Department of Biochemistry and Microbial Sciences

School of Basic and Applied Sciences
Central University of Punjab, Bathinda

M.Sc. Program in Life Sciences

Specialization: Biochemistry

2018-19

Department for Biochemistry and Microbial Sciences

School of Basic and Applied Sciences
Central University of Punjab, Bathinda

Vision Statement

The department strives to synergize the study of biochemistry with health disparities research through innovation and collaboration and to provide the highest quality of translational biomedical research, education, and service. The curriculum for M.Sc. Life Sciences program with a specialization in biochemistry of the department is designed to train the students in the diverse branches of biochemistry. The department will also promote R&D activities in the emerging areas of biochemistry. The department is involved in the community service and awareness programs related to medical biochemistry and microbiology.

Mission of the Programme

The programme is committed to provide outstanding teaching in the biochemical sciences and to conduct quality research of international repute. The mission of the department is to train competent professional biochemists with the knowledge, skills and values required to address the need for high-level manpower in the country. The tranined students will further carry out creative, innovative and inventive research, and provide reliable services to the community.

Goals:

- Provide high-quality academic programmes in biochemistry.
- Provide graduates with a sound knowledge of the fundamental principles and practice of biochemistry.
- Recruit high quality students.
- Develop and maintain laboratories with state-of-the-art equipment.
- Conduct community service by offering special training programmes, awareness camps and community development.

Department for Biochemistry and Microbial Sciences

School of Basic and Applied Sciences
Central University of Punjab, Bathinda

M.Sc. Program in Life Sciences (Specialization: Biochemistry)

(Academic Session 2018-19)

Semester – I

Course Code	Course Title	L (hr)	T (hr)	P (hr)	Cr
	Compulsory Foundation				
LMS.513	Research Methodology and Biostatistics	3	1	-	4
	Core				
LBC.506	Biochemistry	3	-	-	3
LMS.507	Microbiology	3	-	-	3
LMS.508	Cell Biology	3	-	-	3
LBC.509	Essentials of Genetics	3	-	-	3
LBC.510	Life Sciences Practical-I (Practical)	-	-	10	5
	Interdisciplinary Course (IDC)				
LBC.512	Basics of Biochemistry (IDC)	2	-	-	2
	Total Credits				**23**

L: Lectures; T: Tutorial; P: Practical; Cr: Credits

Instructional Designs/ Mode of classroom Transaction:

1) Lecture
2) Demonstration
3) Lecture cum demonstration
4) Experimentation
5) Self-learning
6) Group discussion

Semester I – 23 credits
Semester II – 23 credits
Semester III – 23 credits
Semester IV – 22 credits

Total – **91 credits**

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Foundation Courses

LMS.513: Research Methodology and Biostatistics

Learning Objective: To ensure that the student understands various aspects of research methods, ethics, technical and scientific writings and literature search. This course will also help the students to understand the complex outcome of their results using biostatistical approaches in testing hypothesis, designing experiments, analyzing experimental data and interpreting the results.

Unit	Syllabus	Lectures
1.	**General Principles of Research:** Meaning and importance of research, critical thinking, formulating hypothesis and development of research plan, review of literature, interpretation of results and discussion. Scientific writing: writing synopsis, research manuscript and dissertation. Literature search and survey, e-Library, web-based literature search engines. Research presentation and poster preparation.	15
2.	**Bioethics and Biosafety:** Good Laboratory Practices, Sterilization techniques, Cell and tissue culture techniques: Plants and animals. Biosafety for human health and environment. Biosafety issues for using cloned genes in medicine, agriculture, industry, and ecoprotection. Genetic pollution, Risk and safety assessment from genetically engineered organisms. Ethical theories, Ethical considerations during research, Ethical issues related to animal testing and human project. Intellectual property rights (IPRs), Patents copyrights and Fair use, plagiarism and open access publishing.	15
3.	**Overview of Biostatistics:** Differences between parametric and non-parametric statistics, Univariant and multivariant analysis. Frequency distribution. Mean, Median, Mode, Probability Distribution, Standard deviation, Variation, Standard error, significance testing and levels of significance, Hypothesis testing. Measures of central tendency and dispersal, Histograms, Probability distributions (Binomial, Poisson and Normal), Sampling distribution, Kurtosis and Skewness.	15
4.	**Inferential Statistics:** Student's t-test, Paired t-test, Mann-Whitney U-test, Wilcoxon signed-rank, One-way and two-way analysis of variance (ANOVA), Critical difference (CD), Least Significant Difference (LSD), Kruskal–Wallis one-way ANOVA by ranks, Friedman two-way ANOVA by ranks, χ^2 test. Standard errors of regression coefficients and types of correlation coefficient.	15

Suggested Reading:

1. Gupta, S. (2005). *Research Methodology and Statistical Techniques.* Deep & Deep Publications (p) Ltd. New Delhi.
2. Kothari, C.R. (2008). *Research Methodology (s).* New Age International (p) Limited. New Delhi.
3. Fleming, D. O. and Hunt, D.L. (2006). *Biological Safety: Principles and Practices*. American Society for Microbiology, USA.
4. Rockman, H. B. (2004). *Intellectual Property Law for Engineers and Scientists*. Wiley-IEEE Press, USA.

5. Shannon, T. A. (2009). *An Introduction to Bioethics*. Paulist Press, USA.
6. Vaughn, L. (2009). *Bioethics: Principles, Issues, and Cases.* Oxford University Press, UK.
7. WHO (2005). *Laboratory Biosafety Manual*. World Health Organization.
8. Norman, G. and Streiner, D. (2008). *Biostatistics: The Bare Essentials*, Decker Inc. USA, 3rd edition.
9. Myra L. Samuels, Jeff Witmer, Andrew Schaffner (2003). *Statistics for the Life Sciences*. Prentice Hall publishers, 4th edition
10. Sokal, R.R. and Rohlf, F.J. (1994). *Biometry: The Principles and Practices of Statistics in Biological Research.* W.H. Freeman publishers. 3rd edition.
11. Emden, H.V. (2008). *Statistics for Terrified Biologists*. Blackwell publishers

Core Courses

LBC.506: Biochemistry

Learning Objective: The course is designed to teach fundamental and basics of biochemistry and to prepare them for advanced courses in biochemistry.

Unit	Syllabus	Lectures
1.	**Principles of Biophysical Chemistry:** pH, Water, Buffer, Reaction kinetics, Laws of Thermodynamics, Colligative properties, Structure of atoms, Molecules and chemical bonds. **Composition, Structure and Function of Biomacromolecules:** Carbohydrates, Lipids, Proteins, and Nucleic acids. Primary, Secondary, Tertiary and Quaternary structures of proteins, Domains, Motifs and Folds, Stability of protein. **Techniques:** Chromatography: Thin layer chromatography (TLC), gel filtration, ion exchange and affinity chromatography, GC, HPLC and LC-MS Spectrometry: Circular Dichroism, Nuclear Magnetic Resonance and atomic absorption spectroscopy.	12
2.	**Enzymology:** Enzyme classification, Principles of catalysis, Mechanism of enzyme catalysis, Enzyme kinetics, Michaelis-Menten equation and Lineweaver Burk plots, Enzyme regulation, Isozymes and Clinically important enzymes.	12
3.	**Carbohydrate and Lipid Metabolism:** Carbohydrate metabolism: Glycolysis, Kreb's Cycle, Electron transport chain, Pentose phosphate pathway, Gluconeogenesis, Glycogen metabolism; Lipid Metabolism: Fatty acid catabolism, Lipid biosynthesis.	12
4.	**Amino Acid and Nucleic Acid Metabolism**: Amino acid biosynthesis and catabolic pathways; Nucleotide synthesis and degradation pathways.	12

Suggested Reading:

1. Berg, J.M., Tymoczko, J.L., Gatto, Jr., G.J., and Stryer, L. (2015). *Biochemistry,* 8th Edition, W.H. Freeman.
2. Nelson, D. and Cox, M.M. (2017). *Lehninger Principles of Biochemistry,* 7th Edition, W.H. Freeman.
3. Garrett, RH, Grisham, CM. (2012). *Biochemistry*, 5th Edition, Cengage Learning.
4. McKee, T and McKee, JR. (2015). *Biochemistry: The Molecular Basis of Life,* 6th Edition,

Oxford University Press

LMS.507: Microbiology

Learning Objective: Students will learn the basics of microbes, microbial growth, their application in day to day life and beneficial versus harmful micro-organisms.

Unit	Syllabus	Lectures
1.	**Microbial Systematics:** Major characteristics used in taxonomy – morphological, physiological and metabolic, genetic and molecular taxonomy. Classification of bacteria and Archaea according to the Bergey's Manual of Systematic Bacteriology and their economic significance. **Introduction to Microbiology:** Scope and history of Microbiology, Cell structure, different components, function and their significance for bacteria and archaea. Algae, and viruses.	12
2.	**Growth, Nutrition & Control:** Phases in bacterial growth, Growth Curve, Calculation of G-time, Physical and environmental requirements of growth, Microbial nutrient requirements – macro-nutrients, micro-elements – growth factors - sources of nutrients – nutritional classification of bacteria - Phototroph, Chemotroph, Autotroph (lithotroph), Heterotroph (organotroph), Photoautotroph, Photoheterotroph, Chemoautotroph, Chemoheterotroph - Nutritional patterns of pathogens – Saprophytes – Auxotroph	12
3.	**Fungal Systematics and Diversity:** General features of fungi- cell structure; growth, environmental conditions for growth; nutrition and life cycle patterns, Endophytic fungi as latent pathogens and biocontrol agents. Economic importance of fungi and yeast. **General Virology**: Morphology, viral genome – types and structures; nomenclature and classification of virus (Animal, plant, bacterial viruses). Life cycle and replication of animal viruses, Introduction to some emerging viral diseases.	12
4.	**Algae:** Classification; reproduction and life cycles; algal toxins, algal bloom, algae as a source of antibiotics, importance of algae in production of algal pigments and biofuels. **Protozoa:** General account, structure, reproduction and classification of protozoa. Introduction to important protozoan diseases.	12

Suggested Reading:

1. Bauman, R.W. (2011). *Microbiology with Diseases by Body System*. Benjamin Cummings, USA.
2. Capuccino, J.G. and Sherman, N. (2004). *Microbiology-A Laboratory Manual*. Benjamin Cummings, USA.
3. Pelczar, M. J., Chan, E.C.S. and Krieg, N.R. (2001). *Microbiology: Concepts and Applications*. McGraw-Hill Inc. USA.
4. Pommerville, J.C. (2010). *Alcamo's Fundamentals of Microbiology*. Jones & Bartlett Publishers, USA.
5. Prescott, L.M., Harley, J.P. and Klein, D.A. (2005). *Microbiology*. McGraw-Hill Science, USA.
6. *Experiments In Microbiology, Plant Pathology and Biotechnology*. 4th Edition (2010). New Age Intl. Publishers Ltd. - New Delhi

Additional Reading:

7. Strelkauskas, A., Strelkauskas, J. and Moszyk-Strelkauskas, D. (2009). *Microbiology: A Clinical Approach.* Garland Science, New York, USA.

8. Tortora, G.J., Funke, B.R. and Case, C.L. (2009). *Microbiology: An Introduction.* Benjamin Cummings, USA

LMS.508: Cell Biology

Learning Objective: Students will understand the structure and basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles and their related functions.

Unit	Syllabus	Lectures
1.	**Introduction to the Cell:** Evolution of the cell, From molecules to first cell, From prokaryotes to eukaryotes, Prokaryotic and eukaryotic genomes and single cell to multicellular organisms. **Membrane Structure and Function:** Models of membrane structure, Membrane proteins, Membrane carbohydrates, Membrane transport of small molecules, Membrane transport of macromolecules and particles. Techniques: Types of Microscopy (phase contrast, fluorescent, electron microscopy (SEM/TEM), Scanning-probe, Atomic force and, Confocal microscopy. Centrifugation: Principle and applications and types (Differential, Density Gradient, Iso-density centrifugation)	12
2.	**Structural Organization and Function of Intracellular Organelles**: Structure and function of nucleus, Ribosomes, lysosomes, peroxisomes, Golgi apparatus, endoplasmic reticulum, mitochondria and chloroplast. Oxidation of glucose and fatty acids, Electron transport oxidative phosphorylation, and photosynthesis. **Protein Secretion and Sorting:** Organelle biogenesis and protein secretion, synthesis and targeting. Intracellular traffic, vesicular traffic in the secretary pathway, protein sorting in the Golgi bodies, traffic in the endocytic pathway, exocytosis.	12
3.	**The Cytoskeleton:** The nature of cytoskeleton, Intermediate filaments, Microtubules, Actin filaments, Cilia and centrioles, Organization of the cytoskeleton. **Cell communication and cell signaling:** Cell adhesions, Cell junctions and the extra cellular matrix, Cell-cell adhesion and communication, Cell matrix adhesion, Collagen the fibrous protein of the matrix, Noncollagen component of the extra cellular matrix.	12
4.	**Cell Growth and Division:** Overview of the cell cycle and its control, The molecular mechanisms for regulating mitotic and meiotic events, Amitosis, Cell cycle control, Checkpoints in cell cycle regulation. Cell to cell signaling, Overview of the extra cellular signaling, Identification of cell surface receptors, G-protein coupled receptors and their effectors, Second messengers, Enzyme-linked cell surface receptors, Interaction and regulation of signaling pathways.	12

Suggested Reading:

1. Alberts, B., Bray, D., Lews, J., Raff, M., Roberts, K. and Watson, J.D. (2010). *Molecular Biology of the Cell*. Garland publishers, Oxford.
2. Celis, J.E. (2006). *Cell biology: A laboratory handbook*, Vol 1, 2, 3. Academic Press, UK.
3. Gupta, P.K. (2008). *Cytology, Genetics and Evolution*. Rastogi publications, Meerut, India.

4. Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*. John Wiley &Sons. Inc. New Delhi, India.
5. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
6. Lodish H, Berk A, Kaiser CA, Krieger A, Scott MP, et al. (2012). *Molecular Cell Biology*, W. H. Freeman; USA

LBC.509: Essentials of Genetics

Learning Objective: Students will learn the basic principles of inheritance at the molecular, cellular and organismal levels.

Unit	Syllabus	Lectures
1.	**Mendelian Principles:** Dominance, segregation, independent assortment, Allele, multiple alleles, pseudoallele, complementation tests **Extensions of Mendelian Principles:** Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters. **Extra-Chromosomal Inheritance:** Chloroplast and Mitochondrial inheritance; Cytoplasmic inheritance (Coiling in Snails).	12
2.	**Gene Mapping Methods:** Molecular markers: RAPD, RFLP, SSR, SNP, ISSR, and SCAR; Linkage maps, tetrad analysis in *Neurospora*, mapping with molecular markers, development of mapping population in plants **Human Genetics:** Pedigree analysis, LOD score for linkage testing, karyotypes, genetic disorders **Quantitative Genetics:** Polygenic inheritance, heritability and its measurements, QTL mapping	12
3.	**Mutation:** Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis, applications in reverse and forward Genetics; Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications; Hardy Weinberg equilibrium. Molecular basis of spontaneous and induced mutations. **Recombination:** Site-specific, homologous, DNA transposition, retrotransposition and non-homologous end joining (NHEJ).	12
4.	**Microbial Genetics**: Microbes as tools for genetic studies. Organization of genetic material in bacteria; and viruses, Gene transfer mechanisms, F plasmid; Lambda phage: structure, genetic makeup and life cycle (lytic and lysogeny); Natural transformation and competence; Molecular basis of natural transformation – DNA uptake competence systems in gram positive and gram negative bacteria. Bacterial Conjugation- Properties of the F plasmid, F+ x F - mating, F' x F- conjugation. Transduction- Generalized and specialized transduction, virus life cycle and replication	12
Suggested Reading:		

1. Snusted, D.P., Simmons, M. J. (2012). *Principles of Genetics*. 6th Edition, John Wiley & Sons, New York.
2. Raven P, Johnson GB, Mason KA, Losos JB, Singer SS (2014). *Biology*, 10th Edition, McGraw-Hill, USA.
3. Griffiths AJF, Wessler SR, Carroll SB, Doebley J (2015). *An introduction to Genetic Analysis*. 11th Edition W.H. Freeman publication, USA.
4. Larry Snyder, Larry Snyder, Joseph E. Peters, Tina M. Henkin, Wendy Champness (2013) *Molecular Genetics of Bacteria*, 4th edition; ASM Press.
5. Watson, J.D., Baker,T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2014). *Molecular Biology of the Gene*. 7th Edition, Benjamin Cummings, USA.

LBC.510: Life Sciences Practical-I (Practical)

Learning Objective: In this course the students will observe and will be given hands on training for the practicals pertaining to theory courses of biochemistry, microbiology, cell biology & genetics.

Part A. Biochemistry

1. Introduction to Good Laboratory Practices
2. Preparation of solutions, buffers, pH setting etc.
2. Quantitative estimation of proteins, sugars, total lipids and amino acids.
3. Isolation of protein from biological sample
4. Enzyme activity assays: invertase, amylase, alkaline phosphatase
5. Quantitative estimation of phenolic compounds.

Part B. Microbiology

1. Use of Microscope and working in a biosafety cabinet; Preparation of growth media: Liquid and Solid media
2. Microbiological techniques for isolation of pure cultures: Streak Plate, Spread Plate and Pour Plate techniques
3. Staining of bacterial cultures: Simple staining, Negative Staining, Gram Staining, Acid-Fast stain.
4. Glucose uptake by *E. coli* / *Saccharomyces cerevisiae* (Active and Passive diffusion)
5. Effect of UV, gamma radiations, pH, disinfectants, chemicals and heavy metal ions on micro-organisms.
6. Preparation of microbiological media. Autotrophic media, minimal media, basic media, enriched media, enrichment media, differential media.

Microbial growth studies.

7. Isolation of bacterial cultures from different sources (soil, air, water) and determination of CFU.
8. Testing of Antibiotic sensitivity/resistance
9. Use of selective and/or differential media for isolation and identification of specific bacterial cultures
10. Biochemical tests to characterize bacterial cultures: Catalase test, Oxidase test, Methylene blue test

Part C. Cell Biology

1. Temporary staining for epithelial cells and blood cells.
2. Cell count using haemocytometer
3. Preparations of temporary mount and study the different stages of Mitosis (Onion root tip).
4. Study of polyploidy in onion root tip by colchicine treatment.
5. Study of structure of cell organelles through electron micrographs
6. To demonstrate the presence of mitochondria and other cell organelles using vital stains
7. Depicting nature of cellular membranes: Osmosis, Hypertonicity, Hypotonicity, Isotonicity
8. Preparation of cell culture media

Part D. Genetics

1. Learning Blood group typing with its genetic basis.
2. Identification of inactivated X chromosome as Barr body and drumstick
3. To demonstrate and understand the principle of Hardy-Weinberg equilibrium. Calculation of genotypic and allelic frequencies for a specific trait in a random sample
4. Techniques for screening and isolation of bacterial cultures with specific phenotypic/genotypic characteristics.
5. Differentiating genetic variants (species/strains) using RFLP
6. Studying *Drosophila melanogaster* as a Model organism: Identification of normal and mutant flies (*Drosophila melanogaster*), Demonstration of *Drosophila* polytene chromosomes

- Practical may be added/modified from time to time depending on available faculties/facilities.

Interdisciplinary Course

LBC.512: Basics of Biochemistry (IDC)

Learning Objective: This is an interdisciplinary course to acquaint the students of different streams with a very basic knowledge and understanding of biomolecules, their structure, composition and function.

Unit	Syllabus	Lectures
1.	**Principles of Biophysical Chemistry:** pH, Buffer, Reaction kinetics, Thermodynamics. **Composition, Structure and Function of Biomolecules:** Carbohydrates, Lipids, Proteins: Primary, Secondary, Tertiary and Quaternary structures, Nucleic acids and Vitamins.	7
2.	**Carbohydrate and Protein Metabolism:** Carbohydrate metabolism; Glycolysis, Kreb's Cycle, Hexose monophosphate shunt pathway, Glycogenolysis, Glycogenesis. Protein metabolism, Urea Cycle.	8
3.	**Fatty acid and Nucleic Acid Metabolism:** Fatty acid catabolism and synthesis; Degradation and synthesis of nucleotides.	8
4.	**Enzymology:** Classification of enzymes, Principles of catalysis, Mechanism of enzyme catalysis, Effect of pH and temperature on enzyme activity, Application of enzymes in day to day life. Isozymes.	7

Suggested Reading:

1. Satyanarayana, U. (2013) *Biochemistry*, Publisher: Elsevier; Fourth edition ISBN-9788131236017.

2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2010). *Biochemistry.* W.H. Freeman & Company. USA.
3. Nelson, D. and Cox, M.M. (2008). *Lehninger Principles of Biochemistry*. BI publications Pvt. Ltd. Chennai, India.

Additional Reading:

1. Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*. John Wiley & Sons. Inc. New Delhi, India.

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Semester – II

Course Code	Course Title	L (hr)	T (hr)	P (hr)	Cr
	Compulsory Foundation				
CST.501	Computer Applications/MOOCs	2	-	-	2
CST.502	Computer Applications Lab	-	-	4	2
	Elective Foundation				
XXX	Choose from value based courses/ MOOCs	1	-	-	1
	Core				
LMS.521	Immunology	3	-	-	3
LBC.522	Molecular Biology	3	-	-	3
LBC.524	Enzymology and Enzyme Technology	3	-	-	3
LBC.525	Metabolism-I	3	-	-	3
LBC.526	Biochemistry Practical-I (Practical)	-	-	2	1
LBC.527	Life Sciences Practical-II (Practical)	-	-	6	3
	Interdisciplinary Course (IDC)				
LMS.529	Basics of Microbiology (IDC)	2	-	-	2
	Total Credits				**23**

L: Lectures; T: Tutorial; P: Practical; Cr: Credits

Instructional Designs/ Mode of classroom Transaction:

1) Lecture
2) Demonstration
3) Lecture cum demonstration
4) Brain storming
5) Problem solving
6) Experimentation

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Compulsory Foundation

CST.501: Computer Applications

Learning Objective:

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

1. Use different operating system and their tools easily.
2. Use word processing software, presentation software, spreadsheet software and latex.
3. Understand networking and internet concepts.
4. Use computers in every field like teaching, industry and research.

Unit	Syllabus	Lectures
1.	**Computer Fundamentals:** Introduction to Computer, Input devices, Output Devices, Memory (Primary and Secondary), Concept of Hardware and Software, C.P.U., System bus, Motherboard, Ports and Interfaces, Expansion Cards, Ribbon Cables, Memory Chips, Processors, Software: Types of Software, Operating System, User Interface of popular Operating System, Introduction to programming language, Types of Computer.	8
2.	**Computer Network:** Introduction to Computer Network, Types of Network: LAN, WAN and MAN, Topologies of Network, Internet concept, WWW. **Word Processing using MS Word**: Text creation and Manipulation; Table handling; Spell check, Hyper-linking, Creating Table of Contents and table of figures, Creating and tracking comments, language setting and thesaurus, Header and Footer, Mail Merge, Different views, Creating equations, Page setting, Printing, Shortcut keys.	7
3.	**Presentation Tool:** Creating Presentations, Presentation views, Working on Slide Transition, Making Notes Pages and Handouts, Drawing and Working with Objects, Using Animations, Running and Controlling a Slide Show, Printing Presentations, Shortcut keys. **Spread Sheet**: Entering and editing data in cell, Basic formulas and functions, deleting or inserting cells, deleting or inserting rows and columns, printing of Spread Sheet, Shortcut keys.	8
4.	**Use of Computers in Education and Research**: Data analysis tools, e-Library, Search engines related to research, Research paper editing tools like Latex.	7

Suggested Reading:

1. Sinha, P.K. Computer Fundamentals. BPB Publications.
2. Goel, A., Ray, S. K. 2012. Computers: Basics and Applications. Pearson Education India.
3. Microsoft Office Professional 2013 Step by Step https://ptgmedia.pearsoncmg.com/images/9780735669413/samplepages/9780735669413.pdf

CST.502: Computer Applications Lab

Lab assignments will be given to students based on the theory course, CST.501.

Core Courses

LMS.521: Immunology

Learning Objective: The objective of this course is to instill awareness on basics of immune system where students will learn the components of immunity and various immune responses that work together to protect the host.

Unit	Syllabus	Lectures
1.	**Immune System:** Overview of immune system; cells and organs of immune systems; innate and recognition of self and non-self. Nature of antigen. Components of acquired immunity. Humoral immunity and cell mediated immunity. Immunoglobulins, basic structure, classes and subclasses, structural and functional relationships. **Molecular Mechanisms of Antibody Diversity and Cellular Immunity:** Organization of genes coding for constant and variable regions of heavy chains and light chains, antibody diversity & class switching. **Complement System:** Complement components, their structure and functions and mechanisms of complement activation by classical, alternative and lectin pathway.	12
2.	**Functions of Acquired Immunity:** Types and characterstics of Lymphocytes, cytokines, chemokines, interferons, interleukins, antigen recognition-membrane receptors for antigens. Structure and functions of Major Histocompatibility Complex (MHC) and Human Leukocyte Antigen (HLA) system, polymorphism, distribution variation and function. Association of MHC with disease and superantigen, recognition of antigens by T and B-cells, antigen processing, role of MHC molecules in antigen presentation and co-stimulatory signals.	12
3.	**Immunity and Human Diseases:** Types of hypersensitivity, features and mechanisms of immediate and delayed hypersensitivity reactions, immunity to microbes, immunity to tumors, AIDS, hepatitis and human immune-deficiencies and allergies. Recent advances in vaccine development for diseases like AIDS, cancer and malaria. Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines.	12
4.	**Monoclonal Antibodies and Diagnostic Immunology:** Immunotoxins production, characterization and applications in diagnosis, therapy and basic research. Antibody genes and antibody engineering- chimeric and hybrid monoclonal antibodies. Methods for immunoglobulin determination-quantitative and qualitative antigen and antibody reactions, agglutination-precipitation, immunocytochemistry, radioimmunoassay (RIA), Enzyme Linked Immunosorbent Assay (ELISA), immunofluorescence, immunoblotting and Flow cytometry.	12

Suggested Reading:

1. Kindt, T.J., Osborne, B.A. and Goldsby, R.A. (2007). *Kuby Immunology* .7th Edition. W.H. Freeman, USA.
2. Abbas. (2008). *Cellular and Molecular immunology*. CBS Publishers & Distributors, India.
3. Charles, A. and Janeway, J.R. (1994). *Immunobiology: The immune system in health and*

disease. Blackwell Publishing, USA.

4. Delves, P.J., Roitt, I.M. and Seamus, J.M. (2006). *Roitt's essential immunology (Series–Essentials).* Blackwell Publishers, USA.
5. Elgert K.D. (2009). *Immunology: Understanding the immune system*. Wiley-Blackwell, USA.

Additional reading:

6. Paul, W.E. (1993). *Fundamental immunology.* Raven Press, SD, USA.
7. Sawhney, S.K. and Randhir, S. (2005). *Introductory practical biochemistry*. Alpha Science International Ltd. New Delhi, India.
8. Tizard (2008). *Immunology: An Introduction*. Cengage Learning, Thompson, USA.

LBC.522: Molecular Biology

Learning Objective: This course is designed for understanding the molecular processes of DNA replication, transcription, translation, and basic mechanisms of cellular signal transduction and regulation of gene expression.

Unit	Syllabus	Lectures
1.	**Structure and Conformation of Nucleic Acids:** Structure of DNA, Denaturation and Renaturation, Conformation of nucleic acids (A, B, Z), Organelle DNA **Genome organization:** Chromosome Structure, Chromatin and its regulation, nucleosome and its assembly, repetitive DNA, interrupted genes, gene shuffling **Molecular Techniques and Bioinformatics:** Gel electrophoresis, Southern, Northern, Western, hybridization, DNA fingerprinting, cloning, PCR, real-time PCR, DNA sequencing including NGS, microarrays, chromatin immunoprecipitation, metabolomics, proteomics, biological databases and searches, analysis of genomic and proteomic data, DNA-protein interactions, protein-protein interactions, protein sequencing, emerging techniques	12
2.	**DNA Replication and Repair:** Prokaryotic and eukaryotic DNA replication, Mechanism of DNA replication, Enzymes and accessory proteins involved in DNA replication, Replication errors, DNA damage and repair, gene editing. **Transcription and mRNA Processing:** Types of RNA, Prokaryotic &, eukaryotic transcription, general and specific transcription factors, Regulatory elements and mechanisms of transcription regulation, Transcriptional and posttranscriptional gene silencing: Initiation, Elongation & Termination of transcription, Capping, Polyadenylation, Splicing, editing, mRNA stability, RNA interference and microarray analysis, RNA editing	12
3.	**Translation:** Genetic code, prokaryotic & eukaryotic translation, the translation machinery, mechanisms of chain initiation, elongation and termination, regulation of translation, co-and post- translational modifications, mode of action of antibiotics	12
4.	**Gene Regulation:** Prokaryotic – lac, trp, gal and ara operons, lambda gene regulation during lysogeny and lytic cycle; Eukaryotic – yeast, higher eukaryotes, hormonal regulation of genes, epigenetic regulation; Gene network analysis, coexpression; Recent trends.	12

Suggested Reading:

1. Watson, J.D., Baker,T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2014). *Molecular Biology of the Gene*. 7th Edition, Benjamin Cummings, USA.
2. Krebs, J.E., Goldstein, E.S., Kilpatrick, S.T. (2014). *Lewin's Genes XI.* Jones & Bartlett Learning, USA.

3. Green, M.R., Sambrook, J. (2012). *Molecular cloning: A laboratory manual*. Cold Spring Harbor Laboratory Press, New York.

LBC.524: Enzymology and Enzyme Technology

Learning Objective: In this course, the students will learn about enzymes, their classification, structure, function and interaction.

Unit	Syllabus	Lectures
1.	**Historical Perspective, Enzyme Classification**: Recommendation and Systemic Nomenclature. **Enzyme Chemistry:** Subcellular Distribution of Enzymes. Isolation and Purification of Enzymes, Criteria for Enzyme homogeneity, General Properties, Enzyme Activity, Specific Activity and Turnover Number, Marker Enzymes.	12
2.	**Mechanism of Enzyme Action:** Enzyme-substrate complementarity, Stereochemistry of enzyme substrate action, acid base and covalent catalysis, factors associated with catalytic efficiency – orientation, distortion and strain, induced fit hypothesis. **Structure and Function of Selected Enzymes:** Chemical modification of active-site group, substrate /- driven mutagen etc. Chymotrypsin, Glyceraldehyde-3P-Dehydrogenase, Serine and Cysteine Proteases. **Multi Enzyme Complexes:** Occurrence, isolation & their properties: Mechanism of action and regulation of pyruvate dehydrogenase & fatty acid synthase complexes. Enzyme-enzyme interaction, multiple forms of enzymes with special reference to lactate dehydrogenase.	12
3.	**Enzyme Kinetics**: Enzyme-Substrate Interaction, ES Complex, Binding Site, Active Site. Specificity, Steady-State, Pre- Steady State and Equilibrium-State Kinetics, Michael- Menten Equation and its derivation, Graphical Methods for determination of K_m, V_{max}. Significance. **Factors Affecting of Enzyme-catalysed Reaction:** Enzyme, Substrate, pH, temperature. Collision and transitional state theories, Significance of Activation, Energy, Mechanism of bisubstrate and multisubstrate reaction, Methods for identifying mechanism.	12
4.	**Enzyme Inhibition and Activation:** Types of inhibition, and activation, Kinetics of competitive, non-competitive and uncompetitive inhibition, Determination of K_i, Suicide Inhibitors. **Enzyme Regulation:** Allosteric and Hysteric Enzymes, Proenzymes-Zymogens and activation. **Immobilized Enzymes:** Immobilization methods, Kinetics, Industrial applications. Various types of enzymatic bioprocesses and Bioreactors used in enzymatic processes.	10

Suggested Reading:

1. Palmer, T. (1995) *Understanding Enzymes*. Fourth edition, Prentice Hall.
2. Shukla, AN. (2009) *Elements of Enzymology*, Discovery Publishing house, New Delhi.
3. Price, NC, and Stevens, L. (1999) *Fundamentals of Enzymology*, Third edition, Oxford University Press.
4. Stein, RL. (2011) *Kinetics of Enzyme Action*, Wiley.

5. Bisswanger, H. (2008) *Enzyme Kinetics*, Wiley-VCH.
6. Marangoni, AG (2003) *Enzyme Kinetics*, Wiley.
7. Yon-Kahn, J and Herve, G. (2010) *Molecular and Cellular Enzymology*, Springer.
8. J.E. Bailey and D.F. Olis. Biochemical Engineering fundamentals 2nd Edition.Mcgraw Hill Publication
9. Segel and Irwin H.. Enzyme kinetics, behavior and analysis of rapid equilibrium and steady-state enzyme systems. ACS Publication.

LBC.525: Metabolism-I

Learning Objective: The course will provide insights into bioenergetics, various components of cells essential for energy generation and their biosynthesis.

Unit	Syllabus	Lectures
1.	Bioenergetics – Concept of free energy, standard free energy, determination of ΔG for a reaction. Relationship between equilibrium constant and standard free energy change, biological standard state & standard free energy change in coupled reactions. Biological oxidation-reduction reactions, redox potentials, relation between standard reduction potentials & free energy change. High energy phosphate compounds – introduction, phosphate group transfer, free energy of hydrolysis of ATP and sugar phosphates along with reasons for high ΔG. Energy change.	14
2.	Fundamentals of Biological Membranes - Membrane lipids and proteins, Membrane receptors, Transport of ion across plasma membrane, Transepithilial transport of solute and water, Electrical excitability and action potential.	10
3.	Coenzymes and Cofactors – Role and mechanism of action of NAD+ /NADP+, FAD, lipoic acid, thiamine pyrophosphate, tetrahydrofolate, biotin, pyridoxal phosphate, B12 coenzymes and metal ions with specific examples.	10
4.	Carbohydrates – Glycolysis, various forms of fermentations in micro-organisms, citric acid cycle, its function in energy generation and biosynthesis of energy rich bond, pentose phosphate pathway and its regulation. Gluconeogenesis, glycogenesis and glycogenolysis, glyoxylate and gamma aminobutyrate shunt pathways, Cori cycle, anaplerotic reactions, Entner-Doudoroff pathway, glucuronate pathway. Carbohydrate metabolism.	14

Suggested Reading:

1. Campbell, MK and Farrell, SO. (2002) Biochemistry, 4th ed. Brooks/Cole Pub Co.
2. Davidson, VL and Sittman, DB (1999) Biochemistry NMS, 4th ed. Lippincott. Willams and Wilkins.
3. Voet, D and Voet JG (2011) Biochemistry, 4th ed. Wiley
4. Kuchel, Philip W., et al. (1988) *Schaum's outline of theory and problems of biochemistry*. 2nd ed. McGraw-Hill.
5. Rodwell V, Bender D, Botham KM, Kennelly PJ and Weil PA (2015) Harper's Biochemistry. 30th ed. McGraw Hill.
6. Nelson DL and Cox MM (2004) Lehninger's Principles of Biochemistry, 4th ed. WH Freeman.
7. Berg JM, Tymoczko JL, Stryer L, Gregory J, Jr. Gatto (2010) Biochemistry, WH Freeman, 7th ed.
8. Lodish, H, Birk, A, et al. (2012) *Molecular Cell Biology*. 7th ed. WH Freeman.
9. Nelson DL and Cox MM (2012) Lehninger's Principles of Biochemistry, 6th ed. WH Freeman.
10. Filnean JB, Coleman R and Michell RH (1984) *Membranes and their cellular functions.* 3rd ed.

Blackwell scientific publishers, Oxford.

LBC.526 Biochemistry Practical-I (Practical): In this course the students will observe and perform experiments related to enzymology and metabolism will enhance their laboratory skills, and scientific knowledge.

1. Preparation of Chromic acid for glassware cleaning. 2. Prepration of calibration curves. 3. Determination of protein by Biuret and Lowry's method. 4. Determination of protein by Bradford method. 5. Quantitaive estimation of glucose by glucose oxidase method 6. Estimation of fructose and glucose in honey 7. Isolation of casein from milk and its quantification 8. Isolation of gluten, glutelin and gliadin from wheat. 9. Enzyme assay for Salivary amylase i.Activity ii.Determination of optimum pH iii.Determination of optimum temperature iv.Determination of Km v.Determination of specific activity 10. Acid phosphatase activity in plant tissue
• Practicals may be added/modified from time to time depending on available faculties/facilities.

LBC.527: Life Sciences Practical-II (Practical)

Learning Objective: The students will be learning to design, perform, observe and trouble shoot the practicals pertaining to theory courses of immunology and molecular biology. The advanced techniques used during the practicals will also motivate the students and stimulate their interest in respective fields.

Part A. Immunology 1. To perform Total Leukocyte Count of the given blood sample. 2. To perform Differential Leukocyte Count of the given blood sample. 3. Separation of serum from blood. 4. Double immunodiffusion test using specific antibody and antigen. 5.To perform immunoelectrophoresis using specific antibody and antigen. 6. Dot Immuno blot assay (DIBA). 7. ELISA 8. Polyacrylamide gel electrophoresis and Western blotting. 9. Isolation of mononuclear cells from peripheral blood and viability test by dye exclusion method. 10. Growth and maintenance of cell lines. 11. Trypsinization method for recovery of cells from monolayer. 12. Cytotoxic assay method for a given cell line and testing by trypan blue dye exclusion

method.
13. Demonstration of Flow Cytometry.
14. Immunohistochemistry: H & E staining, Fluorescent staining, Fluorescent Microscopy, Confocal Microscopy

Part B. Molecular Biology
1. Isolation of genomic DNA
2. DNA amplification by Polymerase Chain Reaction (PCR).
3. Ligation and E.coli transformation using chemical transformation, plating, colony selection,
4. Isolation of plasmid DNA, restriction enzyme digestion and agarose gel electrophoresis.
5. Construction of restriction map by single and double digestion, Designing DNA probe, Southern blot hybridization (demonstration only).
6. RNA isolation from biological samples.
7. cDNA synthesis and real time PCR (qPCR).
8. DNA sequencing (demonstration only).
9. NCBI BLAST search and Primer design.
10. Multiple Sequence Alignment and Phylogenetic analysis using MEGA
11. Determination of genes mapped within a specific chromosomal locus using GeneLoc integration resource and gene orthologue prediction using Ensembl.
12. Protein-protein interactions using STRING; Introduction to KEGG and Metacyc databases

- Practical may be added/modified from time to time depending on available faculties/facilities.

Interdisciplinary Course

LMS.529: Basics in Microbiology (IDC)

Learning Objective: Basics in microbiology course is designed as an interdisciplinary course to acquaint the students of different streams with a very basic knowledge and understanding of microbes, pathogens and their control.

Unit	Syllabus	Lecture
1	**Introduction to Microbiology:** Scope and history of Microbiology, Classification of Bacteria, Fungi, Protozoa, Algae, and viruses. **Basic principles and techniques used in bacterial classification.** Phylogenetic and numerical taxonomy. General characteristics, structure and classification of plant animal and bacterial viruses.	8
2	**Microbial Growth, and Nutrition:** Microbial growth. Bacterial generation time. Monoauxic, Diauxic and synchronized growth curves. Factors affecting microbial growth. Principles of microbial nutrition- Chemoautotrophs, chemo-heterotrophs, photoautotrophs and photo-heterotrophs. Types of growth media, pure culture methods. Culture maintenance and preservation	8
3	**Pathogens.** Medically important bacteria. Retroviruses, Viroids, Prions and emerging viruses such as HIV, Avian and swine flu viruses. Medically	8

	important fungi and protozoans **Beneficial applications of microbes**: Human Microflora, Pre and Probiotics, Industrially important microbes	
4	**Control of Microorganism:** Control of Microorganism by physical and chemical agents. Narrow and broad spectrum antibiotics, Mode of action of Antimicrobial agents. Antibiotic resistance mechanisms.	7

Suggested Reading

1. Madigan,M.T.,Martinko, J.M., Bender, K., and Buckley, D. (2011) *Brock Biology of Microorganisms,* 13th Ed., Pearson Education, USA
2. Tauro, P., Kapoor,K.K. and Yadav, K.S. (1996). *Introduction to Microbiology*, New Age Pub., New Delhi
3. Pelczar, M.J. et al. (2001), *Microbiology- Concepts and Applications*, International Ed. McGraw Hill Publication, New York
4. Black, J.G. (2012), *Microbiology: Principles and Explorations*, 8 Sons, USA.
5. Willey, J.M., Sherwood, L., and Woolverton, C. (2013) *Prescott's Microbiology* 9th Revised Edition, McGraw Hill Higher Education, New York
6. Pommerville, J.C. (2009) *Alcamo's Fundamentals of Microbiology*, Jones and Bartlett Publishers.
7. Tortora, G.J., Funke, B.R., Case, C.L. (2012) *Microbiology -An Introduction*, Pearson education Pvt. Ltd. Singapore.

List of Value Added Courses

The list of Value added courses has been provided to choose any two courses in a programme

Si No.	Name of Course
1.	Ethics for Science
2.	Professional Ethics
3.	Academic Writing
4.	Value Education
5.	Stress Management
6.	Personality Development through Life Skills
7.	Physical & Mental Well Being
8.	Pedagogical Studies
9.	Data Analysis using spread sheet
10.	Soft Skill Training
11.	Leadership
12.	Personal Management
13.	Wealth Management
14.	Reasoning Ability
15.	MS office Specialist
16.	Practical Taxation
17.	Ethical Issues & Legal Awareness
18.	Disaster Management
19.	Nutrition and Specialty Foods
20.	Shorthand & Typing
21.	SPSS

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Semester – III

Course Code	Course Title	L (hr)	T (hr)	P (hr)	Cr
	Core Courses				
LBC.551	Metabolism-II	3	-	-	3
LBC.552	Clinical and Nutritional Biochemistry	3	-	-	3
LBC.553	Animal Physiology	3	-	-	3
LBC. 554	Biochemistry Practical-II (Practical)	-	-	6	3
	Discipline Elective (opt any one)				
LMS.560	Principles of Evolutionary and Developmental Biology	3	1	-	4
LBC.561	Cell Culture Techniques	3	1	-	4
	Skill Based				
LBC.543	Seminar-I	-	-	-	1
LBC.599	Project	-	-	12	6
	Total Credits				**23**

L: Lectures; T: Tutorial; P: Practical; Cr: Credits

Instructional Designs/ Mode of classroom Transaction:

1) Lecture
2) Problem solving
3) Experimentation
4) Tutorial
5) Problem solving
6) Seminars
7) Case Study

Core Courses

LBC.551: Metabolism-II

Learning Objective: This course is designed to cover the advanced aspects of biochemistry and biological molecules, including their biosynthesis and mechanisms by which they facilitate biochemical reactions.

Unit	Syllabus	Lectures
1.	**Lipids:** Introduction, hydrolysis of tri-acylglycerols, α-, β-, ω- oxidation of fatty acids. Oxidation of odd numbered fatty acids – fate of propionate, role of carnitine, degradation of complex lipids. Fatty acid biosynthesis, Acetyl CoA carboxylase, fatty acid synthase, ACP structure and function.	12
2.	Lipid biosynthesis, biosynthetic pathway for tri-acylglycerols, phosphoglycerides, sphingomyelin and prostaglandins. Metabolism of cholesterol and its regulation. Energetics of fatty acid cycle.	12
3.	**Amino Acids**: General reactions of amino acid metabolism - Transamination, decarboxylation, oxidative & non-oxidative deamination of amino acids. Special metabolism of methionine, histidine, phenylalanine, tyrosine, tryptophan, lysine, valine, leucine, isoleucine and polyamines. Urea cycle and its regulation.	12
4.	**Nucleic Acids:** Biosynthesis and degradation of purine and pyrimidine nucleotides and its regulation. Purine salvage pathway. Role of ribonucleotide reductase. Biosynthesis of deoxyribonucleotides and polynucleotides including inhibitors of nucleic acid biosynthesis.	12

Suggested Reading:

1. Campbell, MK and Farrell, SO. (2012) *Biochemistry*, 7th ed. Brooks/Cole Pub Co.
2. Davidson, VL and Sittman, DB (1999) *Biochemistry* NMS, 4th ed. Lippincott. Willams and Wilkins.
3. Voet, D and Voet JG (2011) *Biochemistry*, 4th ed. Wiley
4. Kuchel, Philip W., et al. (1988) *Schaum's outline of theory and problems of biochemistry*. 2nd ed. McGraw-Hill.
5. Rodwell V, Bender D, Botham KM, Kennelly PJ and Weil PA (2015) *Harper's Biochemistry*. 30th ed. McGraw Hill.
6. Nelson DL and Cox MM (2004) *Lehninger's Principles of Biochemistry*, 4th ed. WH Freeman.
7. Berg JM, Tymoczko JL, Stryer L, Gregory J, Jr. Gatto (2010) *Biochemistry*, WH Freeman, 7th ed.

LBC . 552: Nutritional and Clinical Biochemistry

Learning Objective: This course aims to provide detailed knowledge regarding the biological basis of nutrition and the mechanisms by which diet and its components can influence health. The students will also learn the general principles clinical biochemistry and understand the biochemical changes in metabolism that leads to diverse clinical diseases.

Unit	Syllabus	Lectures
1.	**Nutrition and Nutraceuticals:** Diets and dietary standards, Basal metabolic rate (BMR); Anthropometric measurements and obesity. Assessment of nutritional status and Recommended Daily allowances. Properties, Structure and Functions of Various Nutraceuticals; Nutraceutical	12

	remedies for common disorders; Nutraceutical rich supplements; Probiotics and Prebiotics as nutraceuticals.	
2.	**Disorders of Carbohydrate and Lipid Metabolism**: Diabetes mellitus, Insulin and glucose secretion, glucose and galactose tolerance tests, glycogen storage diseases. Plasma lipoproteins (VLDL, IDL, LDL and IDL), Cholesterol, Triglycerides & Phospholipids in health and disease, Apo-lipoproteins, Atherosclerosis.	12
3.	**Other metabolic disorders** Jaundice, Fatty liver, Normal and abnormal functions of liver and kidney, Inulin and urea clearance. Electrolytes and acid-base balance, Uremia, Hyperuricemia, Porphyria, Factors affecting nitrogen balance. Albinism, Sickle cell anemia, Thalassemia.	12
4.	**Blood Clotting and Diagnostic Enzymes** Blood Clotting, Disturbances in blood clotting mechanisms, Haemorrhagic disorders, Haemophilia, von Willebrand's disease, Purpura, Rendu-Osler-Werber disease, Thromboticthrombocytopenic purpura, Disseminated intravascular coagulation, acquired prothrombin complex disorders, Circulating anticoagulants Enzymes in health and diseases, Enzymes as diagnostic markers	12

Suggested Reading:

1. Gaw, A, Murphy MJ, Cowan RA, O'Reilly D, Stewart M, and Shepherd J (2004) *Clinical Biochemistry:* An Illustrated Colour Text (Paperback) 3rd Ed. Publisher: Churchill Livingstone.
2. Luxton, R (2008) *Clinical Biochemistry*. 2nd Ed. Scion Publishing Ltd.
3. Guyton, AC and Hall, JE (2010) *A text book of Medical Physiology*, 12th Ed. Publisher: Saunders.
4. Maheshwari, N (2008) *Clinical Biochemistry*. Publisher: JPB.
5. Gradwohl RBH (1970) C*linical Laboratory Methods and Diagnosis*: A *textbook on laboratory procedures and their interpretations,* Mosby publishers.
6. Henry, Bernard J et al. (2002), *Clinical diagnosis & Management by laboratory methods.* W.B. Saunders, New York
7. Gradwohls (2000) *Clinical Laboratory Methods and Diagnosis.* (ed) Sonnenwirth AC, and Jarret L, M.D.B.I. Publications, New Delhi
8. Coleman, W. B. and Tsongalis, G. J. (2009). *Molecular Pathology: The Molecular Basis of Human Disease.* Academic Press.
9. Nussbaum, R.L., McInnes, R. Mc., Willard, H.F. (2009). *Genetics in Medicine*. Elsevier Inc., Philadelphia. 10. Read A and Donnai D (2007). *New Clinical Genetics.* Scion Publishing Lmt., Oxfordshire, UK.
11. Patch, H. S. C. (2009). *Genetics for the Health Sciences*. Scion Publishing Ltd., UK.
12. Milunsky, A., Milunsky, J. (2009). *Genetic Disorders and the Fetus: Diagnosis, Prevention and Treatment*, 6th Edition. Wiley-Blackwell publishers.
13. Tom B, (1998) *Nutritional Biochemistry*, 2nd ed, Academic Press, London.
14. Steven HW, Steven J, et al. (2002). *Health promotion and disease prevention in clinical practice*, 2nd ed. J.B.Lippin Cott & Co.
15. Ramesh, C.G. (2010). *Nutraceuticals: Efficacy, Safety and Toxicity,* Academic Press Inc.
16. Debasis B., Harry G.P, and Anand S. (2015). *Nutraceuticals and Functional Foods in Human Health and Disease Preventio.* CRC Press.

LBC.553: Animal Physiology

Learning Objective: This course is designed to provide students with an understanding of the function and regulation of physiological systems which will include neural & hormonal homeostatic

control mechanisms, as well as study of the musculoskeletal, circulatory, respiratory, digestive, urinary, immune, reproductive, and endocrine organ systems.

Unit	Syllabus	Lectures
1.	**Blood and Circulation:** Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, haemostasis **Cardiovascular System:** Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above **Respiratory System:**- Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.	12
2.	**Digestive System:** Digestion, absorption, energy balance, BMR. **Excretory System:** Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance. **Muscle Physiology:** Types of muscles, Properties; Contractile force; Motor Unit. Skeletal, cardiac and smooth Muscle Mechanics & Metabolism.Control of Body Movement. Cartilage, tendons, ligaments, joints, and other connective tissues.	12
3.	**Nervous System:** Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture **Sense organs:** Vision, hearing and tactile response	10
4.	**Endocrinology:** Endocrine glands, basic mechanism of hormone action, hormones and diseases Thermoregulation - Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization. **Reproductive System:** Males and female reproductive system. Gametogenesis, fertilization and early development. Physiology of ageing: Changes in various systems and mechanisms involved, factors affecting ageing. Apoptosis.	12

Suggested Reading:

1. Brody, T. (1998). *Nutritional Biochemistry*. Academic Press, USA.
2. Devlin, T.M. (2005). *Textbook of Biochemistry with clinical correlations*. John Wiley & Sons Inc. USA.
3. Guyton. (2007). *Textbook of medical physiology*. 11th Edition. Elsevier India Pvt. Ltd. New Delhi.
4. Hill, R.W, Wyse, G. A. and Anderson, M. (2008). *Animal physiology*. Sinauer Associates Inc. USA.
5. Murray, R.K. (2009). *Harper's illustrated biochemistry*. Jaypee Publishers, New Delhi, India.
6. Tyagi, P. (2009). *A textbook of Animal Physiology*.Dominant Publishers and distributors, New Delhi, India.

LBC.553: Biochemistry Practical-II (Practical)

Learning Objective: The students will learn and perform experiments pertaining to the theory papers of clinical and nutritional biochemistry. The students will be taught to make links between

observations, scientific ideas and how to calculate various vital human parameters.

1. Estimation of cholesterol in biological tissue 2. Estimation of Ribonucleic acid 3. Estimation of Deoxyribonucleic acid 4. Estimation and Separation of serum/plasma Proteins in Blood 5. Estimation of blood/serum glucose 6. Estimation of Serum Total Cholesterol 7. Tests for Proteins, Glucose, Ketone Bodies, Bilirubin & Urobilinogen in Urine 8. Estimation of Urea in Blood (Serum) 9. Determination of Uric Acid in Serum 10. Estimation of Serum Bilirubin 11. Oral Glucose Tolerance Test
• Practicals may be added/modified from time to time depending on available faculties/facilities.

Discipline Elective Courses

LMS.560: Principles of Evolutionary and Developmental Biology

Learning Objective: In this course the students will learn the about the origin of life and development of plants and animals, with a particular emphasis on the molecular genetic basis for developmental events. The course will focus on developmental phenomena studied in several of the most prominently utilized model organisms.

Unit	Syllabus	Lectures
1.	**Origin of Life:** Lamarckism, Darwinism, Concepts of variation, adaptation, struggle, Mendelism, Spontaneity of mutations, Theories of phyletic gradualism vs. punctuated equilibria, Modern evolutionary synthesis. Origin of basic biological molecules, Abiotic synthesis of organic monomers and polymers, Concept of Oparin and Haldane model, Origin of eukaryotic cells, Evolution of unicellular eukaryotes, Anaerobic metabolism, Photosynthesis and aerobic metabolism.	15
2.	**Basic Concepts of Development:** Totipotency, Commitment, Specification, Induction, Competence, Determination and Differentiation, Morphogenetic gradients, Cell fate and cell lineages, Stem cells, Genomic equivalence and cytoplasmic determinants. Model organisms in Developmental biology (*Drosophila, C. elegans, Xenopus*)	15
3.	**Gametogenesis, Fertilization and Cell Death:** Production of gametes, Cell surface molecules in sperm-egg recognition in animals; Embryo-sac development and double fertilization in plants, Zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals. Embryogenesis and establishment of symmetry in plants, Seed formation.	15

4.	**Molecular Genetic Basis for Developmental Events:** Genetic and molecular control of development of limbs, Gastrointestinal system and cardiovascular system. Cell-Cell Communication and Signaling. Apoptosis, Caspases, Importance of programmed cell death (PCD) in animal/plant development. Medical implications of developmental biology: genetic errors/ teratogenesis/ stem cell therapy.	15

Suggested Reading:

1. Darwin, C.R. (1911). *On the origin of species by means of natural Selection, or preservation of favoured races in the struggle for life*. Hurst Publishers, UK.
2. Dawkins, R. (1996). *The Blind Watchmaker*, W.W. Norton & Company Jones and Bartlett Publishers.
3. Futuyma, D.J. (2009). *Evolution*. Sinauer Associates Inc. USA.
4. Hake, S. and Wilt, F. (2003). *Principles of Developmental Biology*. W.W. Norton & Company, New York, USA.
5. Hall, B.K. and Hallgrimsson, B. (2007). *Strickberger's Evolution.* Jones and Bartlett Publishers, India.
6. Lewin, R. (2004). *Human Evolution - An Illustrated Introduction*. Wiley-Blackwell, USA.
7. Scott, F. and Gilbert, S.F. (2010). *Developmental Biology*. Sinauer Associates, Inc. USA.
8. Slack, J.M.W. (2005). *Essential Developmental Biology*, Wiley-Blackwell, USA.
9. Green, D. R. & Reed J. C. (2010). *Apoptosis: Physiology and Pathology*. Cambridge press, UK.
10. Sadler, T.W., Tosney, K., Chescheir, N.C., Imseis, H., Leland, J. and Sadler-Redmond, S., L. (2011). *Langman's Medical Embryology (Longmans Medical Embryology).* Lippincott Williams and Wilkins.
11. Schaefer, B.D*.* (2013). *Medical Genetics: An integrated Approach.* McGraw Hill Education, New Delhi.

LBC. 561. Cell Culture Techniques

Learning Objectives: At the end of the course the student will have the background of animal tissue culture essential for understanding their applications in other fields and planning projects in the field of biotechnology encompassing cell culture based system. Students should be able to design and execute cell culture based experiments in a research setting as well as industrial setting with a thorough clarity in the basic principles.

Unit	Syllabus	Lectures
I	Introduction to animal cell cultivation: Basics terms and definitions, historical background, Importance of animal cell culture technology, laboratory facilities-design, equipments and safety parameters, waste disposal in a cell culture set-up. Aseptic techniques for animal cell cultivation.	12
II	**Cell culture technology:** Basic requirement for growing animal cells - Cell culture reagents, media, media supplements, media preparation and	18

	sterilization, Defined-Undefined media, Complete-Incomplete media, Importance of Serum and Serum free Media, culture conditions. Maintenance of cell culture: Culturing, sub-culturing, passaging, cell metabolism during culture, Cell culture types: primary and continuous culture, *in vitro* transformation of animal cells, anchorage-dependence, monolayer and suspension culture, normal cells and transformed cells. Scaling up- techniques for cells in suspension and in monolayer Cell line preservation and authentication: cryopreservation and cell revival, Cell line banking and cell culture databases. Contamination check and prevention: bacterial, yeast, fungal, mycoplasma, viral testing	
III	**Studying biological system using cell culture techniques:** Functional assays based on cell culture: Cell morphology, Quantitation, Growth pattern, DNA content and cell cycle, Cytotoxicity assays, Study of Cell Death: senescence, apoptosis and necrosis, Cell proliferation, Cell viability measurements, Karyotype analysis, FISH. Immunolabeling of cells to study molecular expression pattern–Microscopy, Flowcytometry, Cytospin, Immunohistochemistry, Transfection, Transient,stable cell line generation and Gene Silencing.	15
IV	**Cell and Tissue culture- Trends and Breakthroughs**: Hybridoma technology for monoclonal antibody production, production of genetically-engineered cells and their applications, use of cell cultures in the production of biologicals, Insect Cell Culture and its application., Types of stem cells, current stem cell therapies, stem cells in heart, brain and spinal cord regeneration and regenerative medicine Regenerative Medicine: Tissue engineering, Three-dimensional culture,multicellular tumour spheroids (MCTS)-mono and co-cultures, re-aggregate organ cultures, drug testing *in-vitro.* Nanotechnology**.**	15

Suggested Readings:

1. Michael Butler, “Animal Cell Culture and Technology”, BIOS Scientific Publishers
2. John R.W. Masters, “ Animal Cell Culture-A Practical Approach”, Oxford University Press
3. R. Ian Freshney, “Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications”.
4. Trent, R. J. (2010). Molecular Medicine, Fourth Edition: Genomics to Personalized Healthcare. Academic Press.

LBC. 543: Seminar I

Learning Objective: To read the recent scientific articles and give presentation on a recent topic of biochemistry to further improve student scientific writing and presentation skills. The students select an advanced topic in biochemistry and related fields; they prepare a presentation of approximately 20 minutes based on recent literature available and recent advances on that topic. The students will prepare a report.

Evaluation Criterion: Students are evaluated based on presentation and written report.

LBC.599: Project

Course Objective: The objective of project would be to ensure that the student learns the nuances of the scientific writing. Herein the student will have to write her/ his synopsis including an extensive review of literature with simultaneous identification of scientifically sound (and achievable) objectives backed by a comprehensive and detailed methodology. The student can also write a review for the project work whose outline should be presented as part of synopsis.

Evaluation Criteria

The evaluation will be on the basis of satisfactory and non-satisfactory where satisfactory will be based on the performance of the student as Excellent, Very good, Good, Average whereas student will be given non-satisfactory when their performance is below average. The criteria for the performance will be:

1. Attendance and punctuality
2. Regular discussion with supervisor
3. Extensive review of literature
4. Interest in the field
5. Management of time and resources
6. Synopsis presentation

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Semester – IV

Course Code	Course Title	L (hr)	T (hr)	P (hr)	Cr
	Elective Foundation				
XXX	Choose from value based courses/ MOOCs	1	-	-	1
	Core Courses				
LPS.524	Plant Physiology	3	1	-	4
LBC.572	Secondary Metabolites and Metabolic Engineering	2	-	-	2
	Discipline Elective (opt any one)				
LBC.580	Genetic Engineering	3	1	-	4
LMS. 581	Clinical Diagnostics	3	1	-	4
	Compulsory Foundation (Discipline Enrichment Courses)				
LBC.573	Recent Advances in Life Sciences-I	-	2	-	2
LBC.574	Recent Advances in Life Sciences-II	-	2	-	2
	Skill Based Courses				
LBC.544	Seminar-II	-	-	-	1
LBC.599	Project	-	-	12	6
	Total Credits				**22**

L: Lectures; T: Tutorial; P: Practical; Cr: Credits

Instructional Designs/ Mode of classroom Transaction:

1. Lecture
2. Project Method
3. Problem solving
4. Experimentation
5. Seminar
6. Tutorial

Core Courses

LPS.524: Plant Physiology

Learning Objective: This course will provide insights into physiological processes in plants. Further, the students will understand various mechanisms used by plants to survive in abiotic and biotic stress conditions.

Unit	Syllabus	Lectures
1.	**Photosynthesis, Respiration and Photorespiration:** Light harvesting complexes, Mechanisms of electron transport, Photoprotective mechanisms, CO_2 fixation, C3, C4 and CAM pathways. Citric acid cycle. Plant mitochondrial electron transport and ATP synthesis, Alternate oxidase, Photo-respiratory pathway. **Nitrogen Metabolism:** Nitrate and ammonium assimilation, Amino acid biosynthesis.	16
2.	**Water Relations, Solute Transport and Photoassimilate Translocation:** Properties of water, Properties of solutions, Cell water potential, Soil -plant -atmosphere continuum. Uptake, transport and translocation of water, ions, Solutes and macromolecules from soil, Through cells, Across membranes, Through xylem and phloem, Transpiration, Mechanisms of loading and unloading of photoassimilates, WUE.	16
3.	**Phytohormones:** Biosynthesis, storage, breakdown and transport, physiological effects and mechanisms of action. **Sensory Photobiology:** Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins, Photoperiodism and Biological clocks.	16
4.	**Secondary Metabolism:** Biosynthesis of terpenes, Phenols and nitrogenous compounds and their roles. Growth and development, Programmed cell death: Apoptosis, Caspases, Importance and role of PCD in plant development.	14

Suggested Reading:

1. Buchanan, B.B. and Gruissem, W. (2010). *Biochemistry and Molecular Biology of Plants.* IK International Pvt. Ltd. New Delhi, India.
2. Campbell, M.K. and Farrell, S.O. (2007). *Biochemistry.* Thomson Brooks/cole, USA.
3. Dey, P.M. and Harborne, J.B. (2000). *Plant Biochemistry*. Academic Press, UK.
4. Goodwin, T.W. and Mercer, E.I. (2003). *Introduction to Plant Biochemistry*. CBS Publishers & Distributors, New Delhi, India.
5. Ross and Salisbury. (2009). *Plant Physiology.* Cengage Learning (Thompson), New Delhi, India.
7. Taiz, L. and Zeiger, E. (2010). *Plant Physiology*. Sinauer Associates Inc., USA.
8. Taiz, L., Zeiger, E. Mollar, I. M. and Murphy, A. (2015). *Plant Physiology and Development* 6th edition. Sinauer Associates Inc., USA.

LBC.572: Secondary Metabolites and Metabolic Engineering

Learning Objective: The course is designed to make the students understand principles of secondary metabolite synthesis in plants and microbes. The course will build knowledge about

application of dynamic models to metabolism and analysis of metabolic pathway for its utilization in product formation.

Unit	Syllabus	Lectures
1.	**Secondary Metabolites in Plants:** Terpenoids-Mevalonate pathway and Methylerythritol phosphate pathway, Monoterpenes (C10), Sesquiterpenes (C15), Triterpenes (C30), Diterpenes (C20), Tetraterpenes (C40) and Polyterpenoids; Phenolics-shikimic acid pathway and Malonic acis Pathway, Simple Phenolics (*trans*-cinnamic acid, *p*-coumaric acid and their derivatives), Complex Phenolics (Lignin), Flavonoids, Tanins (Condensed tannin and Hydrolyzable tannins); Nitrogen containing compounds- Alkaloids (Cocaine, Nicotine, Morphine, Caffeine, pyrrolizidine alkaloids), Cyanogenic Glycosides; Glucosinolates.	9
2.	**Secondary Metabolites in Microbes:** Organic Metabolites-Ethanol, Acetone; Citric acid, Acetic acid, Lactic acid, Gluconic acid, Itaconic acid, Amino acids; Enzymes- Amylases, Glucose Isomerase, L Asparaginase, Proteases, Renin, Penicillin acylases, Lactases, Pectinases, Lipases; Vitamins- Vitamin B12, Riboflavin, B carotene; Antibiotics: beta-Lactam antibiotics; Amino acid and peptide antibiotics; Carbohydrate antibiotics; Tetracycline and antracyclines; Nucleoside antibiotics; Aromatic antibiotics.	8
3.	**Metabolic Engineering of Plants & Micro-organisms:** Introduction to metabolic engineering: Concept and importance of metabolic engineering, basic enzyme kinetics, metabolite regulation of metabolic pathways, basic metabolic control analysis (MCA), metabolic fluxes and basic flux balance analysis (FBA), Applications of MCA and FBA for the improvement of microbial strains and plant cells fermentation processes.	9
4.	**Tutorials & Case Studies**: Practical for the use of software tools for construction and simulation of small metabolic pathways, Case study using one genome scale metabolic model for the strain improvement for the production of organic metabolites- Ethanol, Acetone; Citric acid, Acetic acid, Lactic acid (Introduction only).	6

Suggested Reading:

1. Taiz, L. and Zeiger, E. (2010). *Plant Physiology*. Sinauer Associates Inc., USA.
2. Dey, P.M. and Harborne, J.B. (2000). *Plant Biochemistry*. Academic Press, UK.
3. Goodwin, T.W. and Mercer, E.I. (2003). *Introduction to Plant Biochemistry*. CBS Publishers & Distributors, New Delhi, India.
4. Crueger, W. and Crueger, A. (1990). *Biotechnology. A Textbook of Industrial Microbiology*. Sinauer Associates., USA.
5. Demain, A. and Solomon, N.A. (1950). *Biology of Industrial microorganisms*. Menlo Park, Calif.: Benjamin/Cummings Pub. Co., Advanced Book Program, CA.
6. David Fell (1997) Understanding the Control of Metabolism, Portland Press, London.
7. Segel, I.H. (1993) Enzyme Kinetics: Behavior and Analysis of Rapid Equilibrium and Steady-State Enzyme Systems. ISBN: 978-0-471-30309-1, 992 pages, Wiley Publication.
8. Stephanopoulos. (1998). Metabolic Engineering: Principles & Methodologies, Published by cbspd
9. Sang Yup Lee, E. Terry Papoutsakis. (1999). *Metabolic Engineering,* CRC Press
10. Orth, J.D., Thiele, I., and Palsson, B.Ø. *What is flux balance analysis?*. *Nature Biotechnology*, **28**: 245-248 (2010).

11. Edwards,J.S., Covert, M., and Palsson, B.Ø. Metabolic Modeling of Microbes: the Flux Balance Approach. Environmental Microbiology, **4(3)**: pp. 133-140 (2002).

Discipline Elective Courses

LBC.580: Genetic Engineering

Learning Objective: The aim of this course is to acquaint the students to versatile tools and techniques employed in genetic engineering. A sound knowledge on methodological repertoire allows students to innovatively apply these in basic and applied fields of biological research

Unit	Syllabus	Lectures
1.	**Tools of Genetic Engineering:** Restriction enzymes, Enzymes in genetic engineering, Cloning vectors, Expression vectors & their biology (Plasmid Vectors, Vectors based on Lambda Bacteriophage, Cosmids, M13 Vectors, Expression Vectors, Vectors for Cloning Large DNA Molecules), Transformation and Selection, genomic and cDNA library construction & DNA-sequencing techniques, Site-directed mutagenesis	15
2.	**Gene Cloning and Expression in Microbial and Eukaryotic Systems**: Cloning in *E. coli*, in Gram-positive bacteria, in Streptomycetes, in *Saccharomyces Cerevisiae* and *Pichia pastoris*, in Insect Cells, in Mammalian Cells expression system, Fusion proteins, Transcriptional & Translational Fusions, Adding Tags and Signals	15
3.	**Applications of Recombinant DNA Technology:** Vaccines (subunit-, peptide-, attenuated-, DNA- and vector-based), Metabolic Engineering and Protein Engineering: Enzymes, Antibiotics, Therapies for Genetic Diseases, Bioremediation	15
4.	**Genetic Manipulation and functional assessment:** Model organisms, Genetically modified plants and animals, Creating Transgenics, Knockouts, Knockdowns, RNAi technology, CRISPR technology. Generation of Transient and stable cell lines. Functional genomics: Forward and reverse Genetics	15

Suggested Reading:

1. Glick BJ, Pasternak JJ, Patten CL. (2010) *Molecular Biotechnology: Principles and Applications of Recombinant DNA.* 4th edition, American Society for Microbiology
2. Kurnaz IA. (2015) *Techniques in Genetic Engineering*.1st edition, CRC Press.
3. Primrose SB, Twyman R. (2006) *Principles of Gene Manipulation and Genomics*. 7th edition, Wiley-Blackwell.
4. Green MR, Sambrook J. (2012). *Molecular cloning: A laboratory manual*. 4th edition, Cold Spring Harbor Laboratory Press, New York.

LMS. 581. Clinical Diagnostics

Learning Objective: The objective this course is to introduce the students to diverse methods of clinically diagnosing human diseases which will further help them to use these techniques various applied fields of biological research

Department for Biochemistry and Microbial Sciences

School of Basic and Applied Sciences
Central University of Punjab, Bathinda

Unit	Syllabus	Lectures
1	**Introduction to Clinical Diagnostics:** Philosophy and general approach to clinical specimens, Sample collection (Blood, urine, spinal fluid, synovial fluid, amniotic fluid) - method of collection, preservation, transport and processing of samples. Diagnosis – disease altered state, prognosis, direct and indirect, concept of antigen and antibody. Principles of validation of diagnostic assays for infectious diseases, Validation and quality control of polymerase chain reaction methods used for the diagnosis of infectious diseases.	12
2	**Protein based Clinical Diagnostics:** Antigen – Antibody Interaction, Lattice Theory, Precipitin Curve, Simple Immunodiffusion (Radial Immunodiffusion – Qualitative, Quantitative); Double Diffusion (Mechanism of Reaction of Identity, Partial Identity, and Non-Identity); Rocket Electrophoresis, Immunoelectrophoresis; Western Blot, Immunofluorescence, Radioimmunossay; ELISA – types and assay development; Agglutination – Antibody titer, Prozone Phenomenon, Direct and Indirect Agglutination, ABO Blood typing, Agglutination Inhibition; Advantages and limitation with respect to clinical diagnosis and research usage. Microparticle based antigen - Antibody interaction techniques. Monoclonal antibody – production, applications, novel approaches in detection, Humanized monoclonal antibodies	18
3	**DNA based Clinical Diagnostics:** Nucleic acid extraction from clinical samples, quantization, digestion, hybridization, Amplification by PCR (Inverse PCR, Multiplex PCR, Nested PCR, Alu-PCR, Hot-start, *In situ* PCR, Long-PCR, PCR-ELISA, iPCR, applications and limitations) DNA fingerprinting and polymorphism studies (SNP, RAPD, RFLP, VNTR, Mutation detection etc). Emphasis on interpretation of results and quality control. **High-throughput Technologies and Pathological Diagnostics:** Microarray (protein, DNA), Real-Time PCR, Reporter assays. Biosensors – types, applications, examples (glucose etc), telemedicine.Fluorescence based techniques (FISH analysis, Flow cytometry, Fluorescent Microscopy) Mass spectrometry, Histopathology, Immunohistochemistry and Real-Time PCR. Microbiological Diagnosis and Hematology. Enzyme and hormone based diagnostic techniques.	15
4	**Case Studies:** Diagnosis of Infectious Diseases – some specific examples.Diagnosis of bacterial infection caused by *Coliforms, Salmonella, Shigella, Vibrio, and Mycobacterium tuberculosis.* Diagnosis of fungal infections. Dermetophytoses, Candidiosis and Aspergillosis. Diagnosis of DNA and RNA viruses. Pox viruses, Adenoviruses, Rhabdo Viruses, Hepatitis Viruses and Retroviruses.Diagnosis of Protozoan diseases: Amoebiosis, Malaria, Trypnosomiosis, Leishmaniasis, Filariasis and Schistosomiasis.Medical	15

	Genetics: Organization of human genome, Human Genome Project, Identifying human disease genes. Genetic Counselling. Genetic disorders: Sickle cell anaemia, Duchenne muscular Dystrophy, Retinoblastoma, Cystic Fibrosis and Sex –linked inherited disorders. Neonatal and Prenatal disease diagnostics.	

Suggested Reading:

1. Burtis, Carl A, Ashwood, Edward R, Bruns, David E., "*Tietz textbook of Clinical Chemistry & Molecular Diagnostics*" USA: Saunders, 2006.
2. World Organization for Animal Health: "*Manual of Diagnostic Tests and Vaccines for Terrestrial Animals"* Volumes I & II, 6th Edition, 2010.
3. Rao, Juluri R, Fleming, Colin C., Moore, John E., "*Molecular Diagnostics: current technology and Applications"*, Horizon Bioscience, U. K., 2006.
4. Goldsby, Richard A., Kuby, Janis, "*Immunology*", New York: WH Freeman and Company, 2003.
5. Mahon, Connie R. ; Lehman, Donald C. ; Manuselis, George "*Textbook of Diagnostic Microbiology*". USA: Saunders, 2007.

Compulsory Foundation (Discipline Enrichment Courses)

LBC. 573. Recent Advances in Life Sciences-I

Learning Objectives: The course deals with the specific content for the national level tests conducted by UGC, CSIR and other agencies. The course is divided into two parts and in Part-I the students will be practicing and revising the topics related to cell biology, genetics, biochemistry and microbiology. The students will be given exercises, mock tests and practice test from the previous year's examinations.

Unit	Syllabus	Lectures
I	**Cell Biology:** Molecules and their Interaction Relevant to Biology, Cellular Organization, Cell Communication, cell Signaling and Cell Cycle.	7
II	**Biochemistry:** Structure and functions of carbohydrates, lipids, amino acids, proteins, nucleic acids and vitamins. Bioenergetics and thermodynamics. Metabolism of carbohydrates, lipids, amino acids and nucleotides.	8
III	**Genetics:** Nucleic acids: types and Functions. Genetic code, Mendelian and non-Mendelian inheritance. Genetic mapping. Recombination. Microbial Genetics.	8
IV	**Microbiology:** Scope and history of Microbiology, classification of Bacteria, Fungi, Protozoa, Algae, and viruses. Microbial growth. Ecology and applied microbiology.	7

The topics covered will be revised from time to time as per the revised NET syllabus.

LBC. 574. Recent Advances in Life Sciences-II

Learning Outcomes: The course deals with the specific content for the national level tests conducted by UGC, CSIR and other agencies. The course is divided into two parts and in Part-II the students will be practicing and revising the topics related to molecular biology, immunology, animal physiology, developmental biology and plant physiology. The students will be given exercises, mock tests and practice test from the previous year's examinations.

Unit	Syllabus	Lectures
I	**Evolution and Developmental Biology:** Lamarckism, Darwinism, Concepts of variation. Molecular divergence and phylogeny. Gametogenesis, Fertilization and Cell Death, Molecular Genetic Basis for Developmental Events and Basic Concepts of Development	7
II	**Animal Physiology**: Muscle Physiology: Types of muscles, Properties; Cardiovascular system, Nutrition and digestive system. Excretory System, Nervous system and Endocrine system. Comparative physiology. Immunology: Molecular Mechanisms of Antibody Diversity and Cellular Immunity. Hybridoma technology and vaccine development associated challenges for chronic and infectious diseases.	8
III	**Plant Physiology:** Photosynthesis, Respiration and Photorespiration: Light harvesting complexes, Mechanisms of electron transport, Photoprotective mechanisms. Photo-respiratory pathways. Phytohormones. Stress Physiology: Mechanisms of resistance to biotic stress and tolerance to abiotic stress.	7
IV	**Molecular Biology and Techniques in Biology:** DNA replication and repair. Transcription and translation. Gene regulation. Molecular techniques. Concepts of bioinformatics. Genomics, proteomics and metabolomics.	8

The topics covered will be revised from time to time as per the revised NET syllabus.

LBC.544: Seminar II

Learning Objective: To read the recent scientific articles and give presentation on a recent topic of biochemistry to further improve student scientific writing and presentation skills.

The students select an advanced topic in biochemistry and related fields; they prepare a presentation of approximately 20 minutes based on recent literature available and recent advances on that topic. The students will prepare a report.

Evaluation Criterion: Students are evaluated based on presentation and written report.

LBC.599: Project

Course Objective: The objective would be to ensure that the student learns the nuances of the scientific research and writing. Herein, the student will carry out the experiments to achieve the

objectives as mentioned in the synopsis. The data collected as a result of experiments must be meticulously analysed in light of established scientific knowledge to arrive at cogent conclusions. The student can also write a review for the project work in place of experimental work.

Evaluation Criteria

The evaluation will be on the basis of satisfactory and non-satisfactory where satisfactory will be based on the performance of the student as Excellent, Very good, Good, Average whereas student will be given non-satisfactory when their performance is below average. The criteria for the performance will be:

1. Attendance and punctuality
2. Regular discussion with supervisor
3. Extensive review of literature
4. Interest in the field
5. Management of time and resources
6. Final presentation

List of Value Added Courses

The list of Value added courses has been provided to choose any two courses in a programme

S. No.	Name of Course
1.	Ethics for Science
2.	Professional Ethics
3.	Academic Writing
4.	Value Education
5.	Stress Management
6.	Personality Development through Life Skills
7.	Physical & Mental Well Being
8.	Pedagogical Studies
9.	Data Analysis using spread sheet
10.	Soft Skill Training
11.	Leadership
12.	Personal Management
13.	Wealth Management
14.	Reasoning Ability
15.	MS office Specialist
16.	Practical Taxation
17.	Ethical Issues & Legal Awareness
18.	Disaster Management
19.	Nutrition and Specialty Foods
20.	Shorthand & Typing
21.	SPSS