

Department of Biochemistry and Microbial Sciences

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



M.Sc. Program in Life Sciences
Specialization: Microbial Sciences
2018-19

Department for Biochemistry and Microbial Sciences

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

Vision Statement

The focus of the department is to combat the diverse problems related to human, animal and plant health due to microorganisms and to prevent and treat diseases. Further, the department envisions to utilize the microbes for sustainable solutions to several global issues. The curriculum for M.Sc. Life Sciences program with specialization in Microbial Sciences is designed to train the students in the diverse branches of Microbiology, particularly covering the contemporary global issues. The department will also promote R&D activities in the emerging areas of microbiology. The department is involved in the community service and awareness programs related to medical microbiology and biochemistry.

Mission of the Programme

The mission of the programme is to provide excellence in teaching, research and training the students in the various fields of microbiology. The areas of research in the department include infectious diseases, cancer pathogenesis, vaccine development, nutrition, cardiovascular disease and microbe-mediated plant growth promotion with a focus on translational research.

Goals

- To teach/train students in the diverse fields of microbiology and produce nationally competitive students.
- To perform research in Microbiology for the betterment of society.
- To deliver expert microbiological diagnostic services to the public.

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M.Sc. Program in Life Sciences (Specialization: Microbial Sciences) (Academic Session 2018-19)

Semester – I

Course Code	Course Title	L (hr)	T (hr)	P (hr)	Cr
	Compulsory Foundation				
LMS.513	Research Methodology & 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
LMS.510	Life Sciences Practical I (Practical)	-	-	10	5
	Interdisciplinary Course (IDC)				
LBC.512	Basics of Biochemistry (IDC)	2	-	-	2
	Semester-I: 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 – 26 credits

Semester III – 21 credits

Semester IV – 20 credits

Total – 90 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, Univariate and multivariate 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: <ol style="list-style-type: none">1. Gupta, S. (2005). <i>Research Methodology and Statistical Techniques</i>. Deep & Deep Publications (p) Ltd. New Delhi.2. Kothari, C.R. (2008). <i>Research Methodology (s)</i>. New Age International (p) Limited. New Delhi.3. Fleming, D. O. and Hunt, D.L. (2006). <i>Biological Safety: Principles and Practices</i>. American Society for Microbiology, USA.		

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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, Krebs'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.

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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 about the microbial taxonomy, the basics of microbes, microbial growth, microbial diversity its importance and application in day to day life and beneficial versus harmful micro-organisms.

Unit	Syllabus	Lectures
1.	<p>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.</p> <p>Introduction to Microbiology: Scope and history of Microbiology, Cell structure, different components, function and their significance for bacteria and archaea. Algae, and viruses.</p>	12
2.	<p>Growth, Nutrition & Control: Phases in bacterial growth, Growth Curve, Calculation of G-time, Physical and environmental requirements of growth, Microbial nutrient requirements.</p> <p>Antimicrobial agents: Mode of action of antibiotics and chemotherapeutic drugs. Antibiotic sensitivity assays, Antibiotic resistance in bacteria, Antifungal agents, Antiparasitic agents.</p>	12
3.	<p>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.</p> <p>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.</p>	12
4.	<p>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.</p> <p>Protozoa: General account, structure, reproduction and classification of protozoa. Introduction to important protozoan diseases.</p>	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). *Alcarno's Fundamentals of Microbiology*. Jones & Bartlett Publishers, USA.

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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.	<p>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.</p> <p>Membrane Structure and Function: Models of membrane structure, Membrane proteins, Membrane carbohydrates, Membrane transport of small molecules, Membrane transport of macromolecules and particles.</p> <p>Techniques: Types of Microscopy (phase contrast, fluorescent, electron microscopy (SEM/TEM), Scanning-probe, Atomic force and, Confocal microscopy.</p> <p>Centrifugation: Principle and applications and types (Differential, Density Gradient, Iso-density centrifugation)</p>	12
2.	<p>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.</p> <p>Protein Secretion and Sorting: Organelle biogenesis and protein secretion, synthesis and targeting. Intracellular traffic, vesicular traffic in the secretory pathway, protein sorting in the Golgi bodies, traffic in the endocytic pathway, exocytosis.</p>	12
3.	<p>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.</p>	12
4.	<p>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.</p>	12

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Suggested Reading:

1. Alberts, B., Bray, D., Lewis, 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.	<p>Mendelian Principles: Dominance, segregation, independent assortment, Allele, multiple alleles, pseudoallele, complementation tests</p> <p>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.</p> <p>Extra-Chromosomal Inheritance: Chloroplast and Mitochondrial inheritance; Cytoplasmic inheritance (Coiling in Snails).</p>	12
2.	<p>Gene Mapping Methods: Molecular markers: RAPD, RFLP, SSR, SNP, ISSR, and SCAR; Linkage maps, tetrad analysis in <i>Neurospora</i>, mapping with molecular markers, development of mapping population in plants</p> <p>Human Genetics: Pedigree analysis, LOD score for linkage testing, karyotypes, genetic disorders</p> <p>Quantitative Genetics: Polygenic inheritance, heritability and its measurements, QTL mapping</p>	12
3.	<p>Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal versus 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.</p> <p>Recombination: Site-specific, homologous, DNA transposition, retrotransposition and non-homologous end joining (NHEJ).</p>	12
4.	<p>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</p>	12

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	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 Reading: <ol style="list-style-type: none">1. Snusted, D.P., Simmons, M. J. (2012). <i>Principles of Genetics</i>. 6th Edition, John Wiley & Sons, New York.2. Raven P, Johnson GB, Mason KA, Losos JB, Singer SS (2014). <i>Biology</i>, 10th Edition, McGraw-Hill, USA.3. Griffiths AJF, Wessler SR, Carroll SB, Doebley J (2015). <i>An introduction to Genetic Analysis</i>. 11th Edition W.H. Freeman publication, USA.4. Larry Snyder, Larry Snyder, Joseph E. Peters, Tina M. Henkin, Wendy Champness (2013) <i>Molecular Genetics of Bacteria</i>, 4th edition; ASM Press.5. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2014). <i>Molecular Biology of the Gene</i>. 7th Edition, Benjamin Cummings, USA.		

LMS.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

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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: Glycolysis, Krebs's Cycle, Hexose monophosphate shunt pathway, Glycogenolysis, Glycogenesis. Protein metabolism; Urea Cycle. fatty acid metabolism, nucleic acid metabolism	8

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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: <ol style="list-style-type: none">1. Satyanarayana, U. (2013) <i>Biochemistry</i>, Publisher: Elsevier; Fourth edition ISBN-9788131236017.2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2010). <i>Biochemistry</i>. W.H. Freeman & Company. USA.3. Nelson, D. and Cox, M.M. (2008). <i>Lehninger Principles of Biochemistry</i>. BI publications Pvt. Ltd. Chennai, India. Additional Reading: <ol style="list-style-type: none">1. Karp, G. (2010). <i>Cell and Molecular Biology: Concepts and Experiments</i>. 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
LMS.524	Clinical Microbiology	4			4
LMS.525	Microbial Physiology and Metabolism	3			3
LMS.526	Microbiology Practical-I (Practical)			6	3
LMS.527	Life Sciences Practical-II (Practical)			6	3
	Interdisciplinary Course (IDC)				
LMS.529	Basics of Microbiology (IDC)	2			2
	Total Credits				26

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		

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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 characteristics 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

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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,	12

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coexpression; Recent trends.
Suggested Reading: <ol style="list-style-type: none"> 1. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2014). <i>Molecular Biology of the Gene</i>. 7th Edition, Benjamin Cummings, USA. 2. Krebs, J.E., Goldstein, E.S., Kilpatrick, S.T. (2014). <i>Lewin's Genes XI</i>. Jones & Bartlett Learning, USA. 3. Green, M.R., Sambrook, J. (2012). <i>Molecular cloning: A laboratory manual</i>. Cold Spring Harbor Laboratory Press, New York.

LMS.524: Clinical Microbiology Learning Objective: The students will understand about the basic concept of epidemiology various cellular processes during disease development and the relevance of microbes and various diseases caused by bacteria, fungi, protozoa and viruses.		
Unit	Syllabus	Lecture
1	Epidemiology: Concept of epidemic, endemic and pandemic, acute, chronic, morbidity, mortality, prevalence, incidence, Normal microflora of human body and their advantage. Molecular Basis of Microbial Pathogenesis Establishment of pathogenic microorganisms: Entry, spread and tissue damage. Mechanism of bacterial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urogenital tracts. Biofilms and quorum sensing, modulation of apoptotic processes and toxins.	15
2	Introduction and Biology of Pathogenic Bacteria: Important developments in medical microbiology, Morphological characteristics, pathogenesis and laboratory diagnosis including rapid methods of following pathogenic bacteria; <i>Staphylococcus</i> , <i>Streptococcus</i> , <i>Enterococcus</i> , <i>Escherichia coli</i> , <i>Neisseria</i> , <i>Klebsiella</i> , <i>Salmonella</i> , <i>Shigella</i> , <i>Vibrio</i> , <i>Campylobacter</i> , <i>Pseudomonas</i> , <i>Acinetobacter</i> , <i>Yersinia</i> , <i>Treponema</i> , <i>Haemophilus</i> , <i>Bordetella</i> , <i>Bacillus</i> , <i>Clostridium</i> , <i>Corynebacterium</i> , <i>Mycobacterium</i> , <i>Actinomyces</i> , <i>Nocardia</i> , <i>Fusobacterium</i> , <i>Listeria</i> , <i>Rickettsiae</i> , <i>Chlamydiae</i> , <i>Spirochetes</i>	15
3	Pathogenic Fungi: Morphological characteristics, pathogenesis and laboratory diagnosis of following pathogenic fungi: <i>Microsporium</i> ; <i>Trichophyton</i> ; <i>Histoplasma capsulatum</i> ; <i>Blastomyces dermatitidis</i> ; <i>Candida albicans</i> ; <i>Cryptococcus neoformans</i> ; <i>Pneumocystis carinii</i> , <i>Aspergillus spp.</i> Protozoal Pathogens: General description, biological properties and diseases caused by Protozoa- <i>Plasmodium spp</i> , <i>Giardia intestinalis</i> , <i>Trypanosoma spp</i> , <i>Leishmania spp</i> , <i>Entamoeba histolytica</i>	15

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4	<p>Recognition and Pathogenesis of Viral Infection: Contributions of various host defense mechanisms in viral infections; Details on important viruses namely Herpesvirus, Poliovirus, Influenza virus, Adeno Virus, Poxviruses, Hepatitis Viruses, Coronaviruses, Retroviruses and Flaviviruses.</p> <p>Oncogenic viruses: oncogenic viruses, viral transformation by activation of cellular signal transduction pathways, viral transformation via cell cycle control pathways. Viral Chemotherapy: Nucleoside analogs, reverse transcriptase inhibitors, protease inhibitors: mechanism of action and drug resistance, viruses as therapeutic agents.</p>	15
<p>Suggested Reading</p> <ol style="list-style-type: none"> 1. Atlas, R.M. (1994) <i>Principles of Microbiology</i>, McMillan, New York 2. Tortora, G.J., Funke, B.R., Case, C.L. (2004) <i>Microbiology -An Introduction</i>, Pearson education Pvt. Ltd. Singapore. 3. Walsh, G. (1998) <i>Biopharmaceuticals: Biochemistry and Biotechnology</i>, John Wiley & Sons, New York. 4. Benjamin, E. (1996), <i>Immunology-A short course</i> 5. Kindt, T.J., Osborne, B.A. and Goldsby, R.A. (2012). <i>Kuby Immunology .7th Edition</i>. W.H. Freeman, USA 6. Madigan, M.T., Martinko, J.M., Bender, K., and Buckley, D. (2011) <i>Brock Biology of Microorganisms</i>, 13th Ed., Pearson Education, USA 		

LMS.525: Microbial Physiology and Metabolism

Learning Objective: Microbial Physiology is the study of structure, function, energy metabolism, growth and regulatory mechanisms of microorganisms. In this course, the students will learn about the metabolic diversity exhibited by microorganisms, their thermodynamics and regulatory networks that support their survival and growth.

Unit	Syllabus	Lecture
1	<p>Bacterial Photosynthesis: Photosynthetic microorganisms, photosynthetic pigments, and generation of reducing power by cyclic and non-cyclic photophosphorylation, electron transport chain in photosynthetic bacteria. Carbon dioxide fixation pathways.</p>	10
2	<p>Bacterial Respiration: Bacterial aerobic respiration, components of electron transport chain, free energy changes and electron transport, oxidative phosphorylation and theories of ATP formation, inhibition of electron transport chain. Electron transport chain in some heterotrophic and chemolithotrophic bacteria.</p> <p>Bacterial Anaerobic Respiration: Introduction. Nitrate, carbonate and sulfate as electron acceptors. Electron transport chains in some anaerobic bacteria. Catalase, super oxide dismutase, mechanism of oxygen toxicity.</p>	12
3	<p>Bacterial Permeation: Structure and organization of membrane (Glyco-conjugants and proteins in membrane systems), fluid mosaic model of membrane. Methods to study diffusion of solutes in bacteria, passive diffusion, facilitated diffusion, different mechanisms of active diffusion.</p>	12

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	Proton Motive Force, PTS, role of permeases in transport, different permeases in <i>E. coli</i> . Transport of amino acids and inorganic ions in microorganisms and their mechanisms.	
4	<p>Bacterial Sporulation: Sporulating bacteria, molecular architecture of spores, induction and stages of sporulation, Influence of different factors on sporulation. Cytological and macromolecular changes during sporulation. Heat resistance and sporulation.</p> <p>Bacterial Chemolithotrophy, Physiological groups of chemolithotrophs, ammonia oxidation by members of Genus Nitroso group, nitrite oxidation by Nitro group of genera. Oxidation of molecular hydrogen by hydrogenomonas species. Ferrous and sulfur/sulfide oxidation by <i>Thiobacillus</i> species.</p>	12
<p>Suggested Reading:</p> <ol style="list-style-type: none"> 1. Caldwell D.R. (1995) <i>Microbial Physiology and Metabolism</i>. Brown Publishers. 2. Moat A.G. and Foster J. W. (2002) <i>Microbial Physiology</i>, Wiley. 3. Brun. Y.V. and Shmkets L.J. (2000) <i>Prokaryotic Development</i>. ASM Press. 4. Rose AH <i>Advances in Microbial Physiology</i>. Vol. 36, Academic Press New York. 5. Gunsalus IC, Stanier R. (1960) <i>The Bacteria</i>, Academic Press. 6. White, D. (2011) <i>The Physiology and Biochemistry of Prokaryotes</i>, 4th Edition, Oxford University Press 		

LMS.526: Microbiology Practical –I

Learning Objective: In this course the students will observe and perform experiments related to clinical microbiology and virology which will enhance their laboratory skills, and scientific knowledge.

1. Preparation of Media: Nutrient broth, Nutrient agar, plates, slants, soft agar; Pure culture technique: Streak plate, spread plate and pour plate methods.
2. Staining methods: Simple staining, Negative Staining, Gram Staining, Acid-Fast stain.
3. Culturing methods of microbes – slant and stab cultures, tube culture, flask cultures, shake flask cultures
4. Methods for studying microbial respiration
5. Preparation of different types of culture media/observation. Blood Agar, Chocolate Agar, Mannitol salt agar, Blair Parker medium, MacConkey agar, Lowenstein-Jensen medium, Wilson Blair Bismuth sulphite medium, Biochemical media.
6. Tests for disinfectants (Phenol coefficient/RWC)
7. Study of normal micro-biota of mouth; isolation, identification and preservation of microorganisms
8. Study of normal micro-biota of skin; isolation identification and preservation of microorganisms
9. Identification and Biochemical tests of respiratory tract bacterial pathogen using avirulent strain of MTCC Culture of *Streptococci/ Klebsiella pneumoniae*.
10. Identification and Biochemical tests of gastrointestinal bacterial infection using avirulent strain of MTCC Culture of *Salmonella / Shigella* spp.
11. Laboratory examination and identification and biochemical tests of pus specimens using avirulent strain of MTCC Culture for *Staphylococcus aureus*, *Streptococcus pyogenes* and *Pseudomonas aeruginosa*.

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12. Laboratory examination of sputum: Collection of sputum. Microbiological examination of sputum for pus cells and predominant bacteria. Ziehl-Neelsen staining to detect the presence of Mycobacterium using avirulent strain of MTCC Culture.
13. Determination of MIC values for antimicrobial chemicals
14. Identification of pathogenic bacteria (any three of *E. coli*, *Salmonella*, *Pseudomonas*, *Staphylococcus*, *Bacillus*) based on cultural, morphological and biochemical characteristics.
15. Biochemical, enzymatic and serological tests (Coagulase, Catalase, WIDAL, VDRL tests).
16. PCR based diagnosis.
17. Estimation of infectivity titre of a virus sample using Plaque assay.
18. Production of a purified virus stock and its quantitation.
19. Determination of size of a virus.
20. Detection of viral antibodies in given sample using agglutination assay.
21. Determination of specificity of anti-viral response by agglutination-inhibition assay.
22. Growth of animal cells in culture medium.
22. Determination of viral titre following infection of animal cells in culture.

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

LMS.527: Life Sciences Practical-II

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).

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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
<ul style="list-style-type: none">• Practical may be added/modified from time to time depending on available faculties/facilities.

Interdisciplinary Course (ID)

LMS.529: Basics in Microbiology

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. A brief account of 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.	8
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		

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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					
LMS.551	Industrial and Environmental Microbiology	4			4
LMS.552	Food and Dairy Microbiology	3			3
LMS.554	Microbiology 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					
LMS.543	Seminar-I				1
LMS.599	Project			12	6
Total Credits					21

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
- 8) Brain storming
- 9) Industrial Visit/tours: Students will relate their theoretical knowledge to practical aspects of the studied courses (LMS.551 & LMS.552), in terms of industrial unit operations, process and design concepts, and impact of its activities on health, safety, environment and society.

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Core Courses

LMS.551: Industrial and Environmental Microbiology

Learning Objective: The students will study the use of microorganisms for the value added products through fermentation processes. Further, they will learn and understand the composition of industrial waste water and xenobiotics, and their treatment using microorganisms.

Unit	Syllabus	Lectures
1	<p>Introduction: Scope and historical development; Sources of industrially important microbes, strain development, types of fermentation and fermenters, process optimization, and recent developments in fermentation technology. Types of fermentation systems; Bioreactor designs and operations.</p> <p>Downstream processing of microbial products: Filtration, centrifugation, cell disruption, liquid-liquid extraction, chromatography, membrane processes, drying (lyophilization and spray drying), and crystallization. Types of fermentation systems; Bioreactor designs and operations.</p>	12
2	<p>Microbes in Industry: Alcohol production- Preparation of medium, Fermentation process and recovery; Production of Malt beverages: Production of Beer- malting process, mashing process and finishing; other malt products. Production of Wine: Microbial process, wine from grapes, Fermentation and recovery, types of wine-white and red wine. Production of distilled beverages or liquors- rum, whiskey and brandy; Microbial production of organic acids- vinegar production (substrate, Microbial processing and product recovery); Citric Acid-fermentation, recovery and uses; Lactic acid-fermentation, medium and manufacturing process, recovery and uses. Production of vitamins: Vitamin B12 (Cyanocobalamine) production; Riboflavin (vitamin B2) production.</p>	14
3	<p>Microbiology of Waste-water: Occurrence and distribution of microbes in water, Role of organic pollution of water, techniques for measurement of microorganisms in aquatic ecosystems, Algal bloom, Concepts of C-BOD, N-BOD and COD, Oxygen-sag curve. General characteristics of industrial waste-water coming from sugar industries, tanneries, paper-pulp and alcohol industries. Disinfection of drinking water with anti-microbial agents. Coliform test of potable water. Primary treatment of wastewater, treatment of industrial effluent by aerobic treatment methods; Trickling filters, and Oxidation ponds. Methods of anaerobic treatment of sludge. Bioaccumulation of heavy metal ions from industrial effluents. Removal of nitrogen and phosphorous and volatile organic matter from water. Water borne risk to human health.</p>	14
4	<p>Microbial Toxicology and Degradation of Xenobiotics: General chemistry of pollutants viz., particulate matter, poly-aromatic hydrocarbons, organosulfur, organophosphorous, organohalides, organonitrogen, organometallic compounds. Fog and smog, acid rain Dose-response relationship, Determination of LD50, Effect of heavy metals, pesticides on the microbial population in air, water and soil. Ames test to determine the genotoxicity of toxicants. Mode of action of carcinogens, Microbial tolerance and resistance against heavy metals, antibiotics and pesticides Concepts of xenobiotics, bio-</p>	14

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	concentration and bio-magnification, Bio-transformation and biodegradation of xenobiotics like organophosphates and organohalides compounds, plastic, paints.	
Suggested Reading		
<ol style="list-style-type: none"> 1. Cruger W and Cruger A. (2004). <i>Biotechnology - A Textbook of Industrial Microbiology</i>. Panima. 2. Kun LY. (2006). <i>Microbial Biotechnology</i>. World Scientific. 3. Marwaha, S.S. and Arora, J.K. (2000), <i>Food Processing: Biotechnological Applications</i>, Asia Tech Publishers Inc., New Delhi. 4. Lee, B.H. (1996), <i>Fundamental of Food Biotechnology</i>, VCH Publishers. 5. Joshi, V.K. and Pandey, A. (1999), <i>Biotechnology: Food Fermentation</i> Vol. 1 & 2, Education Publisher and Distributor, New Delhi. 6. Baker, K.H. And Herson D.S. (1994). <i>Bioremediation</i>. MacGraw Hill Inc. N.Y. 7. Ec Eldowney, S. Hardman D.J. and Waite S. (1993). <i>Pollution: Ecology and Biotreatment</i> Longman Scientific Technical. 8. R. K. Trivedy (1998) <i>Advances in Waste Water Treatment Technologies</i>. Volumes II and I. Global Science Publication. 9. Lawrence, P., Wacekett, C. and Douglas Hershberger. (2000) <i>Biocatalysis and Biodegradation: Microbial transformation of organic compounds</i>. ASM Publications. 10. Christon J. Hurst (2001). <i>A Manual of Environmental Microbiology</i>. 2nd Edition. ASM Publications. 11. N.S. Subba Rao. (1995). <i>Bio-fertilizers in Agriculture and Forestry</i>. 		

LMS.552: Food and Dairy Microbiology

Learning Objective: In this course, the students will learn and understand the microbiology of foods and dairy products. They will also get acquainted with the food spoilage and preservation methods, and understand the industrial aspect of dairy microbiology.

Unit	Syllabus	Lectures
1.	Food Borne Microbes: Importance and significance of microorganisms in food. Food borne diseases- Bacterial food borne diseases- (Staphylococcal intoxicification, Botulism, Salmonellosis, Shigellosis, EPEC Diarrhoea, Clostridium Perfringens gastroenteritis, Bacillus cereus gastroenteritis; Food-borne fungi- Mycotoxins- Aflatoxicosis, Mycotoxicosis, Ergotism.	12
2.	Microbial growth in food: Intrinsic, extrinsic and implicit factors, Microbial interactions, Inorganic, organic and antibiotic additives. Physical and chemical factors influencing the destruction of microorganisms including thermal death time, Z, F and D values. Modern methods of cell culture: synchronous and co-cell culture, continuous cell culture in liquid and solid media, Cell immobilization and applications, Pre and probiotics cultures. Probiotic bacteria in foods.	12
3.	Fermented and Dairy Food Products: Microorganisms involved in food fermentations. Microbiology of Milk. Sources of Milk contamination and their control Microbiology of raw and pasteurized milk, Starter cultures for fermented dairy products (<i>Streptococcus thermophilus</i> , <i>Lactobacillus bulgaricus</i>). Fermented milk products- Acidophilus and Bulgarian milk, yoghurt, cheese, Kefir, Koumiss; Fermented grains and vegetable products - Sauerkraut, Soy sauce, Tempeh, Miso, and Kimchi; Single cell protein, Role	11

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	of microorganisms in beverages – tea and coffee fermentations. Vinegar Fermentation.	
4.	Food Preservation and Safety: Use of High and low temperature, Control of water activity, Use of Radiations in preservation, Modified atmosphere packaging, High pressure processing, chemical preservatives and naturally occurring antimicrobials; Bacteriocins and their applications. Microbial testing of food, Microbiological quality standards of food and regulatory bodies: FDA (Food and Drug Administration), HACCP (Hazard Analysis and critical control points), ISI (Indian Standard Institute).	10
Suggested Reading: <ol style="list-style-type: none">1. Ray, B. and Bhunia, A. (2013). <i>Fundamental Food Microbiology</i>, 5th revised edition. CRC press Inc.2. Frazier, W.C. and Westhoff, D.C. (2013). <i>Food Microbiology</i>. 5th Ed. Tata McGraw Hill.3. Doyle, M.P. and Buchanan, R.L. (2012), <i>Food Microbiology</i>, ASM Press, Washington.4. Jay, J.M., Loessner, M.J. and Golden, D.A. (2005) <i>Modern Food Microbiology</i>, 7th ed. Springer-Verlag New York5. Richard K. Robinson, (2002). Dairy Microbiology Handbook: The Microbiology of Milk and Milk Products, Wiley-Blackwell; 3rd Edition.6. Doyle, M. P. and Beuchat, L. R., 2007, Food Microbiology- Fundamentals and Frontiers, ASM Press.7. Elmer H. Marth, James Steele, (2001). Applied Dairy Microbiology, Second Edition, CRC Press.		

LMS.553: Microbiology Practical –II

Learning Objective: The students will learn and perform experiments pertaining to the theory papers of industrial and environmental microbiology and food and dairy microbiology. The students will be taught to make links between observations and scientific ideas.

<ol style="list-style-type: none">1. Microbiological examination of fresh and canned foods, mushrooms, spoiled foods and fruits, milk and milk products2. Microbiological quality testing of milk (MBRT test)3. Isolation of toxin producing organisms and estimation of their toxins in different foods4. Extraction of Mycotoxins from contaminated food.5. Isolation of bacterial and fungal probiotics6. Development of probiotics <i>in vitro</i>.7. To study various food preservation methods.8. Std method for bacteriological water analysis: Presumptive, confirmatory and completed test.9. Microbial growth studies.10. Isolation of industrially important microorganisms for microbial processes (citric / lactic/ alpha amylase) and improvement of strain for increasing yield by mutation.11. Determination of Thermal Death Point (TDP) and Thermal Death Time (TDT) of microorganisms for design of a sterilizer.12. Extraction of Citric acid/Lactic acid by salt precipitation.13. Monitoring of dissolved oxygen during aerobic fermentation14. Biomass production (Baker's yeast and <i>Spirulina</i>).15. Production of beverages (alcohol and wine).

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16. Estimation of the fermentation products by titration Method 17. Isolation of food poisoning bacteria from contaminated foods, Dairy products 18. Production of fermented milk by <i>Lactobacillus acidophilus</i> . 19. Physical analysis of sewage/industrial effluent by measuring total solids, total dissolved solids and total suspended solids. 20. Determination of indices of pollution by measuring BOD/COD of different effluents. 21. Bacterial reduction of nitrate from ground waters 22. Isolation and purification of degradative plasmid of microbes growing in polluted environment. 23. Recovery of toxic metal ions of an industrial effluent by immobilized cells. 24. Utilization of microbial consortium for the treatment of solid waste [Municipal Solid Waste]. 25. Biotransformation of toxic chromium (+ 6) into non-toxic (+ 3) by <i>Pseudomonas</i> species. 26. Tests for the microbial degradation products of aromatic hydrocarbons /aromatic compounds. 27. Reduction of distillery spent wash (or any other industrial effluent) BOD by bacterial cultures. 28. Microbial dye decolorization/adsorption.
<ul style="list-style-type: none"> • Practical 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 (<i>Drosophila</i> , <i>C. elegans</i> , <i>Xenopus</i>)	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

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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: <ol style="list-style-type: none"> 1. Darwin, C.R. (1911). <i>On the origin of species by means of natural Selection, or preservation of favoured races in the struggle for life</i>. Hurst Publishers, UK. 2. Dawkins, R. (1996). <i>The Blind Watchmaker</i>, W.W. Norton & Company Jones and Bartlett Publishers. 3. Futuyma, D.J. (2009). <i>Evolution</i>. Sinauer Associates Inc. USA. 4. Hake, S. and Wilt, F. (2003). <i>Principles of Developmental Biology</i>. W.W. Norton & Company, New York, USA. 5. Hall, B.K. and Hallgrimsson, B. (2007). <i>Strickberger's Evolution</i>. Jones and Bartlett Publishers, India. 6. Lewin, R. (2004). <i>Human Evolution - An Illustrated Introduction</i>. Wiley-Blackwell, USA. 7. Scott, F. and Gilbert, S.F. (2010). <i>Developmental Biology</i>. Sinauer Associates, Inc. USA. 8. Slack, J.M.W. (2005). <i>Essential Developmental Biology</i>, Wiley-Blackwell, USA. 9. Green, D. R. & Reed J. C. (2010). <i>Apoptosis: Physiology and Pathology</i>. Cambridge press, UK. 10. Sadler, T.W., Tosney, K., Chescheir, N.C., Imseis, H., Leland, J. and Sadler-Redmond, S., L. (2011). <i>Langman's Medical Embryology (Longmans Medical Embryology)</i>. Lippincott Williams and Wilkins. 11. Schaefer, B.D. (2013). <i>Medical Genetics: An integrated Approach</i>. 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.	14

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II	<p>Cell culture technology: Basic requirement for growing animal cells - Cell culture reagents, media, media supplements, media preparation and 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, <i>in vitro</i> 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</p>	16
III	<p>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.</p>	15
IV	<p>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 <i>in-vitro</i>. Nanotechnology.</p>	15
<p>Suggested Readings:</p> <ol style="list-style-type: none"> 1. Michael Butler, “<i>Animal Cell Culture and Technology</i>”, BIOS Scientific Publishers 2. John R.W. Masters, “<i>Animal Cell Culture-A Practical Approach</i>”, Oxford University Press 3. R. Ian Freshney, “<i>Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications</i>”. 4. Trent, R. J. (2010). <i>Molecular Medicine, Fourth Edition: Genomics to Personalized Healthcare</i>. Academic Press. 		

LMS.543: Seminar I

Learning Objective: To read the recent scientific articles and give presentation on a recent topic of microbiology to further improve student scientific writing and presentation skills. The students select an advanced topic in microbiology 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.

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

LMS.599: Project

Course Objective: The objective 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, and 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				
LMS.571	Microbial Biotechnology	4	-	-	4
	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				
LMS.544	Seminar II	-	-	-	1
LMS.599	Project	-	-	12	6
	Total Credits				20

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

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LMS.571: Microbial Biotechnology

Learning Objective: This course focuses on the application and use of micro-organisms in the production of secondary metabolites and enzymes, human and livestock health, nanotechnology and removable energy.

Unit	Syllabus	Lectures
1	Antimicrobials, Organic acids and enzymes- Microbial production of penicillin, Tetracycline and peptide antibiotics; Acetic acid; Lactic acid; Gluconic acid, vaccines. Microbial production and commercial applications of Amylases, Proteases, Lipases. Biotransformation of steroid and non-steroid compounds.	13
2	Single cell protein: Microorganisms used; raw material used as substrate; condition for growth and production; nutritive value and uses of SCP. Mushroom production: cultivation of different types of mushroom; edible mushroom; diseases of mushrooms therapeutic value of an edible mushroom. Genetically modified foods and their importance. Overproduction of metabolites: Metabolic pathway engineering of microbes for production of novel products for industry; Downstream processing; Immobilization of cells/enzymes. Synthesis of commercial products using microbial systems: Biopolymers-xanthan gum and PHA's (Bioplastics).	16
3	Beneficial microbes: Biofertilizers- <i>Rhizobium</i> , <i>Azospirillum</i> , <i>Azotobacter</i> , <i>Gluconacetobacter</i> , <i>Azorhizobium</i> , phosphobacteria - <i>mycorrhizae</i> - Blue Green Algae and <i>Azolla</i> . Mass production of biofertilizers and composting. Designer Microbes and Health: Gut microbiota and diseases, approaches for engineering gut microbiota, therapeutic uses of gut microbiota, Bacteriophages in control of bacteria.	15
4	Microbial Nanotechnology –Microbial synthesis of Nanoparticles. Synthesis of nanodrugs – metal nanoparticles and drug delivery vehicles – Nanoshells – Tectodentrimers Nanoparticle drug systems – Diagnostic applications of nanotechnology. Renewable Bioenergy using Microorganisms: Methanogenesis, Methane production by anaerobic digestion of waste organic materials. Bioethanol and Biobutanol production by using microorganisms. Biohydrogen Generation, Microbial Fuel. Biodiesel from algae.	16

Suggested Reading:

1. W. B. Hugo and A. D. Russell, (2011) *Pharmaceutical Microbiology*, 8th Edition. Blackwell Scientific Publications.
2. Frederick Kavanagh, (2014). *Analytical Microbiology* Volume II. Elsevier.
3. S. P. Vyas and V. K. Dixit, (2012) *Pharmaceutical Biotechnology*. CBS Publishers & Distributors, New Delhi.
4. Elisabeth Papazoglou and Aravind Parthasarathy (2007). *Bionanotechnology*. Morgan & Claypool Publishers.
5. Bernd Rehm (2006). *Microbial Bionanotechnology: Biological Self-assembly Systems and Biopolymer-based Nanostructures*. Horizon Scientific Press.

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6. Willey, J.M., Sherwood, L., and Woolverton, C. (2013). *Prescott's Microbiology* 9th Revised Edition, McGraw Hill Higher Education, New York.
7. Mehrotra RS and KR Aneja (2015). *An Introduction to Mycology*, New Age Publishers
8. Steven L. Stephenson (2010) *The Kingdom Fungi: The Biology of Mushrooms, Molds and Lichens*.
9. Reisner DE, Bronzino JD. (2008). *Bionanotechnology: Global Prospects*. CRC Press.

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 <i>E. coli</i> , in Gram-positive bacteria, in Streptomyces, in <i>Saccharomyces Cerevisiae</i> and <i>Pichia pastoris</i> , 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.

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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

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.	15
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, Radioimmunoassay; 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	15
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, <i>In situ</i> PCR, Long-PCR, PCR-ELISA, 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 <i>Coliforms</i> , <i>Salmonella</i> , <i>Shigella</i> , <i>Vibrio</i> , and <i>Mycobacterium tuberculosis</i> . Diagnosis of fungal infections. Dermatophytoses, Candidiasis and Aspergillosis. Diagnosis of DNA and RNA viruses. Pox viruses, Adenoviruses, Rhabdo Viruses, Hepatitis Viruses and Retroviruses. Diagnosis of Protozoan diseases: Amoebiasis, Malaria, Trypanosomiasis, Leishmaniasis, Filariasis and	15

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	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.	
<p>Suggested Reading:</p> <ol style="list-style-type: none"> 1. Burtis, Carl A, Ashwood, Edward R, Bruns, David E., “<i>Tietz textbook of Clinical Chemistry & Molecular Diagnostics</i>” USA: Saunders, 2006. 2. World Organization for Animal Health: “<i>Manual of Diagnostic Tests and Vaccines for Terrestrial Animals</i>” Volumes I & II, 6th Edition, 2010. 3. Rao, Juluri R, Fleming, Colin C., Moore, John E., “<i>Molecular Diagnostics: current technology and Applications</i>”, Horizon Bioscience, U. K., 2006. 4. Goldsby, Richard A., Kubly, Janis, “<i>Immunology</i>”, New York: WH Freeman and Company, 2003. 5. Mahon, Connie R; Lehman, Donald C. Manuselis, George “<i>Textbook of Diagnostic Microbiology</i>”. 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, Transcription and translation. Regulatory elements and mechanisms of transcription regulation, Transcriptional and posttranscriptional gene silencing.	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.

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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: Methods for immunoglobulin determination-quantitative and qualitative antigen and antibody reactions. Spectrophotometry, Microscopy, Centrifugation and chromatography. Molecular Techniques and Bioinformatics: Gel electrophoresis, Southern, Northern, Western blotting. Genomics, proteomics and metabolomics. Biological databases and search engines.	8

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

LMS.544: Seminar II

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

The students select an advanced topic in microbiology 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.

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LMS.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
22.	Ethics for Science
23.	Professional Ethics
24.	Academic Writing
25.	Value Education
26.	Stress Management
27.	Personality Development through Life Skills
28.	Physical & Mental Well Being
29.	Pedagogical Studies
30.	Data Analysis using spread sheet
31.	Soft Skill Training
32.	Leadership
33.	Personal Management
34.	Wealth Management
35.	Reasoning Ability
36.	MS office Specialist
37.	Practical Taxation
38.	Ethical Issues & Legal Awareness
39.	Disaster Management
40.	Nutrition and Specialty Foods
41.	Shorthand & Typing

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42.	SPSS
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