Department of Biochemistry
Master of Science in Biochemistry (Semester-wise Scheme 2019-2021)

Semester-I (Total credits 24)

Course code	Course title	L	T	P	Type of course	Credit
SIAL BT 1 1 01 C 3003	Cell and Molecular Biology	3	0	0	Core	3
SIAL BC 1 1 01 C 3003	Principles of Biochemistry	3	0	0	Core	3
SIAL MB 1 1 01 C 3003	General Microbiology	3	0	0	Core	3
SIAL BT 1 1 02 C 3003	Genetics	3	0	0	Core	3
SIAL SC 1 1 01 C 3003	**Analytical Techniques**	3	0	0	Core	3
SIAL SC 1 1 02 C 00105	**Practical-I**	0	0	10	Core	5
	Generic Elective Course (to be opted from other Department)	4	0	0	GEC	4

Semester-II (Total credits 30)

Course Code	Course Title	L	T	P	Type of Course	Credit
SIAL BC 1 2 02 C 4004	Immunology	4	0	0	Core	4
SIAL BT 1 2 03 C 4004	Genomics and Genetic Engineering	4	0	0	Core	4
SIAL BC 1 2 03 C 3003	Advance Cell and Molecular Biology	3	0	0	Core	3
SIAL BC 1 2 04 C 4004	Enzymology	4	0	0	Core	4
SIAL BC 1 2 05 C 4004	Intermediary Metabolism	4	0	0	Core	4
SIAL BC 1 2 06 C 00105	Practical-II	0	0	10	Core	5
SIAL SC 1 2 03 DCEC 2002	**Research Methodology and Scientific Communication Skills***	2	0	0	DCEC	2
SIAL SC 1 2 04 DCEC 2002	**Bio-entrepreneurship***	2	0	0	DCEC	2
SIAL BC 1 2 01 DCEC 4004	Cell and Tissue culture Engineering[#]	4	0	0	DCEC	4
SIAL BC 1 2 02 DCEC 4004	Neurobiochemistry[#]	4	0	0	DCEC	4

*One of the courses will be opted by the student. [#] One of the courses will be opted by the student.

Semester-III (Total credits 30)

Course code	Course title	L	T	P	Type of course	Credit
SIAL SC 1 3 05 C 4004	**Biostatistics and Bioinformatics**	4	0	0	Core	4
SIAL BC 1 3 07 C 4004	Biophysics and Nanosciences	4	0	0	Core	4
SIAL BC 1 3 08 C 4004	Plant Biochemistry	4	0	0	Core	4
SIAL BC 1 3 09 C 4004	Clinical Biochemistry and Molecular Diagnostics	4	0	0	Core	4
SIAL BC 1 3 10 C 0084	Practical-III	0	0	8	Core	4
SIAL BC 1 3 11 C 0202	Interactive group discussion cum seminar (Biosafety, Bioethics and IPR)	0	2	0	Core	2
SIAL BC 1 3 03 DCEC 4004	Nutritional Biochemistry[#]	4	0	0	DCEC	4
SIAL BC 1 3 04 DCEC 4004	Pharmaceutical Biochemistry[#]	4	0	0	DCEC	4
	Generic Elective Course(to be opted from other Department)	4	0	0	GEC	4

[#]One of the course will be opted by the student**.**

Semester-IV (Total credits 20)

Skill Enhancement Course

Course code	Course title	Type of course	Credit
SIAL BC 1 4 01 SEEC 0020	Dissertation	Core	20
	Total credits of the Program		**104**

L- Lecture; T- Tutorial P-Practical; C- Core course; DCEC - Discipline Centric Elective Course – to be opted by the student; SEEC- Skill Enhancement Elective Course; GEC- Generic Elective Course.

Credit Summary of Courses Offered by Department of Biochemistry

(Academic Session 2019-21)

Total Credits: 104

Semester	Credits				Total credits
	Core courses	Skill enhancement course	Elective courses		
			DCEC (For Department of Biochemistry students)	GEC (For other Department students)	
I	20	-	-	4	**24**
II	24	-	6	-	**30**
III	22	-	4	4	**30**
IV	-	20	-	-	**20**
Total	**66**	**20**	**10**	**8**	**104**

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

Semester	Type of course	Course code	Course title	Credit
I	GEC	SIAL BC 1 1 01 GEC 4004	Clinical Biochemistry	4
		SIAL BC 1 1 02 GEC 4004	Biochemical and Environmental Toxicology	
III	GEC	SIAL BC 1 3 03 GEC 4004	Advanced Molecular Biology	4
		SIAL BC 1 3 04 GEC 4004	Stem cell biology	

SEMESTER-I

Course title: Cell and Molecular Biology **Credit: 3**
Course code: SIAL BT 1 1 01 C 3003 **Lectures: 45**

Course objectives: To understand cellular organization and function at molecular level.

Learning Outcomes:

- Understanding of fundamental concepts of cellular and sub-cellular organization
- Molecular basis of genetic information and function

Unit-I

Archea, prokaryotic and eukaryotic cell (animal and plant cells); Theory of origin of eukaryotic cells; Structure and function of nucleus - nuclear envelope, nuclear pore complex; Nuclear protein-import and export, regulation of nuclear protein import and export; Organization of golgi, lysosome, structure and functions of ER, lysosome, mitochondria, chloroplasts and peroxisomes; Fluid mosaic model, membrane proteins, membrane lipids and membrane fluidity; Transport across cell membrane, passive transport, active transport-primary (P-type, F-type, V-type ATPases, ABC transporters), co-transport-symport and antiport; Ion channels, aquaporins, pinocytosis and phagocytosis; Cells as experimental models.

Unit-II

Introduction to cytoskeletal proteins; Organization of cytoskeletal protein and smooth muscle and skeletal muscles, movement of vesicles-role of actin and myosin; Structure of cilia and flagella; Prokaryotic and eukaryotic cell wall, cell matrix proteins; Cell-matrix interactions and cell-cell interactions; Adherence junctions, tight junctions, gap junctions, desmosomes, hemi-desmosomes, focal adhesions and plasmodesmata; Signalling molecules, receptors and their functions – G protein coupled receptors- Cyclic-AMP, Cyclic-GMP, IP3, Calcium, Receptor tyrosine kinases - EGF, insulin.

Unit-III

DNA as genetic material, forms of DNA; structure of various type of DNA; chromatin structure; super coiling; polytene and lamp brush chromosomes; properties of DNA in solution; denaturation and renaturation; reassociation reactions; COT curves; types of RNAs and their structures; role of RNA; Unusual bases in RNA; central dogma of molecular biology; DNA polymerases and other enzymes involved in replication; mutagenesis.

Unit-IV

Prokaryotic and eukaryotic gene structure: transcription-RNA polymerase, inhibitors of transcription; proof reading function and fidelity of DNA replication; possible modes of DNA replication; theta model and rolling circle model of DNA replication; replication of DNA in eukaryotes; role of methylation; replication of viral RNA; reverse transcriptase, regulatory region and transcriptional unit of gene; post transcriptional processing of RNA: splicing, cap addition and polyadenylation, polynucleotide phosphorylase.

Suggested readings:

1. The Cell: A Molecular Approach (2018) 8th ed., Cooper, GM, Sinauer Associates is an imprint of Oxford University Press, ISBN: 1605357073.
2. Molecular Cell Biology (2016) 8th ed., Lodish H, Berk A, Zipursky SL, Matsudaira P, Baltimore D and Darnell J, W.H. Freeman &Company (New York), ISBN: 978-1-4641-0981-2 / ISBN:10: 1464183392.

3. Molecular Biology of the Cell (2008) 6th ed., Alberts B, Johnson A. Lewis J and Enlarge M, Garland Science (Princeton), ISBN: 0-8153-1619-4 / ISBN:0-8153-1620-8.
4. Lehninger Principles of Biochemistry (2017) 7th ed., Nelson DL, Cox MM, W.H. Freeman and Company, New York, USA. ISBN-10: 1-4641-2611-9.
5. Biochemistry (2019) 9th ed., Stryer L, Berg JM, Tymoczko JL, Gatto, Jr. GJ, W.H. Freeman and Company, New York, USA. ISBN-10: 1-319-11467-9
6. Genes XII, (2017) 12th Revised edition ed., Lewin B, Krebs J, Kilpatrick ST, Goldstein ES, Jones and Bartlett Publishers, Inc. Sudbury, Massachusetts, USA. ISBN No. 9781284104493.
7. Molecular Biology of the Gene (2013) 7th ed., Watson JD, Baker TA, Bell SP, Gann A, M, Levin RL and Cumming B, San Francisco, ISBN: 0321905377.

SEMESTER-I

Course title: Principles of Biochemistry **Credit: 3**
Course code: SIAL BC 1 1 01 C 3003 **Lectures: 45**

Course objectives: To understand structures and functions of bio-molecules, metabolic pathways in the living systems.

Learning outcomes:

- Comprehensive knowledge of biochemical pathways-synthesis and catabolism of major biomolecules

Unit-I

Monosaccharides-structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers. Disaccharides: maltose, lactose and sucrose. Polysaccharides: homo and hetero-polysaccharides, structural and storage polysaccharides. Glycolysis - a universal pathway, reactions of glycolysis, production of acetyl CoA, reactions of citric acid cycle. Gluconeogenesis, glycogenesis and glycogenolysis.

Unit-II

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. β-oxidation of fatty acids. Fatty acid synthase complex. Synthesis of fatty acids.

Unit-III

Amino acids and peptides- classification (essential and non-essential amino acids), chemical reactions and physical properties. Introduction to protein structure and function. Enzymes: classification, kinetics (significance of k_m, k_{cat} and V_{max}), inhibition; amino acid metabolism-amino acid deamination and transamination, urea cycle. Synthesis and utilization of ketone bodies. Biosynthesis and breakdown of nutritionally non-essential amino acids. Synthesis of other amino acid derivatives such as neurotransmitters.

Unit-IV

Nucleotides - structure and properties. Nucleic acid structure-Watson - Crick Model of DNA. Structure of major species of RNA - mRNA, tRNA and rRNA. De novo synthesis of purine and pyrimidine nucleotides. Catabolism of purine and pyrimidine. Disorders of purine and pyrimidine metabolism.

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. Biochemistry (2017) 6th ed., Garrett RH and Grisham CM, Brooks/Cole, ISBN: 9781305577206.
3. Harper's Illustrated Biochemistry (2018) 7th ed., Rodwell VW, Bender DA, Botham KM, Kennelly, PJ and Weil PA, McGraw-Hill, ISBN: 9781259837937.
4. Lippincott's Illustrated Reviews Biochemistry (2017) 7th ed., Ferrier, Wolters Kluwer India Pvt. Ltd., ISBN: 978-9351297949.
5. Biochemistry (2019) 9th ed., Stryer L, Berg JM, Tymoczko JL, Gatto Jr. GJ, W.H. Freeman and Company, New York, USA. ISBN-10: 1-319-11467-9.

SEMESTER-I

Course title: General Microbiology **Credit: 3**
Course code: SIAL MB 1 1 01 C 3003 **Lecture: 45**

Course objective: To provide an understanding of basic concepts and techniques in Microbiology.

Learning outcomes:

- Demonstrate the practical skills in basic microbiological techniques
- Designate the role of microorganisms in different ecosystems
- Retrieve and use contemporary information on different microbial groups

Unit-I

History of development of Microbiology in 20th century; The spontaneous generation controversy; Germ theory of disease; Methods in microbiology: Physical and chemical methods of sterilization; Pure culture techniques, maintenance and preservation of microbial cultures.

Unit-II

Binomial nomenclature; Haeckel's three kingdom classification; Organization of archae, bacteria and eukaryotic cell; Use of DNA and r-RNA sequencing in classification of microorganisms; Woese's three kingdom classification system and its utility - archaea, eubacteria, eukarya; Different groups of acellular microorganisms - viruses, viriods and prions.

Unit-III

General features of microorganisms - bacteria, algae, fungi and protozoa; Bacterial growth and metabolism; Microbes in different environment: extreme environment, deep ocean, space and air. Special features of the thermophilic, methanogenic and halophilic bacteria; Photosynthetic bacteria, Cyanobacteria.

Unit-IV

Scope of Microbiology - Cycle of matter in nature; Microbial interactions – Symbiosis and parasitism; Biodegradation and Bioremediation; Biofilms; Microbes in composting; Biofertilizers and Biopesticides; Microbes and Industry - SCP, microbial enzymes and fermented foods, Vaccines and antibiotics.

Suggested readings:

1. An Introduction to Microbiology (2019), 3rded., Tauro P, Kapoor KK, Yadav KS, and Sequeira MG. New Age International Publishers. ISBN: 0852268785.
2. Brock Biology of Microorganisms (2018), 15thed., Madigan MT, Martinko JM, Bender KS, Buckley DH, Stahl DA Pearson Education, ISBN 9781292235103.
3. Prescott's Microbiology (2017). 10th ed., Sherwood LM, Woolverton C.J McGraw-Hill Education. ISBN 9781259281594.
4. A text book of Microbiology (2013), 3rd ed. Dubey, R.C. and Maheswari, D.K. Revised S. Chand and Company Ltd, New Delhi. ISBN: 9788121926201.
5. Microbiology (2001) 5th ed., Pelczar Jr. M, McGraw Hill Education ISBN: 9780074623206.

SEMESTER-I

Course title: Genetics **Credit: 3**
Course code: SIAL BT 1 1 02 C 3003 **Lecture: 45**

Course objective: To study the fundamental concepts of genetics and its role in unification of different disciplines of biology.

Learning outcomes:

- Understanding of basic concepts of classical genetics and genetic analysis of eukaryotes

Unit-I

Historical background, Principles of Mendelian inheritance, codominance, incomplete dominance, Gene interactions, pleiotropy, Extra chromosomal inheritance: Maternal inheritance (mitochondria and chloroplast), Sex linked inheritance, Sex influenced and Sex limited traits, Gene interactions: Incomplete dominance, codominance, duplicate genes, complementary genes, supplementary genes, lethal genes, pleotropic genes and multiple alleles.

Unit-II

Linkage: complete and incomplete linkage, linkage analysis and genetic maps, Linkage and recombination of gene, Mechanism of crossing over, Population Genetics and Hardy-Weinberg equilibrium. Genetic analysis: Linkage maps, mapping with molecular markers, Gene mapping by three point test cross, Tetrad analysis, Sex determination and Dosage compensation in Mammals and Drosophila, Quantitative Genetics: Multilocus control; QTL analysis; Quantitative inheritance in plants and human.

Unit-III

Mutations: concept and types, Mechanism of spontaneous mutations, Physical and chemical mutagenesis, Selection and enrichment of mutants, Molecular mechanism of induced mutations, importance of mutation; detection of mutation and directed mutagenesis, Germinal and somatic mutation, insertion, deletion, duplication, translocation, transposition, Numerical alterations of chromosomes: Ploidy and their genetic implications. Types of DNA repair, Molecular mechanism of suppression.

Unit-IV

Nucleosome and chromatin structure, Structure of centromere and telomere, Euchromatin and heterochromatin, Polytene and lamp brush chromosomes, Gene transfer in prokaryotes: Transformation, Conjugation and Transduction, Transposons: types, structures and role in gene regulation, Natural and artificial competence, Operon concept in bacteria and gene regulation, Bacterial plasmids, Lytic and lysogenic cell cycles in Phages.

Suggested readings:

1. Principles of Genetics (2006) 8th ed. Gardner EJ, Simmons, MJ and Snustad DP, John Wiley & Sons Inc, ISBN: 8126510439.
2. Essentials of Genetics (2015) 9th ed. William S, Michael K, Cummings R, Spencer, CA and Palladino MA, Prentice Hall Internationals, ISBN-10: 0134047796
3. Genetics (2017) 9th ed. Daniel L. Hartal&B. Cochrane, ISBN: 128412293X
4. Introduction to Quantitative Genetics (1995) Falconer DS, and Mackay TFC, ISBN: 0582243025.

5. An Introduction to Population Genetics Theory and applications (2013) Nielsen R and Slatkin M, Oxford University Press, ISBN: 1605351539.
6. Evolution 4th ed. (2017) D. Futuma and M. Kirkpatrick, ISBN: 9781605356051
7. An Introduction to Genetic Analysis (2015) Griffith AJFJ, Wessler SR, Carroll SV and Doebley J, ISBN: 0-7167-3520-2.

SEMESTER-I

Course title: Analytical Techniques **Credit: 3**
Course code: SIAL SC 1 1 01 C 3003 **Lecture: 45**

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

Learning outcomes:

- Demonstrate principles of various basic and advanced techniques used in biological experiments
- Critically analyze and interpret the results obtained from biological experiments

Unit-I

Principle of microscopy: resolving powers of different microscopes, magnification; different types of microscopes, principle and applications of compound microscopy, dark microscopy, fluorescence microscopy, phase contrast microscopy, confocal microscopy, atomic force microscopy and electron microscopy (SEM, TEM, STEM); fixation and staining, freeze fracture/etch techniques.

Unit-II

Agarose gel electrophoresis, polyacrylamide gel electrophoresis (native PAGE and SDS-PAGE); Western transfer, iso-electric focusing (IEF), 2-Dimensional gel electrophoresis, pulse field electrophoresis; principle and applications of centrifugation, differential centrifugation, density gradient centrifugation and ultracentrifugation; cell separation by flow cytometry.

Unit-III

Paper chromatography (ascending and descending, 2-Dimensional); principle and applications of thin layer chromatography (TLC), column chromatography (gel filtration, ion exchange and affinity chromatography); methods of ligand immobilization, immuno-adsorption-hydrophobic interaction chromatography, metal chelate chromatography, covalent chromatography, high performance liquid chromatography (HPLC) and gas liquid chromatography (GLC).

Unit-IV

Principle and instrumentation of UV-visible, infrared spectroscopy, atomic absorption spectrophotometery, NMR spectroscopy, X-ray diffraction spectroscopy, N-terminal sequencing and peptide synthesis, introduction to proteomics, Yeast 2- hybrid and 3-hybrid systems, EMSA, foot printing, phage display, principle of mass spectrometry, electrospray ionization MS, MALDI, tandem MS for protein identification, ICAT-MS.

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.

SEMESTER – I

Course Title: Practical-I **Credit: 5**
Course Code: SIAL SC 1 1 02 C 00105 **Lecture: 150**

1. Laboratory orientation, calibration, and demonstration of equipment.
2. Solutions, pH and buffers
3. Determination of pKa of acetic acid and glycine
4. Qualitative tests for carbohydrates, lipids, amino acids, and proteins in food samples
5. Metaphase chromosome preparation with G banding and C banding from blood sample
6. RNA *in-situ* hybridization to study gene expression in tissue section
7. Inheritance patterns in man – numerical on pedigree analysis- autosomal patterns, X–linked patterns, Y–linked patterns, mitochondrial inheritance patterns
8. Numerical on Hardy-Weinberg equilibrium
9. Numerical on linkage mapping
10. Different staining methods and microscopic examination of bacteria, actinomycetes, algae, fungi and protozoa
11. Preparation of specific media for isolation of bacteria, and fungi from natural sources
12. Cell counting and cell viability assay
13. Production of microbial enzymes (amylase, phosphatase) and their separation using chromatographic techniques
14. Biochemical characterization of microbial enzymes.
15. Separation of carbohydrates, amino acids and plant pigments using paper/thin layer chromatography
16. Detection of food adulterants
17. Evaluation of microbiological risks in food processing unit through microbiological risk assessment (MRA) tools
18. Assessment of nutritional status of different age group using anthropometric tools

Suggested readings:

1. 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.
2. An Introduction to Practical Biochemistry (2017) 3rd ed., Plummer, D.T., McGraw Hill Education, ISBN: 978-0070994874.
3. Principles and Techniques of Biochemistry and Molecular Biology (2018) 8th ed. Wilson K, and Walker J, Cambridge University Press. ISBN: 131661476X.
4. Microbes in Action: A Laboratory Manual of Microbiology (1990) 4th ed., Harry W, Seeley, Paul JV, John J, W. H. Freeman ISBN: 978-0716721000.
5. Genetics: A Laboratory Manual, (2009) 2nd ed., American Society of Agronomy; Lab Manual edition, ISBN: 978-0891185611.

6. Infant, Child and Adolescent Nutrition: A Practical Handbook (2013) 1st Addition, More J, CRC Press, ISBN: 9781444111859.
7. Laboratory Manual of Microbiology and Biotechnology (2014) 1sted.Aneja KR, Scientific International Pvt., Ltd. ISBN: 9789381714553.
8. Microbiology: A Laboratory Manual (2017), 11th ed., Cappuccino, JH, Sherman, N., Pearson Education Inc, ISBN: 9780134298597.
9. An Introduction to Practical Biochemistry (2017) 3rd ed., Plummer, DT, McGraw Hill Education, ISBN: 978-0070994874.

SEMESTER-I

Course title: Clinical Biochemistry **Credit: 4**
Course code: SIAL BC 1 1 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:

- 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

Unit-I

Clinical Biochemistry - concept, definition and scope; 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.

Unit-II

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

Unit-III

Biochemical tests in clinical practice – characteristics and uses of a biochemical test; criteria for selecting a method for biochemical analysis; 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.

Suggested readings:

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

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

Course title: Immunology **Credit: 4**
Course code: SIAL BC 1 2 02 C 4004 **Lecture: 60**

Course objective: To understand overall organization of the immune system and to identify the cellular and molecular basis of immune responsiveness.

Learning outcomes:

- Understanding the working mechanism of the immune system
- Understanding of antibody, MHC, complement system, cytokines, cancer, and organ transplant hypersensitivity

Unit-I

Host-defenses, hematopoiesis, cells of the immune system, primary and secondary lymphoid organs and tissues (MALT).Anatomical barriers, cell types of innate immunity, soluble molecules and membrane associated receptors (PRR), connections between innate and adaptive immunity, chemokines. Antigens and haptens, factors that dictate immunogenicity, B and T cell epitopes.

Unit-II

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 V region DNA rearrangement, ways of antibody diversification. Antigen independent phase of B cell maturation and selection, humoral response – T-dependent and T-independent response.

Unit-III

Complement activation by classical, alternate and MB lectin pathway, biological consequences of complement activation, regulation and complement deficiencies. 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).

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. Immunological basis of graft rejection, clinical manifestations, immunosuppressive therapy, Immunohistochemistry, Immunocytochemistry and privileged sites. Vaccines - active and passive immunization, types of vaccines.

Suggested readings:

1. Kuby Immunology (2018) 8th ed., Punt J, Stranford S, Jones P and Owen JA, W.H Freeman and Company, ISBN: 978-1319114701.
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. Lehninger: Principles of Biochemistry (2017) 7th ed., Nelson, DL and Cox, MM, WH Freeman and Company (New York), ISBN: 978-1319108243.
5. Lippincott's illustrated Reviews Immunology (2012) 2nd ed., Doan T, Melvold R, Viselli S and Waltenbaugh, C, Wolters Kluwer India Pvt, Ltd, ISBN: 978-8184737639.

SEMESTER-II

Course title: Genomics and Genetic Engineering **Credit: 4**
Course code: SIAL BT 1 2 03 C 4004 **Lecture: 60**

Course objective: To provide basic and high throughput techniques in the areas of genomics and genetic engineering.

Learning outcomes:

- Understanding of high throughput techniques used in genomics and transcriptomics
- Understand concept of genetic engineering including the techniques, applications and limitations
- Demonstrate the ability of designing recombinant molecules and conducting experiments involving genetic manipulation

Unit-I

Origin of genomics: The first DNA genomes, Structure and organization of prokaryotic and eukaryotic genomes - nuclear, mitochondrial and chloroplast genomes, Microbial genomes (including yeast), Plant genomes (Arabidopsis and rice), Animal genomes (fruit fly, mouse, human), Genomes and human evolution, The concept of minimal genome. Genetic maps, Physical maps, EST and transcript maps, Functional maps and Functional genomics, Human genome project-landmarks on chromosomes generated by various mapping method, Comparative genomics and colinearity/syntenyin maps, Genetic variation polymorphism, deleterious mutation; FISH to identify chromosome landmarks.

Unit-II

BAC libraries and shotgun libraries preparation (shotgun sequencing); Clone-by-clone or 'hierarchical shotgun' Sequencing, Next Generation sequencing,Genomics in medical practice, personalized medicine, use of SNP in pharmacogenomics, DNA Microarray technology: Basic principles and design, Global gene expression analysis, Comparative transcriptomics, Differential gene expression

Unit-III

Recombinant DNA Technology: Enzymes used in Recombinant DNA technology (Restriction endonucleases, DNA modifying enzymes, other nucleases, Polymerases, Ligase, kinases and phosphatases), Isolation and purification of DNA (genomic and plasmid) and RNA. Various methods of separation, characterization of nucleic acids including Southern and Northern hybridizations, Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems. Expression of recombinant proteins using bacterial, animal and plant vectors and their purification.

Unit-IV

Western blotting, Generation of genomic and cDNA libraries. Plasmid, Phage, Cosmid, BAC and YAC vectors. In vitro mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms. Isolation and amplification of specific nucleic acid sequences, PCR, RT PCR and qRT PCR, DNA sequencing methods, strategies for genome sequencing. Methods for analysis of gene expression at RNA and protein level, large scale expression, such as micro array based techniques. Site-directed mutagenesis, protein engineering. Applications of genetic engineering in plants and animal improvements.

Suggested readings:

1. Principles of Gene Manipulation and Genomics (2016) 8th ed., Primrose, SB and Twyman, R, Wiley Blackwell, ISBN 13: 978-1405156660.
2. Gene Cloning and DNA Analysis: An Introduction (201978-6) 7th ed., Brown, TA, Wiley Blackwell, ISBN 13: 978-1119072560.
3. Genome 4 (2017) 4th Brown, TA, Garland science, ISBN 13: 978-0815345084.
4. Introduction to Genomics (2015) 2nd ed., Lesk, AM, Oxford university Press India, ISBN 13: 978-0198745891.
5. Genomics and Personalized Medicine: What Everyone needs to Know (2016) 1st ed., Snyder, M, OUP-USA, ISBN 13: 978-0190234768

SEMESTER-II

Course title: Advance Cell and Molecular Biology **Credit: 3**
Course code: SIAL BC 1 2 03 C 3003 **Lectures: 45**

Course objective: To demonstrate knowledge and understanding of the molecular machinery of living cells.

Learning outcomes:

- Understanding sorting and transport of protein to ER and targeting of protein to other organelles
- Outlining the processes that control eukaryotic cell cycle and cell death
- Understanding the structural organization of genes and the control of gene expression, DNA replication, Transcription and Translation process

Unit-I

Selective transport of proteins to and from the nucleus. Targeting proteins to ER, smooth ER and lipid synthesis. Quality control in ER, targeting of protein to other organelles. Export of proteins and lipids from ER and into ER. Lipid and polysaccharide metabolism in Golgi, protein sorting and export from Golgi. Mechanism of vesicular transport, cargo selection, coat proteins and vesicle budding, vesicle fusion. Protein import and mitochondrial assembly, protein export from mitochondrial matrix. Import and sorting of chloroplast proteins.

Unit-II

Eukaryotic cell cycle, restriction point, and checkpoints. Cell division. Apoptosis and necrosis - brief outline. Cancer; characteristics of tumor cells, oncogenes, tumor suppressor genes. Ras and Raf, MAP kinase pathway, JAK/STAT Pathway.

Unit-III

Translation; adapter role of RNA in protein synthesis; size of the code; methods of deciphering the genetic code; code word dictionary; general features of the genetic code; identification of anticodons; wobble hypothesis; ribosome as the site of protein synthesis; polysomes ; 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, Gel retardation assay (EMSA), DNA finger printing, post-translational processing of the polypeptide chains; acetylation, methylation, phosphorylation by protein kinases; sulfation; glycosylation.

Unit-IV

Gene expression in prokaryotes; enzyme induction and repression; negative and positive control; concept of operon; catabolite repression; transcriptional termination control via mRNA alternative conformations; regulation of gene expression in eukaryotes; promoters ,enhancers, silencer and response elements; regulation at transcriptional level: Britten Davidson Model; control by steroid hormones. Role of chromatin structure in gene expression; cytoplasmic regulation of gene expression; role of splicing and alternate splicing in regulation of gene expression, organelle genome; epigenetics. Mutation. Various types of mutations. Spontaneous mutation and induced mutation. Reversion of mutations. Conditional mutation. Induced mutations. Radiation induced mutation. Effect of UV. Chemically induced mutation. Mutagenesis. Site directed mutagenesis. Oligonucleotide directed site mutagenesis.

Mutagenecity of a chemical substance. Ames Test. DNA damage and repair. Types of DNA damage. Deamination. Depurination. Thymine dimer formation. Basic pathways for DNA repair. Direct repair. Excision repair. Mismatch repair. Error prone repair of DNA. Other mechanisms of DNA repair. DNA modification.

Suggested readings:

1. The Cell: A Molecular Approach (2015) 7th ed., Cooper GM and Hausman RE, Sinauer Associates Inc, ISBN: 978-1605352909.
2. Molecular Biology of the Cell (2014) 6th ed., Alberts B**,** Johnson AD, Lewis J, Morgan D, Raff M and Roberts K, WW Norton & Company, ISBN: 978-0815344643.
3. Molecular Cell Biology (2016) 8th ed., Lodish H, Berk A, Caiser CA, Krieger M and Bretscher A, WH Freeman and Company, ISBN:978-1464183393.
4. Lewin's Genes XII (2017) 12th ed., Krebs JE, Goldstein ES and Kilpatrick ST, Jones and Bartlett Publishers, ISBN: 978-1284104493.
5. Molecular Biology of the Gene (2017) 7th ed., Watson JD, Tania B, Stephen PB, Alexander G, Michael L and Richard L, Pearson Education, ISBN: 978-9332585478.
6. Molecular Biology (2011) 5th ed., Weaver RF, McGraw Hill, ISBN: 978-0073525327.

SEMESTER-II

Course title: Enzymology **Credit: 4**
Course code: SIAL BC 1 2 04 C 4004 **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:

- 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

Introduction, general characteristics of enzymes, nature of enzymes - protein and non-protein (ribozyme). Cofactor and prosthetic group, apoenzyme, holoenzyme, metal-activated and metallo-enzymes, isozymes; ribozymes. Classification and nomenclature of enzymes. Factors affecting the rate of chemical reactions, collision theory, activation energy and transition state theory, reaction rates and thermodynamics of reaction, Arrhenius plot, determination of activation energy. Effect of pH, temperature and metal ions on the activity of enzyme. Fundamentals of enzyme assay – enzyme units, proximity, orientation effect. Strain & distortion theory. Catalytic power and specificity of enzymes (concept of active site), Fischer's lock and key hypothesis, Koshland's induced fit hypothesis.

Unit-II

Relationship between initial velocity and substrate concentration, derivation of Michaelis-Menten equation for uni-substrate reactions, Briggs and Haldane theory (rapid equilibrium and steady state theory), Significance of Km, Vmax, Kcat, Kcat/Km. Different plots (LineweaverBurk plot, Eadie-Hofstee and Hanes plot) for the determination of Km & Vmax and their physiological significances. Reversible inhibition (competitive, uncompetitive, non-competitive, Mixed and substrate). Mechanism based inhibitors - antibiotics as inhibitors, suicide inhibitor, transition state analogues.

Unit-III

Chemical nature of enzyme catalysis-General acid-base catalysis, electrostatic catalysis, covalent catalysis. General mechanisms of enzyme regulation, Control of activities of single enzymes (end product inhibition) reversible (glutamine synthase & phosphorylase) and Irreversible (proteases), covalent modifications of enzymes. Feedback inhibition and feed forward stimulation, Allosteric enzymes, binding of ligands to proteins, co-operativity, Hill equation. sigmoidal kinetics: MWC and KNF models. Significance of sigmoidal behavior. Study of ATCase as typical allosteric enzyme. Multienzyme complex as regulatory enzymes, mechanism of action and regulation of pyruvate dehydrogenase.

Unit-IV

Classification of multi substrate reactions with examples of each class. Kinetics of bi- substrate reactions: sequential mechanism, compulsory order and random order mechanism, ping-pong mechanism. Application of enzymes in diagnostics (SGPT, SGOT, Creatine kinase, alkaline and acid phosphatases), enzyme therapy (Streptokinase), immobilized enzymes.

Suggested readings:

1. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry (2007) 2nd ed., Palmer T, and Bonner PL, Woodhead Publishing, ISBN: 978-1904275275.
2. Fundamentals of Enzyme Kinetics (2017) 3rd ed., Bowden AC, Medtech, ISBN: 978-9385998508.
3. Lehninger: Principles of Biochemistry (2017) 7th ed., Nelson DL and Cox MM, WH Freeman and Company (New York), ISBN: 978-1319108243.
4. Essentials of Enzymology (2016) 1st ed., Herald J, Syrawood Publishing House, ISBN: 978-16182862285.
5. Biochemistry (2015) 8th ed., Berg JM, Stryer L and Tymoczko JL, WH Freeman and Company (New York), ISBN: 9781464126109.

SEMESTER-II

Course title: Intermediary Metabolism **Credit: 4**
Course code: SIAL BC 1 2 05 C 4004 **Lectures: 60**

Course objective: To help students navigate the discipline of biochemistry that explains how the collection of inanimate molecules that constitute the living systems interact, to maintain and perpetuate life.

Learning outcomes:

- Understanding the structures and functions of biological molecules
- Understanding of intermediary metabolism and its control

Unit-I

Basic design of metabolism, metabolic pathways, catabolism, anabolism, ATP as energy currency. Glycolysis - a universal pathway, reactions of Glycolysis, Fermentation, Regulation of glycolysis, fates of pyruvate, feeder pathways for glycolysis. Production of acetyl CoA. Reactions of citric acid cycle, Regulation of citric acid cycle, anaplerotic reactions, amphibolic role glyoxalate pathway, synthesis of glucose from non-carbohydrate sources, pentose phosphate pathway and its importance. Regulation of glycogen metabolism, glycogen storage diseases.

Unit-II

Oxidative phosphorylation, electron transport chain - its organization and function. Inhibitors of ETC and uncouplers. Proton motive force. Fo F1ATP synthase, structure and mechanism of ATP synthesis. Regulation of oxidative phosphorylation. Integration of metabolic pathways (carbohydrate, lipid and amino acid metabolic pathways), tissue specific metabolism (brain, muscle, and liver).

Unit-III

Digestion, mobilisation and transport of cholesterol and triacylglycerols, fatty acid transport to mitochondria, β oxidation of saturated, unsaturated, odd and even numbered and branched chain fatty acids, regulation of fatty acid oxidation, ketone bodies metabolism, ketoacidosis. Fatty acid synthase complex. Synthesis of saturated, unsaturated, odd and even chain fatty acids and regulation. Biosynthesis of steroids and isoprenoids, Integration of metabolism. Synthesis of prostagladins, Leukotrienes and Thromboxanes and their clinical applications, cholesterol, regulation of cholesterol synthesis.

Unit-IV

Glucogenic and ketogenic amino acids. Metabolism of one carbon units, metabolic fates of amino groups. Digestion and absorption of dietary proteins. Protein calorie malnutrition. transamination, role of pyridoxal phosphate, glucose-alanine cycle, Kreb's bicycle, urea cycle and inherited defects of urea cycle. Catabolic pathways of individual amino acids. Disorders of amino acids metabolism, overview of amino acid synthesis. Biosynthesis of non-essential amino acids and its regulation. De novo synthesis of purine and pyrimidine nucleotides, regulation and salvage pathways. Digestion of nucleic acids, degradation of purine and pyrimidine nucleotides. Inhibitors of nucleotide metabolism. Disorders of purine and pyrimidine metabolism

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 Freeman and Company (New York), ISBN: 9781464126109
4. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin TM, John Wiley & Sons, Inc, ISBN 13: 978-0470281734.
5. Harper's Illustrated Biochemistry (2018) 7th ed., Rodwell VW, Bender DA, Botham KM, Kennelly PJ and Weil PA, McGraw-Hill, ISBN 13: 978-1259837937.

SEMESTER-II

Course title: Practical-II **Credit: 5**
Course code: SIAL BC 1 2 06 C 00105 **Lectures: 150**

1. Quantitative test for determination of protein in plants/animals
2. Quantitative test for determination of carbohydrates in plants/animals
3. Separation of amino acids/ sugars by thin layer chromatography
4. Ammonium sulphate fractionation of plants/animals protein
5. Column chromatography for purification of plants/animals protein
6. Enzymatic assay of partially purified plants/animals protein
7. Determination of K_m and V_{max} using Lineweaver-Burk grap
8. Enzyme linked immune-sorbent assay (ELISA)
9. SDS-PAGE analysis of proteins. Visualization of protein bands by Coomassie and Silver staining.
10. Western blot analysis of the proteins using antibodies (immunoblotting), development by DAB/ECL

Suggested readings:

1. An Introduction to Practical Biochemistry (2017) 3rd ed., Plummer D, Tata McGraw Hill Education ISBN: 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: 978-1108716987.
3. Physical Biochemistry: Principles and Applications (2016) 2nd ed., 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) 4th ed., Upadhyay A Upadhyay K and Nath N, Himalaya Publishing House, ISBN: 978-9351422273

SEMESTER-II

Course title: Research Methodology and Scientific Communication Skills Credit: 2
Course code: SIAL SC 1 2 03 DCEC 2002 Lectures: 30

Course objective: To provide knowledge about tools and techniques related with scientific communication and research methodology.

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

Unit-I

Empirical science; scientific method; manipulative experiments and controls; deductive and inductive reasoning; descriptive science; reductionist vs holistic biology.

Unit-II

Choosing a mentor, lab and research question; maintaining a lab notebook. Concept of effective communication- setting clear goals for communication; determining outcomes and results; initiating communication; avoiding breakdowns while communicating; creating value in conversation; barriers to effective communication; non-verbal communication-interpreting non-verbal cues; importance of body language, power of effective listening; recognizing cultural differences.

Unit-III

Presentation skills - formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation; scientific poster preparation & presentation; participating in group discussions; Computing skills for scientific research - web browsing for information search; search engines and their mechanism of searching; hidden Web and its importance in scientific research; internet as a medium of interaction between scientists; effective email strategy using the right tone and conciseness.

Unit-IV

Technical writing skills - types of reports; layout of a formal report; scientific writing skills - importance of communicating science; problems while writing a scientific document; plagiarism, software for plagiarism; scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and framing abstracts; publishing scientific papers - peer review process and problems, recent developments such as open access and non-blind review; plagiarism; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct.

Suggested readings:

1. Research Methodology: Methods And Techniques (2019) 4th ed., Kothari CR and Garg G, New Age International Publishers, ISBN: 978-9386649225.
2. Communicate Science Papers, Presentations, and Posters Effectively (2015) Patience GS, Boffito DC, Patience P, Academic Press, ISBN: 978-0128015001.

3. Successful Scientific Writing: A Step-by-Step Guide for the Biological and Medical Sciences (2014) 4th ed., Matthews JR and Matthews RW, Cambridge University Press ISBN: 978-1107691933.
4. Doing Science: Design, Analysis, and Communication of Scientific Research. (2001) Valiela I, Oxford: Oxford University Press, ISBN 10:019538573X.
5. On Being a Scientist: a Guide to Responsible Conduct in Research. (2009) 3rd ed., Washington DC, National Academies Press.

SEMESTER-II

Course title: Bio-entrepreneurship **Credit: 2**
Course code: SIAL SC 1 2 04 DCEC 2002 **Lectures: 30**

Course objectives: To teach students about concepts of entrepreneurship including identifying a winning business opportunity, gathering funding and launching a business, growing and nurturing the organization and harvesting the rewards.

Learning Outcomes:

- Gain entrepreneurial skills and understand the various operations involved in venture creation
- Identifying scope for entrepreneurship in biosciences and utilize the schemes promoted through knowledge centres and various agencies

Unit-I

Introduction and scope in Bio-entrepreneurship, Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector (e.g. pharmaceuticals vs. Industrial biotech), Strategy and operations of bio-sector firms: Factors shaping opportunities. For innovation and entrepreneurship in bio-sectors, and the business implications of those opportunities, Alternatives faced by emerging bio-firms and the relevant tools for strategic decision, Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India), strategic dimensions of patenting & commercialization strategies.

Unit-II

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

Unit-III

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

Unit-IV

Technology – assessment, development & upgradation, Managing technology transfer, Quality control & transfer of foreign technologies, Knowledge centers and Technology transfer agencies, Understanding of regulatory compliances and procedures (CDSCO, NBA, GCP, GLA, GMP).

Suggested readings:

1. Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge, Routledge Studies in Innovation, Organizations and Technology (2018) 1st ed. Onetti, A, & Zucchella, A, CRC press, Taylor and Francis group. ISBN: 9781138616905.
2. Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies. Shimasaki, CD (2014) Amsterdam: Elsevier. Academic Press is an imprint of Elsevier, ISBN: 0124047300.

3. Innovation, Commercialization, and Start-Ups in Life Sciences. (2014) 1st ed. Jordan, JF, CRC Press. Taylor and Francis group, ISBN: 9781482210125.
4. The Dynamics of Entrepreneurial Development and Management. (2011) 6th ed., Desai V, New Delhi: Himalaya Pub. House, ISBN: 9350244543.
5. Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences (2008) Adams, DJ, Sparrow JC, Bloxham, Scion, ISBN:1904842364.

SEMESTER-II

Course title: Cell and Tissue Engineering **Credit: 4**
Course code: SIAL BC 1 2 01 DCEC 4004 **Lectures: 60**

Course objective: To design, optimize and maintain biomedical systems in tune with community needs and environmental concerns.

Learning outcomes:

- Designing a system to meet desired needs within realistic constraints
- Understanding professional and ethical responsibilities as well as regulatory issues

Unit-I

Definition of biomaterials, requirements of biomaterials, classification of biomaterials, properties of common biomaterials, Physical and mechanical properties of biomaterials, Engineering biomaterials for tissue engineering, Degradable materials (collagen, silk, hydrogels and polylactic acid), 3-D architecture/printing and cell incorporation, Biocompatibility, basic transplant immunology.

Unit-II

Fundamental of tissue engineering, Structural and organization of tissues: Epithelial, Endothelial, Mesenchymel, Connective. Basic wound healing, cell migration, in-vitro testing.

Unit-III

Types of cells for tissue engineering, progenitor cells and cell differentiations, cell matrix and cell-cell interaction. Aspect of cell culture: cell expansion, cell transfer, genetic engineering of cell, cell storage and cell characterization, growth factor delivery in tissue engineering, cell attachment: differential cell adhesion, receptor-ligand binding, and tissue specific cell surface markers.

Unit-IV

Tissue engineering of Bone, Cartilage, Blood vessels, Heart, Cell transplantation, Ethical, social and regulatory issues with tissue engineering.

Suggested readings:

1. Principles of Tissue Engineering (2013) 4th ed., Lanza, RP, Langer, R and Vacanti, JP, Academic Press, ISBN: 978-0123983589.
2. Biomaterials (Bioengineering and Health Science (2014) 1st ed., Migonney, V, ISTE Ltd., ISBN: 978-1848215856.
3. Nanomedicine and Tissue Engineering: State of the Art and Recent Trends (2016) 1st ed., Kalarikkal, N, Augustine, R, Oluwafemi, OS, Joshy, KS and Thomas, S, Apple Academic Press. ISBN: 978-1771881180.
4. Tissue Engineering (2018) 2nd ed., Blitterswijk, CV and Boer, JD, Academic Press ISBN: 978-0128100288.
5. Biomaterials: A Basic Introduction (2018) Ist ed., Chen, Q and Thouas, G, CRC Press, ISBN: 978-1138749665.

SEMESTER-II

Course title: Neurobiochemistry **Credit: 4**
Course code: SIAL BC 1 2 02 DCEC 4004 **Lectures: 60**

Course objective: The course aims to provide an advanced understanding of the core principles and topics of Neurobiochemistry and their experimental basis, and to enable students to acquire a specialized knowledge and understanding of selected aspects by means of a stem/branch lecture series and a research project.

Learning outcomes:

- Actively discussing contemporary issues in neuroscience with critical thinking and methods generation in mind.
- Developing methods to test a research question in neuroscience.

Unit-I

Central nervous system – general features of neuron. Cellular organization of neuron, dendrites and axons, neurotubules, neurofilaments, synapse neuralgia, astrocytes, oligodendrocytes, ependymal cells, Schwan cells. Muscle, nerve ending, sensory receptors and effectors endings, peripheral nerves, spinal and cranial nerves, plexuses ganglia, afferent pathways and sense organs

Unit-II

Topographical anatomy, spinal nerves, spinal meninges, joint reflexes, gray and white matter of spinal cord. Cellular organization of specific regions such as cerebellum, cerebral cortex, hippocampus, retina, evolution of nervous system – a comparative aspect. Neuronal membrane, excitability, ion channels and transport of ions.

Unit-III

Structure function correlation at the synapse. Transmission across the synapse: membrane potential in the steady state, action potential generation and propagation. Cholinergic and non-cholinergic synapses. Postsynaptic Events at the Neuromuscular Junction. Formation, structure and biochemistry of myelin, chemistry of major brain lipid, developmental changes, lipid composition, biosynthesis and catabolism of major lipid, characteristics of brain lipid, regional variations.

Unit-IV

Neurotransmitter: chemistry, synthesis, storage and release of nervous neurotransmitters, transmitter action, synaptic modulation and mechanism of neuronal integration. Energy metabolism: normal oxygen consumption by the brain, energy demanding function, role of cerebral circulation, local cerebral blood flow and metabolism, effects of glucose deprivation.

Suggested Readings:

1. Basic Neurochemistry: Principles of Molecular, Cellular, and Medical Neurobiology (2011) 8th ed., Brady S, Siegel G, Albers RW and Price D, Academic Press, ISBN: 978-0123749475.
2. Guyton & Hall Textbook of Medical Physiology (2016) 2nd ed., Vaz M, Raj T and Anura K Elsevier India, ISBN: 978-8131244661.
3. Molecular Biology of the Cell (2014) 6th ed., Alberts B**,** Johnson AD, Lewis J, Morgan D, Raff M and Roberts K, W. W. Norton & Company, ISBN: 978-0815344643.N

4. Neuroprogression in Psychiatry (2019) 1st ed., Kapczinski F, Magalhaes PVS and Berk M, Oxford University Press, ISBN: 978-0198787143.
5. Advances in Neurochemistry (2012), 1st ed., Agranoff BW and Aprison, MH, Springer, ISBN: 978-1468475432.

SEMESTER-III

Course title: Biostatistics and Bioinformatics **Credit: 4**
Course code: SIAL SC 1 3 05 C 4004 **Lectures: 60**

Course objective: The course is aimed at introducing the students to the field of Bioinformatics and enable them to understand the concepts of statistics in biology.

Learning outcomes:

- Understanding statistical analysis of biological data
- Understanding the role of computer science in predicting structure and function of biomolecules
- Understanding similarities and differences among living organisms on the basis of genetic information

Unit-I

Definition of selected terms scale of measurements related to statistics; Methods of collecting data, Presentation of data statistical Tables, Need for reduction of data measures of averages and location, Measures of dispersion: Range, quartile deviation, mean deviation and relative deviation.

Unit-II

Probability: basic concepts; basic theorems of probability addition and multiplication theorems; Conditional probability of Bayes Theorems. Probability mass function, probability density function, cumulative distribution function. Probability distribution definition and applications; Binominal distribution, Poisson distribution, Normal distribution, Logic of statistical standard error estimation testing of hypothesis.

Tests of significance: Null hypothesis, alternative hypothesis, type I error, type II error, level of significance, and power of test. Tests for mean based on normal distribution, one sample t-test, two-sample t-test, paired-sample t-test, Chi-Squared test, and Tests for variance based on normal distribution – one sample and two-sample problem. One-way and Two-way analysis of variance (ANOVA) techniques. Correlation concept and applications, Spearman's rank correlation coefficient, regression concept and applications.

Unit-III

Historical background. Scope of bioinformatics - genomics, proteomics, computer aided drug design (structure based and ligand based approaches), Applications of bioinformatics. Introduction to biological databases - primary, secondary and composite databases, Different formats of molecular biology data. NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss-Prot, TrEMBL, PDB)

Exercises

- Sequence retrieval (protein and gene) from NCBI.
- Structure download (protein and DNA) from PDB.
- Molecular file formats - FASTA, GenBank,

Unit-IV

Similarity, identity and homology. Alignment – local and global alignment, pairwise and multiple sequence alignments, alignment algorithms, amino acid substitution matrices (PAM and BLOSUM), BLAST and CLUSTAL omega. Identification of open reading frames (ORF)

Concept of orthology, paralogy and homology in gene and protein sequences. Methods and tools for phylogenetic analysis- trees - maximum parsimony, maximum likelihood and distance methods; Creation, evaluation and interpretation of evolutionary trees phylogenetic tree.

Exercises

- BLAST suite of tools for pairwise alignment.
- Multiple sequence alignment using CLUSTAL omega
- Generating phylogenetic tree using PHYLIP.
- Primary sequence analyses (Protparam)

Suggested Readings:

1. Fundamentals of Statistics (2016) Goon, AM, Gupta, MK and Dasgupta, B. Vol. I & II. World Press, ASIN: B01LB7MH74.
2. Statistical Methods (2012) 1st ed., Das, NG. Vol I & II. Tata McGraw Hill, ISBN: 9780070263512.
3. Probability and Statistics for Engineers and Scientists (2013) 9th ed., Walpole, RE, Myers, RH, Myers, SL and Ye, Pearson Education India KE ISBN: 978-9332519084
4. Biostatistics: A Foundation. for Analysis in the Health Sciences (2012) 10th ed., Daniel, WW and Cross, CL. John Wiley & Sons, ISBN: 978-1118302798
5. Essential Bioinformatics (2006) 1st ed., Xiong J, Cambridge University Press, ISBN 13: 978-0521600828.
6. Fundamental concepts of Bioinformatics (2003) Krane DE and Raymer ML Pearson, ISBN: 978-8177587579.
7. An Introduction to Bioinformatics (2017) 1st ed., Knight R, Larsen and Keller Education, ISBN: 978-1635490459.
8. Concepts of Bioinformatics and Genomics (2016) 1st ed., Momand J, McCardy A, Heubah, S and Warter-Perez N, Oxford University Press, ISBN: 978-0199936991

SEMESTER-III

Course title: Biophysics and Nanosciences **Credit: 4**
Course code: SIAL BC 1 3 07 C 4004 **Lectures: 60**

Course objectives: To explore the complexity of living systems with a quantitative physical approach, fundamentals of nanoscale structured materials and also discuss various biomedical & agricultural applications of different nanomaterials.

Learning outcomes:

- Understanding the core concepts of biology, chemistry and physics and how they interconnect in biophysical systems
- Expansion of knowledge of standard molecular and biophysical techniques to design experiments in a specific research area
- Understanding fundamental principles of nanotechnology also discuss state-of-the-art synthesis of different nanomaterials
- Elucidating the emerging need of nanotechnology in environment, health; and safety, and incorporate them into basic education that can be immediately employed in industry

Unit-I

Introduction to Biophysics and history of Biophysics, main features of quantum theory, Elementary particles and their interactions, mechanism of molecular energy transfer, Distribution of molecular energy and velocity at equilibrium, Energy of activation, Different types of forces and stereo-chemical factors responsible for molecular conformation, Defining conformation of a macromolecular chain, complex array of biomolecular structures found in DNA and proteins due to interactions. Main methods of studying the structure of proteins and DNA, protein folding pathways, Levinthal's paradox, Molten globule, Anfinsen's experiment, Methods for investigating folding: Fluorescence spectroscopy, Circular dichroism. Macromolecular interactions, Biophysical methods of interactions: Microcalorimetry (Isothermal Titration Calorimetry (ITC), Surface Plasmon Resonance (SPR).

Unit-II

Basic concepts and laws of thermodynamics, Gibbs free energy, Enthalpy and Entropy, Energetic processes in living organism, Information and Entropy, Coupling of fluxes, Coupling of Chemical Reactions, Redox potential in biological system, ATP production. Introduction to membrane Biophysics, fundamental role of biomembranes, interfacial phenomena and membranes, surface and interfacial tensions, self-assembly of membranes, molecular structure of membranes, Structure & function of membranes, Nernst equation (based on membrane permeable for a single kind of ions), Resting membrane potential, Action potential, Biophysics of synapse, patch clamping/voltage clamp and their applications to the study of biomacromolecules.

Unit-III

Overview of Nanotechnology - Historical perspective of integration of biology, chemistry, and material science. Opportunities and promises of Nanobiotechnology. Top down and bottom up approaches of synthesis of nanoparticles, synthesis of nanoparticles by physical, chemical and biological methods; nucleation and growth of nanosystems, factors affecting synthesis of nanoparticles, Debye-Scherrer method, particle size determination using UV absorption spectra peaks and photoluminescence peaks, dynamic light scattering (DLS), SEM. Nanomaterials used in biotechnology-nanoparticles, carbon nanotubes, quantum dots and nanofibres.

Unit-IV

Miniaturized Devices-nanotechnology and biomedical devices: Overview of smart devices for medical field, lab on chip concept, epipen, intelligent pill, wobbling gels.

Nanotechnology and diagnostics and therapy-Nano-Biosensing-biosensors and nanobiosensors -basics, DNA aptamers for nano-biosensing. Use of nanotechnology in diagnosis of chronic diseases like diabetes and coronary heart diseases; parasitic disease like malaria.
Nanotechnology in agriculture, food technology & environment: Insecticides development using nanotechnology and Nanofertilizers, nanotechnology in food processing, safety & smart packaging, applications of nanotechnology in water purification and oil spill removal.

Suggested readings:

1. An introduction to Biophysics (2018), 1st ed., Burns, D, Forgotten Books, ISBN: 978-1330860212.
2. Biophysics - An Introduction (2014) 1st ed., Cotterill, R, Wiley, ISBN: 978-8126551606.
3. Biophysics: An Introduction (2012) 2nd ed., Glazer, Springer, ISBN**:** 978-3642252112.
4. Nanobiotechnology: Concepts, Applications and Perspectives (2012) 1st ed., Niemeyer, CM and Mirkin, CA, Wiley India Pvt Ltd., ISBN 13: 978-8126538409.
5. A Textbook of Nanoscience and Nanotechnology (2017) 1st ed., Pradeep T, McGraw Hill Education, ISBN: 978-1259007323.

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. Successful completion of this course will provide students with fundamental knowledge of biochemistry and specific knowledge of compounds and biochemical pathways that occur in plants.

Learning outcomes:

- Understanding 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

Unit-I

Introduction to plant cell structure, fluid mosaic model, photosynthesis and carbon assimilation plasma membrane, vacuole and tonoplast membrane, cell wall, plastids and peroxisomes. Structure of PSI and PSII complexes, Light reaction, Cyclic and non-cyclic photophosphorylation, 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. Seed storage proteins in legumes and cereals.

Unit-III

Secondary metabolites, representatives 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

Regulation of plant growth, Introduction to plant hormones and their effect on plant growth and development, Regulation of plant morphogenetic processes by light. Cell and tissue culture techniques, types of cultures: organ and explants culture, callus culture, cell suspension culture and protoplast culture. Plant regeneration pathways: organogenesis and somatic embryogenesis. Applications of cell and tissue culture and somoclonal variation.

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: Clinical Biochemistry and Molecular Diagnostics **Credit: 4**
Course code: SIAL BC 1 3 09 C 4004 **Lectures: 60**

Course objective: This course provides a comprehensive overview of the fundamental principles of clinical and molecular diagnostics and explores the use of molecular techniques in the diagnosis of disease.

Learning outcomes:

- Gaining a solid foundation in the most commonly utilized molecular diagnostic testing protocols
- Applying the knowledge of molecular testing to the most commonly performed applications in the clinical laboratory
- Interpreting the correct execution and interpretation of a molecular test

Unit-I

Clinical Biochemistry - concept, definition and scope; 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 range; quality assurance; accuracy and precision; factors influencing the accuracy of results; Levy-Jennings's chart; Reliability of a laboratory method; interferents; responsibilities of a clinical biochemist.

Unit-II

Biochemical tests in clinical practice – characteristics and uses of a biochemical test; criteria for selecting a method for biochemical analysis; enzymes as diagnostic tool; advantages and disadvantages of enzyme assays; Isozymes and their diagnostic importance; methods for the detection of isoenzymes; organ function tests - clinical presentation and diagnosis of the diseases of the liver and kidney; bilirubin metabolism; Acid base disorders.

Unit-III

Overview of molecular diagnostics, molecular diagnostics: past, present, and future, history & scope, definition, principle of biosensors: classification of biosensors based on transducer & recognition element. Components & basic designing of biosensors, different types of biosensors. Nanotechnology and biosensors: carbon nanotubes, gold nanoparticles. Latex agglutination test, Enzyme Linked Immunosorbantassay, dot and slot blot assay.

Unit-IV

PCR in molecular diagnostics; multiplex-PCR, quantitative real time PCR (qRT-PCR) and their applications for diagnosis of disease applications, DNA diagnostic system: molecular beacons and its variants for their applications in detection, Molecular diagnostics in bacterial detection, rolling circle amplification, application of padlock and selector probes in molecular medicine, DNA aptamers for nano-biosensing, diagnostics for point-of-care and resource limited settings, Smartphones in medical diagnostics, rapid diagnostic tests (lateral flow assays), concepts of microfluidics, BioMEMs in diagnostics.

Suggested readings:

1. Clinical Biochemistry (2018) 6th ed., Murphy M, Srivastava, R and Deans, K, Elsevier ISBN 13: 978-0702072987.

2. Tietz Fundamentals of Clinical chemistry and Molecular diagnostics. (2014) 7th ed., Burtis, CA and Bruns DE, Elsevier, ISBN: 978-8131238851.
3. Biomedical Nanotechnology (2005) 1st ed., Malsch N, CRC Press, ISBN: 978-0824725792.
4. Biosensors and Nanotechnology: Applications in Health Care Diagnostics (2018) 1st ed., Altintas Z, Wiley-Blackwell, ISBN: 978-1119065012
5. Biosensors: Essentials (2016) 1st ed., Evtugyn G, Springer, ISBN 13: 978-3662509388
6. Nucleic Acids as Molecular Diagnostics (2014) 1st ed., Keller A, Wiley VCH, ISBN: 978-3527335565.

SEMESTER-III

Course title: Practical-III **Credit: 4**
Course code: SIAL BC 1 3 10 C 0084 **Lectures: 120**

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. Assay based on agglutination reactions- blood typing (native) and passive agglutination
11. Estimation of blood glucose.
12. Estimation of tryglycerides, 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: Interactive group discussion cum seminar

Course code: SIAL BC 1 3 11 C 0202 **Credit: 2**

This course is aimed for interactive group discussion on IPR, Bioetheics and Biosafety. 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-III

Course title: Nutritional Biochemistry **Credit: 4**
Course code: SIAL BC 1 3 03 DCEC 4004 **Lectures: 60**

Course objective: The students will learn how nutrients effect biochemical processes and signal transduction pathways, and how this can lead to development of nutritionally related diseases.

Learning outcomes:

- Critically analyze and evaluate concepts in nutritional biochemistry that are important for an understanding of nutrition
- Understanding the major metabolic pathways involved in the metabolism of nutrients in the human body

Unit-I

Definition of Nutrition, role of nutrients. Unit of energy, Biological oxidation of foodstuff. Physiological energy value of foods, SDA. Recommended Nutrient Intakes (RNI) and Recommended Dietary Allowances for different age groups.

Unit-II

Functions of carbohydrates. Digestion, absorption, utilization and storage, hormonal regulation of blood glucose. Dietary requirements and source of carbohydrates, dietary fiber, role of fibre in lipid metabolism, colon function, blood glucose level and GI tract functions. Classification, sources, functions, digestion, absorption, utilization and storage. Essential Fatty Acids; Functions of EFA, RDA, – excess and deficiency of EFA, role of saturated fat, cholesterol, lipoprotein and triglycerides. Importance of the following: a) Omega – fatty acids. Omega 3/ omega 6 ratio b) phospholipids c) cholesterol in the body d) mono, polyunsaturated and saturated Fatty Acids. Dietary implications of fats and oils, MUFA, PUFA and SFA. Functions of proteins in the body, digestion and absorption. Essential and non-essential amino acids, Toxicity and imbalance, amino acid supplementation. Effects of deficiency. Food source and recommended dietary allowances. Nitrogen balance.

Unit-III

Vitamin A, D, E, K Dietary sources, RDA, adsorption, distribution, metabolism and excretion (ADME), Deficiency. Role of Vitamin A as an antioxidant, Role of vitamin K. Role of vitamin E as an antioxidant. Extra-skeletal role of vitamin D. Hypervitaminosis. Vitamin C role as cofactor. Niacin and NAD/ NADP. Vitamin B6-Dietary source, RDA, conversion to Pyridoxal Phosphate. Role in metabolism, Biochemical basis for deficiency symptoms. Vitamin B12 and folate; dietary source, RDA, absorption, metabolic role, biochemical basis for deficiency symptoms.

Unit-IV

Calcium, phosphorus, iodine, fluoride, Mg, Cu, Zn, Se, manganese, chromium, molybdenum and iron - distribution in the body digestion, absorption, utilization, transport, excretion, balance. anthropometric measurements. Biochemical assessment. ROS assessment, GTT and glycosylated Hb, Differential diagnosis of B12 and folate.

Suggested readings:

1. Textbook of Biochemistry with Clinical Correlations (2011) Devlin TM, John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
2. Nutrition for Health, Fitness and Sport (2016) 11th ed., Williams MH, Anderson DE and Rawson ES, McGraw Hill Education, ISBN: 978-0078021350

3. Krause's Food and Nutrition Care Process (2016) 14th ed., Mahan LK, Strings SE and Raymond, J, Elsevier's Publications. ISBN: 978-0323340755.
4. The vitamins, Fundamental aspects in Nutrition and Health (2017) 5th ed., Coombs Jr, GF and McClung JP, Academic Press. ISBN:978-0128029657
5. Nutritional Biochemistry: Current Topics in Nutrition Research (2015) 1st ed., Cox C, Apple Academic Press, ISBN: 978-1771881456

SEMESTER-III

Course title: Pharmaceutical Biochemistry **Credit: 4**
Course code: SIAL BC 1 3 04 DCEC 4004 **Lectures: 60**

Course objective: To apply the basic concepts in the specific field of Pharmaceutical Industry. The student will gain insight into the working of a pharma industry, various classes of biotech products and the regulations governing production and marketing of pharmaceutical products.

Learning outcomes:

- Understanding the structural and functional properties of cells, their chemical composition and their overall metabolism with special reference to the situation in man
- Identifying the causes of disease and effects of existing drugs and development of new modes of treatment

Unit-I

Definition, introduction, importance and history, drug, medicine, difference between drug and medicine, drug discovery process, methods of drug discovery and development.

Unit-II

Physicochemical properties in relation to biological action – effects of route of administration, drug targets, validation techniques of pharmaceutical targets, pharmacokinetics and pharmacodynamics of drugs, drug toxicity.

Unit-III

Introduction to vaccines, types of vaccine, importance of vaccine, DNA vaccines, vaccines & monoclonal antibody based pharmaceuticals, antibiotics, characterization and bioanalytical aspects of recombinant proteins as pharmaceutical drugs**.**

Unit-IV

formulation of biotechnological products, drug delivery, examples of some biotecnhological products in clinical development, food and drug administration (FDA) role of FDA, international council for harmonization (ICH), ICH guidelines, current good manufacturing practice (cGMP), importance of cGMP, the regulation of pharmaceutical biotechnological products and ethical issues.

Suggested readings:

1. An Introduction to Medicinal Chemistry (2018) International ed., Patrick G, Oxford University, ISBN: 978-0198796589
2. Pharmaceutical Biotechnology: Fundamentals and Applications (2019) 5th ed., Crommelin DJ, Sindelar RD and Meibohm B, Springer, ISBN: 978-3030007096.
3. Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications (2012) 2nd ed., Kayser O and Warzecha H, John Wiley & Sons, ISBN: 978-3527329946
4. The Indian Pharmaceutical Industry: Impact of Changes in the IPR Regime. (2018) 1st ed., Mitsumori Y, Springer, ISBN: 978-9811067907.
5. The Pharmacist Guide to Implementing Pharmaceutical Care (2018) 1st ed., da Costa, FA, van Mil JWF and Risco AA, Springer, ISBN: 978-3319925752

SEMESTER-III

Course title: Advance Molecular Biology **Credit: 4**
Course code: SIAL BC 1 3 03 GEC 4004 **Lectures: 60**

Course objective: To acquaint students with chromatin structure and gene expression, post-transcriptional events and translation.

Learning outcomes:

- Understanding the basic concepts of transcription and translation in prokaryotes and eukaryotes
- Understanding the mechanism of gene expression in prokaryotes and eukaryotes

Unit-I

DNA as genetic material; primary, secondary and three-dimensional structures of DNA; super coiling; forms of DNA; polytene and lamp brush chromosomes; properties of DNA in solution; denaturation and renaturation; reassociation reactions; COT curves; types of RNAs and their primary and secondary structure; role of RNA; unusual bases in RNA.

Unit-II

Replication of DNA and synthesis of RNA; central dogma of molecular biology; DNA and RNA polymerases and other enzymes involved in replication; mechanisms of replication; inhibitors of transcription; proof reading function and fidelity of DNA replication; possible modes of DNA replication; theta model and rolling circle model of DNA replication; replication of DNA in eukaryotes; role of methylation; replication of viral RNA; reverse transcriptase. Prokaryotic and eukaryotic gene structure; transposable elements in bacteria; mobile elements in eukaryotes; regulatory region and transcriptional unit of gene; post transcriptional processing of RNA: splicing, cap addition and polyadenylation polynucleotide phosphorylase; classification and molecular basis of mutation; Ames test and other testing systems; repair mechanism in prokaryotes and eukaryotes; site directed mutagenesis.

Unit-III

Translation; adapter role of RNA in protein synthesis; size of the code; methods of deciphering the genetic code; code word dictionary; general features of the genetic code; identification of anticodons ; wobble hypothesis; ribosome as the site of protein synthesis; polysomes ; activation of amino acids; initiation, elongation and termination of protein synthesis in prokaryotes and eukaryotes. Control of translation: role of guanine nucleotides; post-translational processing of the polypeptide chains; acetylation, methylation, phosphorylation by protein kinases; sulfation; glycosylation.

Unit-IV

Gene expression in prokaryotes; enzyme induction and repression; negative and positive control; concept of operon; catabolite repression; transcriptional termination control via mRNA alternative conformations; regulation of gene expression in eukaryotes; promoters ,enhancers and response elements; regulation at transcriptional level: Britten Davidson Model; control by steroid hormones. Role of chromatin structure in gene expression; cytoplasmic regulation of gene expression; organelle genome; epigenetics.

Suggested readings:

1. Lewin's Genes XII (2017) 12th ed., Krebs, JE, Goldstein, ES and Kilpatrick, ST, Jones and Bartlett Publishers, ISBN 13: 978-1284104493.

2. Molecular Biology of the Gene (2017) 7th ed., Watson, JD, Tania, B, Stephen PB, Alexander, G, Michael, L and Richard, L, Pearson Education, ISBN13: 978-9332585478.
3. Molecular Biology (2011) 5th ed., Weaver, RF, McGraw Hill, ISBN 13; 978-0073525327
4. Lehninger: Principles of Biochemistry (2017) 7th ed., Nelson, DL and Cox, MM, WH Freeman and Company (New York), ISBN 13: 978-1319108243.
5. Biochemistry (2017) 6th ed., Garrett, RH and Grisham, CM, Brooks/Cole, ISBN: 9781305577206.

SEMESTER-III

Course title: Stem Cell Biology **Credit: 4**
Course code: SIAL BC 1 3 04 GEC 4004 **Lectures: 60**

Course objective: The course will provide students with knowledge of wide-ranging topics related to stem cell and regenerative biology, including: a brief history of the field, research on animal models of regeneration, tissue engineering, and the political and ethical issues surrounding the stem cell debate.

Learning outcomes:

- Understanding how stem cells are derived for scientific research
- Compare and contrast tissue-specific stem cell types, and the basic mechanisms that regulate them

Unit-I

Introduction to Stem cell biology - What are stem cells (Properties, Existence), applications and current understanding of the stem cell technology.

Unit-II

Stem Cells in detail: embryonic stem cells, stem cells from adults. Pluripotency necessary, or is unipotency enough? What are the mechanisms? Stem-cell plasticity, regulators of pluripotency and differentiation of stem cell. The isolation, expansion, genetic manipulation, genomic reprogramming, and cloning of stem cells. The problem of differentiation of stem cells. Stem cells and imprinted genes. Differences between adult and embryonic stem cells, what types of cells adult stem cells can become.

Unit-III

Regenerative medicine: current stem cell therapies, How we can use stem cells for studying cancer and finding cures to other diseases, correlation between stem cells and cancer, stem cells and aging. Clinical applications of hematopoietic stem cells from cord blood first successful transplantation of cord blood in a child with Fanconi's anemia. Treatment of neural diseases such as Parkinson's disease, Huntington's disease and Alzheimer's disease. Repair of damaged organs such as the liver and pancreas.

Unit-IV

culture and differentiation of human pluripotent stem cells, classroom and laboratory experience in the techniques for deriving, culturing and differentiating human pluripotent stem cells (hPSCs) and related cell types.

Suggested readings:

1. Trends in stem cell biology and Technology (2009) Baharvand H, Humana Press, ISBN: 978-1603279048.
2. Essentials of Stem Cell biology (2013) 3rd ed., Lanza RP and Anthony A, Elsevier Academic Press, ISBN: 978-0124095038.
3. Stem Cell Therapy: A Rising Tide: How Stem Cells Are Disrupting Medicine and Transforming Lives (2017) Riordan NH, ISBN: 978-0999045305.
4. The Stem Cell Revolution (2015) Lander E and Berman MD, Author House, ISBN: 978-1504920018.
5. The Cell Biology of Stem Cells (2010) Eran M and Kathrin P, Springer, ISBN: 978-1441970374.

SEMESTER-IV

Course title: Dissertation **Credit: 20**
Course code: SIAL BT 1 4 01 SEEC 0020

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:
  .

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 organised 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 AND MARGIN:

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

5. MANUSCRIPT PREPARATION:

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.

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

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

5.3 **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 1.5line spacing.

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

5.5 **Table of contents** - The table of contents should list all material following it as wellas 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 under this head. A specimen copy of the Table of Contents for report / thesis is given in Annexure III.

5.6 **List of Table** - The list should use exactly the same captions as they appear above thetables 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.

5.7 **List of Figures** - The list should use exactly the same captions as they appear belowthe 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

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

5.9 **Chapters** - The chapters may include

Chapter I – Introduction

Chapter II - Literature Review

Chapter III –Materials and Methods

Chapter IV- Results and Discussion

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

1.11. List of References - Any works of other researchers, if used either directly orindirectly, 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. TYPING INSTRUCTIONS

6.1 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

6.2 Chapters The format for typing chapter headings, division headings and sub division 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 greencolor, 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