Central University of Punjab, Bathinda

M.Sc. Program in Life Sciences
Specialization: Biochemistry

Session - 2019-21

Department of Biochemistry

Programme Outcome: The Master's Programme in Biochemistry is to prepare students for future careers in the various fields in which a core understanding of chemistry of biological processes is important. Students completing this programme will master aspects related to biochemistry and human health. The Biochemistry Programme will benefit the society on the whole by adding to the highly skilled scientific workforce, in biomedical and agricultural sectors, in academia industry and research institutions across the country and the globe.

Semester – I

Course Code	Course Title	Course Type	Credit Hours			
			L	T	P	Total
XXX LBC.504*	Choose from value based courses/ MOOCs Ethics for Science*	Elective Foundation	1	-	-	1
LBC.506	Biochemistry	Core	3	-	-	3
LMS.507	Microbiology	Core	3	-	-	3
LMS.508	Cell Biology	Core	3	-	-	3
LBC.509	Essentials of Genetics	Core	3	-	-	3
LBC.510	Life Sciences Practical-I	Core	-	-	10	5
LBC.512	Basics of Biochemistry	Interdisciplinary Course (IDC)/MOOC#	2	-	-	2
Total Credits						**20**

*Value based course offered by the department

A course from UGC approved MOOC (4 Credits) can replace two IDC credits each in semester I and semester II which has to be approved by department MOOC coordinator.

Semester – II

Course Code	Course Title	Course Type	Credit Hours			
			L	T	P	Total
LMS.513	Research Methodology and Biostatistics	Compulsory Foundatio	3	1	-	4
LMS.521	Immunology	Core	3	-	-	3
LBC.522	Molecular Biology	Core	3	-	-	3
LBC.524	Enzymology and Enzyme Technology	Core	3	-	-	3
LBC.525	Metabolism-I	Core	3	1	-	4
LBC.526	Biochemistry Practical-I (Practical)	Core	-	-	2	1
LBC.527	Life Sciences Practical-II	Core	-	-	6	3
LMS.529	Basics of Microbiology	Interdisciplinary Course (IDC)/MOOC#	2	-	-	2
Total Credits						**23**

A course from UGC approved MOOC (4 Credits) can replace two IDC credits each in semester I and semester II which has to be approved by department MOOC coordinator.

Semester – III

Course Code	Course Title	Course Type	Credit Hours			
			L	T	P	Total
LBC.551	Metabolism-II	Core	3	1	-	4
LBC.552	Clinical and Nutritional Biochemistry	Core	3		-	3
LBC.553	Animal Physiology	Core	3	-	-	3
LBC. 554	Biochemistry Practical-II	Core	-	-	6	3
LMS.560	Principles of Ecology, Evolution and Developmental Biology	Discipline Elective (opt any one)	3	1	-	4
LBC.561	Cell Culture Techniques	Discipline Elective (opt any one)/MOOC#	3	1	-	4
LBC.543	Seminar-I	Skill Based	1	-	-	1
LBC.599	Project	Skill Based	-	-	12	6
					Total Credits	**24**

A course from UGC approved MOOC (4 Credits) can be taken which has to be approved by department MOOC coordinator.

Semester – IV

Course Code	Course Title	Course Type	Credit Hours			
			L	T	P	Total
XXX LBC.504*	Choose from value based courses/ MOOCs Ethics for Science*	Elective Foundation	1	-	-	1
LPS.524	Plant Physiology	Core	3	1	-	4
LBC.572	Secondary Metabolites and Metabolic Engineering	Core	2	1	-	3
LBC.580	Genetic Engineering	Discipline Elective (opt any one)	3	1	-	4
LMS. 581	Clinical Diagnostics	Discipline Elective (opt any one)	3	1	-	4
LBC.573	Recent Advances in Life Sciences-I	Compulsory Foundation (Discipline Enrichment Courses)	-	2	-	2
LBC.574	Recent Advances in Life Sciences-II	Compulsory Foundation (Discipline Enrichment Courses)	-	2	-	2
LBC.544	Seminar-II	Skill Based	1	-	-	1
LBC.599	Project	Skill Based	-	-	12	6
					Total Credits	**23**

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

*Value based course offered by the department

Semester – I

L	T	P	Cr
3	-	-	3

Course Code: LBC.506
Course Title: Biochemistry
Total Hours: 48

Learning Outcomes:
The course is designed to teach fundamental and basics of biochemistry and to prepare them for advanced courses in biochemistry. The students will be able to demonstrate an understanding of fundamental biochemical principles, such as the structure/function of biomolecules, metabolic pathways, and the regulation of biological/biochemical processes.

Unit I **12 Hours**

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.

Unit II **12 Hours**

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.

Unit III **12 Hours**

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.

Unit IV **12 Hours**

Amino Acid and Nucleic Acid Metabolism: Amino acid biosynthesis and catabolic pathways; Nucleotide synthesis and degradation pathways.

Suggested Readings:

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

Modes of transaction

-Lecture
-Problem solving
-Panel discussion
-Tutorial

Course Code: LMS.507:
Course Title: Microbiology
Total Hours: 48

L	T	P	Cr
3	-	-	3

Learning Outcomes:

Students will learn the basics of microbes, microbial growth, their application in day to day life and beneficial versus harmful micro-organisms. At the end of the course the student will acquire a broad understanding of different group of microorganisms important in health, disease and industry. Students will also be able to comprehend the microbiological principles that can optimize, enhance or inhibit the microbial growth in different settings viz industrial microbiology, medical microbiology.

Unit I **12 Hours**

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.

Unit II **12 Hours**

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.

Unit III **12 Hours**

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.

Unit IV **12 Hours**

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.

Suggested Readings:

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
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

Modes of transaction

-Lecture
- Problem solving
-Panel discussion
- Group discussion

Course Code: LMS. 508
Course Title: Cell Biology
Total Hours: 48

L	T	P	Cr
3	-	-	3

Learning Outcomes: Students will understand the structure and basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles and their related functions. Students will be able to apply the basic scientific and quantitative knowledge of cell biology to enhance understanding of cell structure and functions at the molecular level.

Unit I **12 Hours**

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).

Unit II **12 Hours**

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.

Unit III **12 Hours**

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.

Unit IV **12 Hours**

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.

Suggested Readings:

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

Modes of transaction

-Lecture
- Problem solving
- Group discussion
- Self-learning

Course Code: LBC.509
Course Title: Essentials of Genetics
Total Hours: 48

L	T	P	Cr
3	-	-	3

Learning Outcomes:

Students will learn the basic principles of inheritance at the molecular, cellular and organismal levels. The students will understand the various concepts of hereditary information and how they work in living organisms and to apply them to real life situations.

Unit I **12 Hours**

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).

Unit II **12 Hours**

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.

Unit III **12 Hours**

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).

Unit IV **12 Hours**

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.

Suggested Readings:

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.

Modes of transaction

-Lecture
-Problem Solving
-Self-Learning
-Inquiry training
-Co-operative learning

Tools used

PPT, Videos, Google Drive

Course Code: LBC.510
Course Title: Life Sciences Practical-I (Practical)
Total Hours: 150

L	T	P	Cr
-	-	10	5

Learning Outcomes:
The students will demonstrate the ability to perform experiments pertaining to biochemistry, microbiology, cell biology & genetics. They will also gain an understanding of the principles of the experiments and will be able to apply them to real world problems.

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

Modes of transaction

-Lecture cum demonstration
-Problem Solving
-Self-Learning
-Inquiry training
-Team teaching

Tools used

PPT, Video, Google Drive

Course Code: LBC.512
Course Title: Basics of Biochemistry (IDC)
Total Hours: 30

L	T	P	Cr
2	-	-	2

Learning Outcomes:

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. The students from different backgrounds will develop a basic understanding of various biochemical processes in living systems.

Unit I **7 Hours**

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.

Unit II **8 Hours**

Carbohydrate and Protein Metabolism: Carbohydrate metabolism; Glycolysis, Kreb's Cycle, Hexose monophosphate shunt pathway, Glycogenolysis, Glycogenesis. Protein metabolism, Urea Cycle.

Unit III **8 Hours**

Fatty acid and Nucleic Acid Metabolism: Fatty acid catabolism and synthesis; Degradation and synthesis of nucleotides.

Unit IV **7 Hours**

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.

Suggested Readings:

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

Modes of transaction

-Lecture
-Inquiry training
-Team teaching

Tools used

PPT, Video, Google Drive

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

Course Code: LBC.504
Course Title: Ethics for Science
Total Hours: 16

L	T	P	Cr
1	-	-	1

Learning Outcomes:
On completion of this course the students will be able to appraise the aspects of ethics in research which will help them to understand the set of conduct norms applicable in the field of science. The course will cover the ethics involved in human, animals and plants research and misconduct, fraud and plagiarism. The students from inter-disciplinary background will learn about the basic good practices to be followed in research and academics.

Unit I **3 Hours**

Introduction and Basic Principles of Ethics: Ethical theories, Ethical considerations during research, Data Manipulations. Ethical review procedure and committees

Unit II **4 Hours**

Ethics in Basic and Applied Sciences: Ethics in cloning, recombinant technology, Genetically Engineered Organisms and r-DNA based products. Animal Testing. Animal Rights, Perspectives and Methodology.

Unit III **5 Hours**

Principles of Ethics in Clinical and Medical Sciences: Code of Ethics in Medical/clinical laboratories. Healthcare rationing, Ethical Issues of Xeno-transplantation, Ethics involved in embryonic and adult stem cell research, Ethics in assisted reproductive technologies: animal and human cloning and *In-vitro* fertilization. Ethical issues in MTP and Euthanasia. Types of consents and Human Genome project.

Unit IV **4 Hours**

Ethics in Research: Intellectual property rights (IPRs), Patents copyrights. Fair use and plagiarism. Collaboration in research: authorship, resources sharing and mentoring, publications, conflict of interest, collaboration between academia and industry. Scientific misconduct.

Suggested Readings:

1. Clarke, A (2012). *Genetic Counseling: Practice and Principles*. Taylor & Francis
2. Fleming, D.O. and Hunt, D.L. (2006). *Biological Safety: Principles and Practices*. American Society for Microbiology, USA.
3. Mahop, M.T. (2010). *Intellectual Property, Community Rights and Human Rights: The Biological and Genetic Resources of Developing Countries.* Routledge.
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. Thompson J and Schaefer, B.*D (2013).Medical Genetics: An Integrated Approach*. McGraw Hill.
7. Vaughn, L. (2009). *Bioethics: Principles, Issues, and Cases*. Oxford University Press, UK.
8. WHO. (2005). *Laboratory Biosafety Manual*. World Health Organization.
   Ethical guidelines for biomedical research on human participants, ICMR,

Modes of transaction

-Lecture -Self-learning
-Demonstration -Group discussion

SEMESTER II

Course Code: LMS.530
Course Title: Research Methodology and Biostatistics
Total Hours: 60

L	T	P	Cr
3	1	-	4

Learning Outcomes:

This course will 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 I **15 Hours**

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.

Unit II **15 Hours**

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.

Unit III **15 Hours**

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.

Unit IV **15 Hours**

Statistical Tools: 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, x^2 test. Standard errors of regression coefficients and types of correlation coefficient. Computer application of statistical softwares, Microsoft Excel as statistical tool, Formating of excel spreadsheet cells, formula based calculation in excel sheets.

Suggested Readings:

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.

Modes of transaction

-Lecture
-Demonstration
-Lecture cum demonstration
-Inquiry training
-Panel discussion
-Problem solving
-Self-learning

Course Code: LMS.521
Course Title: Immunology
Total Hours: 48

L	T	P	Cr
3	-	-	3

Learning Outcomes:

At the end of the course students will be able to describe the fundamental concepts in immunology using correct scientific terminologies. They will be able to interpret and apply their knowledge in health and diseases from an immunological perspective.

Unit I **12 Hours**

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.

Unit II **12 Hours**

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.

Unit III **12 Hours**

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.

Unit IV **12 Hours**

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.

Suggested Readings:

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.*
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.

Modes of transaction

-Lecture
-Inquiry training
-Panel discussion
-Problem solving
-Self-learning

Course Code: LBC.522
Course Title: Molecular Biology
Total Hours: 48

L	T	P	Cr
3	-	-	3

Learning Outcomes:
The students will master basic and advanced concepts related to molecular processes in a cell and how they are related to biochemical processes in microbes and higher organisms. In addition, they will understand the applications of molecular biology to societal needs with reference to medicine, industry and agriculture.

Unit I **12 Hours**

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.

Unit II **12 Hours**

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

Unit III **12 Hours**

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.

Unit IV **12 Hours**

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.

Suggested Readings:

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.

Modes of transaction

-Lecture
-Problem Solving
-Self-Learning
-Inquiry training
-Co-operative learning
-Team teaching

Tools used

PPT, Video, Google Drive

Course Code: LBC.524
Course Title: Enzymology and Enzyme Technology
Total Hours: 46

L	T	P	Cr
3	-	-	3

Learning Outcomes:

In this course, the students will learn about enzymes, their classification, structure, function and interaction**.** Students will learn the native and recombinant proteins expression, isolation and various techniques of protein purification and biochemical characterization of enzymes. Later this will help the students to understand and utilize the knowledge of enzymes in research, diagnostics and industrial biotransformation processes.

Unit I **12 Hours**

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.

Unit II **12 Hours**

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

Unit III **12 Hours**

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 Km, Vmax. 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.

Unit IV **10 Hours**

Enzyme Inhibition and Activation: Types of inhibition, and activation, Kinetics of competitive, non-competitive and uncompetitive inhibition, Determination of Ki, 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.

Suggested Readings:

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.

Modes of transaction

-Lecture
-Demonstration
-Lecture cum demonstration
-Self-learning
- Field visits

L	T	P	Cr
3	1	-	4

Course Code: LBC.525
Course Title: Metabolism-I
Total Hours: 60

Learning Outcomes:
The course will provide insights into bioenergetics, various components of cells essential for energy generation and their biosynthesis. After the completion of this course the students will understand the fundamental energetics of biochemical processes, role of membrane and enzymes in various metabolic processes. They will also be able to describe and correlate metabolism of carbohydrate with their clinical aspects.

Unit I **15 Hours**

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.

Unit II **15 Hours**

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.

Unit III **15 Hours**

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.

Unit IV **15 Hours**

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.

Suggested Readings:

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.

Modes of transaction

-Lecture
-Problem Solving
-Self-Learning
-Inquiry training
-Co-operative learning

L	T	P	Cr
-	-	2	1

Course Code: LBC.526
Course Title: Biochemistry Practical-I (Practical)
Total Hours: 30

Learning Outcomes:

In this course the students will observe and perform experiments related to enzymology and metabolism will enhance their laboratory skills, and scientific knowledge. On completion of this course, students will be able to prepare analytical quality solutions, buffers, dilution series and would understand the principles of calibration which will further help them to demonstrate their utility in various biochemical methods/techniques.

Course Contents

1. Preparation of Chromic acid for glassware cleaning.
2. Preparation of calibration curves.
3. Determination of protein by Biuret and Lowry's method.
4. Determination of protein by Bradford method.
5. Quantitative 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, gluten 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.
11. Practicals may be added/modified from time to time depending on available faculties/facilities.

Modes of transaction

-Lecture cum demonstration
-Problem Solving
-Self-Learning
-Inquiry training
-Experimentation

L	T	P	Cr
-	-	6	3

Course Code: LBC.527
Course Title: Life Sciences Practical-II (Practical)
Total Hours: 90

Learning Outcomes:

Students will be able to understand and carry out basic molecular biology, cell culture and immunological techniques to correlate them with their fundamental concepts and utilize them health and diseases. At the end of the course, students will gain a broad appreciation of the techniques and their application to study bacterial and mammalian cells, cellular DNA, RNA, proteins along with different aspects of immune processes.

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. cDNA synthesis and real time PCR (qPCR).
7. DNA sequencing (demonstration only).
8. NCBI BLAST search and Primer design.
9. Multiple Sequence Alignment and Phylogenetic analysis using MEGA
10. Determination of genes mapped within a specific chromosomal locus using
11. GeneLoc integration resource and gene orthologue prediction using Ensemble.
12. Protein-protein interactions using STRING; Introduction to KEGG and Metacyc databases
13. Practical may be added/modified from time to time depending on available faculties/facilities.

Modes of transaction

-Lecture cum demonstration
-Problem Solving
-Self-Learning
-Inquiry training
-Team teaching
-Experimentation

Tools used
PPT, Video, Google Drive

Software tools
BLAST, MEGA

Course Code: LMS. 529
Course Title: Basics in Microbiology (IDC)
Total Hours: 31

L	T	P	Cr
2	-	-	2

Learning Outcomes:
The course will impart a basic foundation of microbiology to the students from different backgrounds. The course is designed to acquaint the students of different streams with a very basic knowledge and understanding of microbes, pathogens and their control. At the end of the course the student will acquire a broad understanding of different group of microorganisms important in health, diseases and industry.

Unit I **8 Hours**
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.

Unit II **8 Hours**
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

Unit III **8 Hours**
Pathogens. Medically important bacteria. Retroviruses, Viroids, Prions and emerging viruses such as HIV, Avian and swine flu viruses. Medically important fungi and protozoans. **Beneficial applications of microbes**: Human Microflora, Pre and Probiotics, Industrially important microbes.

Unit IV **7 Hours**
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.

Suggested Readings:

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.

Modes of transaction

-Lecture
-Brain storming
-Problem solving

Semester – III

Course Code: LBC.551
Course Title: Metabolism-II
Total Hours: 60

L	T	P	Cr
3	1	-	4

Learning Outcomes:

Students will learn the biosynthesis and metabolism of macromolecules and their monomeric units and related metabolic pathways. Also, up-regulation and down-regulation of metabolic pathways and accumulation of metabolites in the various disease conditions, which can be used as metabolic markers for disease diagnosis. Later, the students can extend their knowledge for drug development and metabolic engineering of microorganisms.

Unit I **15 Hours**

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.

Unit II **15 Hours**

Lipid biosynthesis: Biosynthetic pathway for tri-acylglycerols, phosphoglycerides, sphingomyelin and prostaglandins. Metabolism of cholesterol and its regulation. Energetics of fatty acid cycle.

Unit III **15 Hours**

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.

Unit IV **15 Hours**

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.

Suggested Readings:

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

Modes of transaction:

-Lecture
-Demonstration
-Lecture cum demonstration
-Inquiry training
-Group discussion

L	T	P	Cr
3	-	-	3

Course Code: LBC.552
Course Title: Nutritional and Clinical Biochemistry
Total Hours: 48

Learning Outcomes:

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 learn the general principles clinical biochemistry and understand the biochemical changes in metabolism that lead to diverse clinical diseases. The course is designed to provide students with a detailed scientific understanding of how nutrition can be used in the management of various diseases. Students will learn the role of diet in the causation, progression, and

treatment of different disease conditions and to evaluate nutritional needs in various medical conditions and recommend dietary therapy based on established guidelines and treatment protocols.

Unit I **12 Hours**

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 remedies for common disorders; Nutraceutical rich supplements; Probiotics and Prebiotics as nutraceuticals.

Unit II **12 Hours**

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.

Unit III **12 Hours**

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.

Unit IV **12 Hours**

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.

Suggested Readings:

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. Henry, Bernard J et al. (2002), *Clinical diagnosis & Management by laboratory methods.* W.B. Saunders, New York
6. Gradwohls (2000) *Clinical Laboratory Methods and Diagnosis.* (ed) Sonnenwirth AC, and Jarret L, M.D.B.I. Publications, New Delhi

7. Coleman, W. B. and Tsongalis, G. J. (2009). *Molecular Pathology: The Molecular Basis of Human Disease.* Academic Press.
8. Nussbaum, R.L., McInnes, R. Mc., Willard, H.F. (2009). *Genetics in Medicine*. Elsevier Inc.,Philadelphia.
9. Read A and Donnai D (2007). *New Clinical Genetics*. Scion Publishing Lmt., Oxfordshire, UK.
10. Patch, H. S. C. (2009). *Genetics for the Health Sciences*. Scion Publishing Ltd., UK.
11. Milunsky, A., Milunsky, J. (2009). *Genetic Disorders and the Fetus: Diagnosis, Prevention and Treatment*, 6th Edition. Wiley-Blackwell publishers.
12. Tom B, (1998) *Nutritional Biochemistry*, 2nd ed, Academic Press, London.
13. Steven HW, Steven J, et al. (2002). *Health promotion and disease prevention in clinical practice*, 2nd ed. J.B.Lippin Cott & Co.
14. Ramesh, C.G. (2010). *Nutraceuticals: Efficacy, Safety and Toxicity,* Academic Press Inc.
15. Debasis B., Harry G.P, and Anand S. (2015). *Nutraceuticals and Functional Foods in Human Health and Disease Preventio.* CRC Press.

Modes of transaction:

-Lecture
-Demonstration
-Lecture cum demonstration
-Inquiry training
-Group discussion

Course Code: LBC.553
Course Title: Animal Physiology
Total Hours: 46

L	T	P	Cr
3	-	-	3

Learning Outcomes:

This course is designed to provide students with a fundamental knowledge about function and regulation of physiological systems which includes neural & hormonal homeostatic control mechanisms, as well as study of the musculoskeletal, circulatory, respiratory, digestive, urinary, reproductive, and endocrine organ systems. On successful completion of the course students will be able to understand the basic control processes of the nervous and endocrine systems, how cardiovascular and respiratory systems are integrated and controlled, how animals move with muscles and navigate their movement by the neural control.

Unit I **12 Hours**

Blood and Circulation: Blood corpuscles and plasma, haemopoiesis and blood volume regulation, blood groups, haemoglobin, and haemostasis. **Cardiovascular System:** Anatomy of heart, myogenic heart, , Principle and significance of ECG, cardiac cycle, blood pressure and its regulation,

Respiratory System:- Anatomical considerations, transport of gases, exchange of gases, waste elimination and regulation of respiration.

Unit II **12 Hours**

Digestive System: Digestion, absorption, energy balance and regulation. **Excretory System:** Physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, electrolyte balance and 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.

Unit III **12 Hours**

Nervous System: Types of neurons, action potential, Central Nervous System, Peripheral Nervous System and neural regulation. Physiology of special senses: vision, hearing, gestation, olfaction and tactile response.

Unit IV **10 Hours**

Endocrinology: Endocrine glands, basic mechanism of hormone action, hormones and diseases and Thermoregulation. **Reproductive System:** Males and female reproductive system. Gametogenesis, fertilization and early development. Physiology of ageing andapoptosis.

Suggested Readings:

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.

Modes of transaction:

-Lecture
-Demonstration
-Lecture cum demonstration
-Inquiry training
-Group discussion
-Self-learning

Course Code: LBC.553
Course Title: Biochemistry Practical-II (Practical)
Total Hours: 90

L	T	P	Cr
-	-	6	3

Learning Outcomes:
The students will learn and perform experiments pertaining to the theory papers of clinical and nutritional biochemistry. The students will be able to apply this knowledge to make links between observations, scientific ideas and how to calculate various vital human parameters.

Course Contents

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.

Modes of transaction:

-Lecture
-Demonstration
-Lecture cum demonstration
-Experimentation
-Problem solving

Course Code: LMS.560
Course Title: Principles of Ecology, Evolution and Developmental Biology
Total Hours: 60

L	T	P	Cr
3	1	-	4

Learning Outcomes:
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 impart an understanding on developmental phenomena studied in several prominently utilized model organisms.

Unit I **15 Hours**

Principles of Ecology

Biotic and abiotic interactions, concept of habitat and niche, characteristics of a population, life history strategies, concept of metapopulation, species interactions, levels of species diversity and its measurement, ecological succession, Indian ecosystems, altruism and evolution-group selection, kin selection, reciprocal altruism, use of space and territoriality; mating systems, parental investment and reproductive success; parental care, habitat selection.

Unit II **12 Hours**

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.

Unit III **18 Hours**

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*). 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.

Unit IV **15 Hours**

Morphogenesis and organogenesis in animals and plants: Cell aggregation and differentiation in *Dictyostelium*, axes and pattern formation in *Drosophila,* Organogenesis: vulva formation, eye lens induction, limb development and regeneration in vertebrates; Metamorphosis. Shoot, root and leaf development; floral meristems and development in plant.. 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.

Suggested Readings:

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. 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.

Modes of transaction:

-Lecture
-Demonstration
-Lecture cum demonstration
-Problem solving
-Self-learning

Course Code: LBC.561
Course Title: Cell Culture Techniques
Total Hours: 60

L	T	P	Cr
3	1	-	4

Learning Outcomes:

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 will 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 I **12 Hours**

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.

Unit II **18 Hours**

Cell culture technology: Basic requirement for growing animal cells - Cell culture reagents, media preparation and their types. 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. Contamination check and prevention: bacterial, yeast, fungal, mycoplasma, viral testing.

Unit III **15 Hours**

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.

Unit IV **15 Hours**

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.

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

Modes of transaction

-Lecture
-Self-Learning
-Group discussion
- Team teaching
- Experimentation

Course Code: LBC.543
Course Title: Seminar I
Total Hours: 15

L	T	P	Cr
1	-	-	1

Learning Outcomes:
The course is designed so that the students understand and read the recent scientific articles and give presentation on a recent topic of biochemistry. Students will augment their understanding about current research topics and recent advances of biochemistry. The course will further improve the scientific writing, communication and presentation skills of the students.

Evaluation Criterion: The student selects 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 and will also prepare a report. Students are evaluated based on presentation and written report.

Course Code: LBC.599
Course Title: Project
Total Hours: 180

L	T	P	Cr
-	-	12	6

Learning Outcome:
The project would 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. Upon completion of this course the students will be able to use various search engines and websites to identify the area of their research interest. Students will also be able to formulate their hypothesis and work plan with simultaneous identification of scientifically sound (and achievable) objectives backed by a comprehensive and detailed methodology.

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

Modes of transaction

-Lecture
-Self-Learning
-Group discussion
- Team teaching
- Experimentation

Semester IV

Course Code: LPS.524
Course Title: Plant Physiology
Total Hours: 62

L	T	P	Cr
3	1	-	4

Learning Outcomes:
This course will provide insights into physiological processes in plants and various mechanisms used by plants to survive in abiotic and biotic stress conditions. Later. Students can implement this knowledge

Unit I **16 Hours**

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.

Unit II **16 Hours**

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.

Unit III **16 Hours**

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.

Unit IV **14 Hours**

Stress Physiology: Responses of plant to biotic and abiotic stress. Mechanisms of resistance to biotic stress and tolerance to abiotic stress. 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.

Suggested Readings:

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.

Modes of transaction:

-Lecture
-Problem Solving
-Self-Learning
-Inquiry training
-Team teaching

Tools used

PPT, Video, Google Drive

Course Code: LBC.572
Course Title: Secondary Metabolites and Metabolic Engineering
Total Hours: 45

L	T	P	Cr
2	1	-	2

Learning Outcomes:

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 I **12 Hours**

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.

Unit II **12 Hours**

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.

Unit III **11 Hours**

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.

Unit IV **10 Hours**

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).

Suggested Readings:

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

Modes of transaction

-Lecture
-Problem Solving
-Self-Learning
-Inquiry training
- Field visit
-Case Studies

Course Code: LBC.580
Course Title: Genetic Engineering
Total Hours: 60

L	T	P	Cr
3	1	-	4

Learning Outcomes:

The course will 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. At the end of the course, the student will acquire conceptual understanding of the application of basic molecular biology in manipulating and modifying genetic material, cells and organisms. They will have thorough understanding of the techniques and applications of genetic engineering from academic and industrial perspectives. The students will be capable of applying the acquired knowledge in a setting of Medical Biotechnology, Industrial Biotechnology, and Agricultural Biotechnology.

Unit I **15 Hours**

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.

Unit II **15 Hours**

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.

Unit III **15 Hours**

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.

Unit IV **15 Hours**

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.

Suggested Readings:

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.

Modes of transaction

-Lecture
-Problem Solving
-Self-Learning
-Inquiry training
-Team teaching

Course Code: LBC.581
Course Title: Clinical Diagnostics
Total Hours: 60

L	T	P	Cr
3	1	-	4

Learning Outcomes:

The students will be able to comprehend diverse methods in clinically diagnosing human diseases which will further help them to use these techniques in various applied fields of biological research.

Unit I **12 Hours**

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.

Unit II **18 Hours**

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.

Unit III **15 Hours**

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

Unit IV **15 Hours**

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 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 Readings:

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.

Modes of transaction

-Lecture
-Problem Solving
-Self-Learning
- Case study
-Case analysis

Course Code: LBC.573
Course Title: Recent Advances in Life Sciences-I
Total Hours: 30

L	T	P	Cr
-	2	-	2

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-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. Students will be prepared and trained for national level competitive examinations. After completion of this course students will be able to manage the time to attempt the questions and would be able to understand the technical difficulties.

Unit I **7 Hours**

Cell Biology: Molecules and their Interaction Relevant to Biology, Cellular Organization, Cell Communication, cell Signaling and Cell Cycle.

Unit II **8 Hours**

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.

Unit III **8 Hours**

Genetics: Nucleic acids: types and Functions. Genetic code, Mendelian and non-Mendelian inheritance. Genetic mapping. Recombination. Microbial Genetics.

Unit IV **7 Hours**

Microbiology: Scope and history of Microbiology, classification of Bacteria, Fungi, Protozoa, Algae, and viruses. Microbial growth. Ecology and applied microbiology.

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

Modes of transaction

-Lecture
-Problem Solving
-Self-Learning
-Panel discussion
-Inquiry training
-Group discussion
-Brain storming

Course Code: LBC.574
Course Title: Recent Advances in Life Sciences-II
Total Hours: 30

L	T	P	Cr
-	2	-	2

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. Students will be prepared and trained for national level competitive examinations. After completion of this course students will be able to manage the time to attempt the questions and would be able to understand the technical difficulties.

Unit I **7 Hours**

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.

Unit II **8 Hours**

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.

Unit III **7 Hours**

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.

Unit IV **8 Hours**

Molecular Biology and Techniques in Biology: DNA replication and repair. Transcription and translation. Gene regulation. Molecular techniques. Concepts of bioinformatics. Genomics, proteomics and metabolomics.

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

Modes of transaction

-Lecture
-Problem Solving
-Self-Learning
-Panel discussion
-Inquiry training
-Group discussion
-Brain storming

Course Code: LBC.544
Course Title: Seminar II:
Total Hours: 15

L	T	P	Cr
1	-	-	1

Learning Outcomes:
The course is designed so that the students understand and read the recent scientific articles and give presentation on a recent topic of biochemistry. Students will augment their understanding about current research topics and recent advances of biochemistry. The course will further improve the scientific writing, communication and presentation skills of the students.

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

Course Code: LBC.599
Course Title: Project
Total Hours: 180

L	T	P	Cr
-	-	12	6

Learning Outcomes: The project would ensure that the student learns the nuances of the scientific 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 analyzed in light of

established scientific knowledge to arrive at cogent conclusions. The student can also write a review for the project work. Upon completion of the project the students will be able to critically analyze, interpret and present the data in light of established scientific knowledge to arrive at cogent conclusions. The student will also be able to demonstrate their substantial research-based capabilities.

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

Course Code: LBC.504
Course Title: Ethics for Science
Total Hours: 16

L	T	P	Cr
1	-	-	1

Learning Outcomes:
To ensure that the student knows the aspects of ethics in research which will help them to understand the set of conduct norms applied in science. The course will cover the ethics involved in human, animals and plants research and misconduct, fraud and plagiarism. The students from inter-disciplinary background will learn about the basic good practices to be followed in research and overall as a student.

Unit I **3 Hours**

Introduction and Basic Principles of Ethics: Ethical theories, Ethical considerations during research, Data Manipulations. Ethical review procedure and committees

Unit II **4 Hours**

Ethics in Basic and Applied Sciences: Ethics in cloning, recombinant technology, Genetically Engineered Organisms and r-DNA based products. Animal Testing. Animal Rights, Perspectives and Methodology.

Unit III **5 Hours**

Principles of Ethics in Clinical and Medical Sciences: Code of Ethics in Medical/clinical laboratories. Healthcare rationing, Ethical Issues of Xeno-transplantation, Ethics involved in embryonic and adult stem cell research, Ethics in assisted reproductive technologies: animal and human cloning and *In-vitro* fertilization. Ethical issues in MTP and Euthanasia. Types of consents and Human Genome project.

Unit IV **4 Hours**

Ethics in Research: Intellectual property rights (IPRs), Patents copyrights. Fair use and plagiarism. Collaboration in research: authorship, resources sharing and mentoring, publications, conflict of interest, collaboration between academia and industry. Scientific misconduct.

Suggested Readings:

1. Clarke, A (2012). *Genetic Counseling: Practice and Principles*. Taylor & Francis
2. Fleming, D.O. and Hunt, D.L. (2006). *Biological Safety: Principles and Practices*. American Society for Microbiology, USA.
3. Mahop, M.T. (2010). *Intellectual Property, Community Rights and Human Rights: The Biological and Genetic Resources of Developing Countries.* Routledge.

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. Thompson J and Schaefer, B.*D (2013).Medical Genetics: An Integrated Approach*. McGraw Hill.
7. Vaughn, L. (2009). *Bioethics: Principles, Issues, and Cases*. Oxford University Press, UK.
8. WHO. (2005). *Laboratory Biosafety Manual*. World Health Organization.
9. *Ethical guidelines for biomedical research on human participants*. ICMR, 2006.

Modes of transaction

-Lectures
-Self-Learning
-Tutorial