava R and Deans K, Elsevier, ISBN:978-0702072987.
2. Clinical Biochemistry: Metabolic and Clinical Aspects (2014) 3rded., Marshall WJ, Churchill Livingstone, ISBN: 978-0702051401.
3. Clinical Biochemistry (Lecture Notes) (2017) 10thed., Rae P, Crane M and Pattenden R, Wiley-Blackwell, ISBN:111924868X.
4. Lecture Notes: Clinical Biochemistry (2010) 8thed., Becket G, Walker SW, Race PandAshby P, Wiley-Blackwell, ISBN: 978-1405193054.
5. Principles of Medical Biochemistry (2016) 4thed., Meisenberg G and Simmons WH, Elsevier, ISBN: 978-03232 96168.
6. Tietz Fundamentals of Clinical chemistry and Molecular diagnostics. (2014) 7thed.,Burtis CA and Bruns DE, Elsevier, ISBN: 978-813123885
7. Textbook of Biochemistry with Clinical Correlation. Thomas M. Devlin. Wiley, 2019

Course title: Analytical Techniques **Credit: 4**
Course code: SIAL BC 1 3 02 GEC 4004 **Lecture: 60**

Course objective: To provide an advanced understanding of the core principles of various techniques used in biological experiments.

Learning outcomes:

Upon completion of this course, the student will be able to:

- Demonstrate principles of various basic and advanced techniques used in biological experiments

- Critically analyses and interpret the results obtained from biological experiments
- Learn basics and application of many types of microscopy and its application in research
- Acquire knowledge about the basics and latest developments in the instrumentation techniques of Centrifugation, Electrophoresis (IEF, 2D PAGE), Chromatography, NMR and Mass spectrometry along with their applications in various research fields

Unit-I

Microscopy; principle, resolving, magnification power and application of compound microscopy, Fluorescence microscopy, phase contrast microscopy, fixation and staining, freeze fracture/etch techniques.

Unit-II

Agarose gel electrophoresis, polyacrylamide gel electrophoresis (native and SDS-PAGE), iso-electric focusing (IEF), 2-Dimensional gel electrophoresis, principle and applications of centrifugation, differential centrifugation, density gradient centrifugation, and ultracentrifugation.

Unit-III

Principle and types of Chromatography; paper chromatography, thin layer chromatography (TLC), column chromatography, principle and applications, High performance liquid chromatography (HPLC) and gas liquid chromatography (GLC). Radioactivity, autoradiography, Safety measures of radioisotope handling.

Unit-IV

Beer-Lambert's Law, principle and instrumentation of UV-visible, NMR spectroscopy, X-ray diffraction spectroscopy,mass spectrometry (MS), electrospray ionization mass spectrometry (ESI-MS), MALDI, tandem MS for protein identification, Circular Dichroism (CD), N-terminal sequencing and peptide synthesis, EMSA, foot printing, ELISA.

Suggested readings:

1. Principles and Techniques of Biochemistry and Molecular Biology (2018) 8th ed. Wilson K and Walker J, Cambridge University Press, ISBN No. 131661476X.
2. Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D., Wiley Blackwell (West Sussex), ISBN: 978-0-470-85602-4 / ISBN: 978-0-470-85603-1.
3. Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982) 2nd ed., Freifelder D, W.H. Freeman and Company (New York), ISBN:0-7167-1315-2 /ISBN:0-7167-1444-2.
4. Principles of Instrumental Analysis (2018) 7th ed., Douglous A. Skoog, F. James Holler, Stanley R Crouch, Singapore: Cengage Learning Asia Pte Ltd.

SEMESTER-IV

SEMESTER-IV

Course title: Presentation and Research Skills **Credit: 3**
Course code: SIAS BC 1 4 01 SEC 0003 **Lectures: 45**

Course objectives:

- To provide knowledge about tools and techniques related with scientific communication and research methodology.
- To impart knowledge on scientific writing skills

Learning outcomes:

- Understanding the existence of scientific knowledge in ancient times
- Acquiring the skills of scientific reading, writing and presentations
- Appreciating the scientific ethics through case studies

This course is aimed for interactive group discussion on presentation and research skills. Seminar will be of 45-minute duration during which the presentation will be followed by questions session by the audience comprising of faculty and students. Every student shall be required to submit the topic of his/her seminar in consultation with the Head of the Department/Faculty members/student advisors well in advance so that the same may be displayed on the notice board. The presenter has to write an Abstract to be distributed during Seminar in addition to two copies of write-up giving relevant details of the background of the subject, methods used and references/List of sources from where the material for presentation has been collected.

SEMESTER-IV

Course title: Dissertation **Credit: 22**
Course code: SIAL BC 1 4 01 SEC 0022

Learning outcomes:

Upon completion of this course, the student will be able to:

- Nurture their scientific capabilities
- Define their own research questions; simultaneously experiencing the process of producing knowledge
- Identify own areas of interest with in depth exploration
- consolidate communication, information-seeking and intellectual skills

Guidelines for Project File

Research experience is as close to a professional problem-solving activity as anything in the curriculum. It provides exposure to research methodology and an opportunity to work closely with a faculty guide. It usually requires the use of advanced concepts, a variety of experimental techniques, and state-of-the-art instrumentation.

Research is genuine exploration of the unknown that leads to new knowledge which often

warrants publication. But whether or not the results of a research project are publishable, the project should be communicated in the form of a research report written by the student.

Sufficient time should be allowed for satisfactory completion of reports, taking into account that initial drafts should be critiqued by the faculty guide and corrected by the student at each stage.

The file is the principal means by which the work carried out will be assessed and therefore great care should be taken in its preparation.

In general, the File should be comprehensive and include

- A short account of the activities that were undertaken as part of the project;
- A statement about the extent to which the project has achieved its stated goals.
- A statement about the outcomes of the evaluation and dissemination processes engaged in as part of the project;
- Any activities planned but not yet completed as part of the project, or as a future initiative directly resulting from the project;
- Any problems that have arisen that may be useful to document for future reference.
- The guidelines and format for dissertation is given below:

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Dissertation Guidelines

1. GENERAL:

The manual is intended to provide broad guidelines to the M.Sc. candidates in the preparation of the dissertation report. In general, the project report shall report in an organized and scholarly fashion an account of original research work of the candidate leading to the discovery of new facts or techniques or correlation of facts already known.

2. NUMBER OF COPIES TO BE SUBMITTED:

Students should submit three copies to the Head of the Department concerned on or before the specified date.

3. ARRANGEMENT OF CONTENTS OF DISSERTATION:

Dissertation material should be arranged as follows:

1. Cover Page &Title page
2. Declaration
3. Certificate
4. Abstract (Hindi and English)
5. Acknowledgements
6. Table of Contents
7. List of Tables
8. List of Figures
9. List of Symbols, Abbreviations and Nomenclature (Optional)
10. Chapters
11. References
12. Appendices
13. One page CV

The Tables and Figures shall be introduced in the appropriate places.

4. PAGE DIMENSIONS ANDMARGIN:

The dimensions of the dissertation should be standard A4 size paper may be used for preparing the copies, **standard margin** with 1.5 line spacing.

5. MANUSCRIPTPREPARATION:

The general text of thesis shall be typed in font style Times New Roman and font size 12. Same quality of paper should be used for the preparation of the entire report/thesis; except figure, photos are shown.

Cover Page & Title Page - A specimen copy of the Cover page & Title page for report/thesis are given in Annexure I.

Certificate-The Bonafide Certificate as per the format shown in Annexure II

Abstract: Abstract should be an essay type (HINDI and ENGLISH) of narration not exceeding 500 words outlining the research problem, the methodology used for tackling it and a summary of the findings, typed in 1.5linespacing.

Acknowledgements: The acknowledgements shall be brief and should not exceed one page. The student's signature shall be made at the right bottom above his / her name typed in capitals.

Table of contents - The table of contents should list all material following it as well as any material which precedes it. The title page, Bonafide Certificate and Acknowledgment will not find a place among the items listed in the Table of Contents but the page numbers in lower case Roman letters are to be accounted for them. One and a half spacing should be adopted for typing the matter ender this head. A specimen copy of the Table of Contents for report / thesis is given in Annexure III.

List of Table-The list should use exactly the same captions as they appear above the tables in the text and the caption shall follow 'sentence case'. One and a half spacing should be adopted for typing the matter under this head.

List of Figures - The list should use the same captions as they appear below the figures in the text and the caption shall follow 'sentence case'. One and a half spacing should be adopted for typing the matter under this head

List of Symbols, Abbreviations and Nomenclature - One and a half spacing should be adopted for typing the matter under this head. Standard symbols, abbreviations etc. should be used.

Chapters - The chapters may include

Chapter I –

Introduction Chapter II

- Literature Review

Chapter III –Materials and Methods

Chapter IV- Results and Discussion

Research output/outcome if any published or presented in conference/seminar/symposium may be included.

List of References - Any works of other researchers, if used either directly or indirectly, should be indicated at appropriate places in the report/thesis. The citation may assume any one of the following forms**. APA Style.**

APA in-text citation style uses the author's last name and the year of publication, for example: (Field, 2005).

Example:

Derwing, T. M., Rossiter, M. J., & Munro, M. J. (2002). Teaching native speakers to listen to foreign-accented speech. *Journal of Multilingual and Multicultural Development,* 23(4), 245- 259.

Thomas, H. K. (2004). *Training strategies for improving listeners' comprehension of foreign- accented speech* (Doctoral dissertation). University of Colorado, Boulder.

6. TYPINGINSTRUCTIONS

General

This section includes additional information for final typing of the thesis. Some information given earlier under 'Manuscript preparation' shall also be referred. The impressions on the typed/duplicated/printed copies should be black in colour. Corrections, interlineations and crossing out of letters or words will not be permitted in any of the copies of the report/thesis intended for submission. Erasures, if made, should be neatly carried out in all copies. A sub- heading at the bottom of a page must have at least two full lines below it or else it should be carried over to the next page. The last word of any page should not be split using a hyphen. One and a half spacing should be used for typing the general text. The general text shall be typed in Font Style Times New Roman and Font Size 12.

Single spacing should be used for typing:

(i) Long Tables

(ii) Long quotations

(iii) Foot notes

(iv) Multilane captions
(v) References

Chapters: The format for typing chapter headings, division headings and subdivision headings shall be same as given in Table of Contents.

7. BINDING SPECIFICATIONS

Thesis should be spiral or soft cover book bound, the cover of thesis should be of dark green color, printed with golden ink and the text for printing should be identical as prescribed for the title page.

APPENDIX I.A:(A typical Specimen of Cover Page & Title Page–**DISSERTATION**)

<Font Style Times New Roman - Bold>

TITLE OF DISSERTATION

<Font Size 18><1.5 line spacing>

DISSERTATION

<Font Size 14>

Submitted by

<Font Size 14><Italic>

NAME OF THE CANDIDATE

<Font Size 16>

Under the Supervision of

NAME OF THE SUPERVISOR

in partial fulfillment for the award of the degree of

<Font Size 14><1.5 line spacing>

MASTER OF SCIENCE IN

NAME OF THE PROGRAMME

<Font Size 16>

DEPARTMENT OF

SCHOOL OF ……..

CENTRAL UNIVERSITY OF HARYANA MAHENDERGARH-HARYANA

<Font Size 14><1.5 line spacing>

MONTH AND YEAR

DECLARATION

I ……..……..…, student of the School of Interdisciplinary and Life Sciences, Central University of Haryana, Mahendergarh hereby declare and certify with my signature that my thesis entitled

……..……..……..……..…… submitted to the Department of .....,Central University of Haryana, India in partial fulfillment of the requirements for the award of the Degree of Masters of Science is a record of original research work done by me and the dissertation has not been the basis for the award of any degree/diploma/associateship/fellowship or similar title of any candidate of any University. I have faithfully and accurately cited all my sources, including books, journals, handouts and unpublished manuscripts, as well as any other media, such as the Internet, letters or significant personal communications.

I understand the concept of "plagiarism" and declare that while drafting this dissertation I have refrained from plagiarism. I know that plagiarism not only includes direct copying, but also the extensive use of other's ideas without proper referencing or acknowledgement (which includes the proper use of references and quotation marks).

If my dissertation found to be plagiarized at any point of time, I'll be solely responsible and will be ready to accept any decision taken by the competent authority including rejection of my dissertation.

(Supervisor) (Signature of student)

For example

(A typical Specimen of Table of Contents)

<Font Style Times New Roman, Font Size 14>

TABLE OF CONTENTS

ANNEXURE II

Curriculum vitae

<Font Style Times New Roman, Font Size 14>

Personal Details

Name:

Date of birth: DD Month, YYYY

Place of birth:

Nationality: Indian

Permanent Address:

Email Id:

Mobile No. :

Education

M.Sc. (Subject): YYYY Central University of Haryana, India

B.Sc. (Subject). : YYYY (Name of the University) with …. % of marks Higher Secondary:

YYYY (Name of the board) with …. % of marks Secondary: YYYY, (Name of the board)

with …. % of marks

9. Teaching Learning Process

While Teaching is a process of imparting knowledge and information, learning is a process of receiving them and display a long-term positive or negative change in them. Teaching-Learning Process is carried out through the teaching in an environment set-up within which the learners (students) can interact and study how to learn. Effective teaching help to engage and motivate learners to get involved in the process of learning. Learning activities are designed by the teacher to result in learning.

Components of the learning process includes:

- Focus/Attention
- Recall/Memory
- Language
- Processing and composing/organizing
- Writing
- Higher Order thinking

It helps the teacher to assess, evaluate and improvise their instructional techniques and in setting-up, modifying the teaching methods to fulfil the teaching-learning objectives that include:

- To transfer knowledge
- To Impart skills
- To inculcate values, attitudes and behavior

Following teaching, four phases of learning includes

- Preparation
- Presentation
- Practice
- Performance

As learners are unique and different in different ways, there is no single teaching method that can meet the objectives. In the present era, a good teacher needs to have the following skills to bring about the learning process;

- Communication skills
- Creativity
- Abreast and updated knowledge
- Information literacy
- Media Literacy

- Technology literacy
- Flexibility
- Collaboration and team spirit
- Analytical skills
- Critical thinking

To bring about best Teaching -Learning process, the biochemistry course is designed with the following combination of teaching activities:

1. Lectures
2. Discussion/Debates
3. Simulation
4. Role playing
5. Participative Learning
6. Interactive sessions
7. Hands-On trainings
8. Seminars
9. Research based learning/Dissertation/Project Work
10. Technology -embedded learning
11. Building Models

10. Blended Learning

The efforts rendered to improve the critical thinking skills and student learning activities in biochemistry course, Department of Biochemistry is adopted to implement problem based learning model under the blended learning. The blended learning in biochemistry will be implemented by applying both the Computer aided learning (40%) and face to face learning (60%). The face to face learning is accomplished in the class room and Computer aided learning is done by utilizing the internet for accessing the software, online education forum, online discussion forum, online visual education forum etc. The computer aided learning requires access to adequate hardware and software, and the development of knowledge and abilities which students are not often explored in the face-face learning method. The development of a new educational strategy, such as these blended lessons and activities, must be accompanied with a broad discussion and analysis of the specific context of their application,

considering not only the nature, structure, and educational objectives, but also the profile and expectations of the students involved in the biochemistry. The outcomes of both learning activities are monitored by using different evaluation that appear and determine the criteria. In conclusion the problem-based learning that is applied by using the blended learning method can improve the students learning activities, and critical thinking skills of students.

12. Assessment and Evaluation

- Continuous Comprehensive Evaluation at regular after achievement of each Course-level learning outcome
- Formative Assessment on the basis of activities of a learner throughout the programme instead of one-time assessment
- Oral Examinations to test presentation and communication skills
- Open Book Examination for better understanding and application of the knowledge acquired
- Group Examinations on Problem solving exercises
- Seminar Presentations
- Review of Literature
- Collaborative Assignments

13. Key words

- Biochemistry
- LOCF
- NEP-2020
- Blended Learning
- Face to face (F to F) Learning
- Programme Outcomes
- Programme Specific Outcomes
- Course-level Learning Outcomes
- Postgraduate Attributes

- Learning Outcome Index
- Formative Assessment and Evaluation
- Comprehensive and Continuous Evaluation

14. References

- National Education Policy-2020. https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf
- The draft subject specific LOCF templates available on UGC website. https://www.ugc.ac.in/ugc_notices.aspx?id=MjY5OQ==
- Draft Blended Mode of Teaching and Learning: Concept Note available on UGC website. https://www.ugc.ac.in/pdfnews/6100340_Concept-Note-Blended-Mode-of-Teaching-and-Learning.pdf

15. Appendices

- Curricular Reforms— Extracts from National Education Policy-2020