SOMAIYA VIDYAVIHAR

K J Somaiya College of Science & Commerce

Autonomous (Affiliated to University of Mumbai)

Somaiya TRUST

K. J. SOMAIYA COLLEGE OF SCIENCE AND COMMERCE,

VIDYAVIHAR, MUMBAI 400 077

AUTONOMOUS- AFFILIATED TO UNIVERSITY OF MUMBAI

Syllabus for M.Sc.-Part I

Program: M.Sc.

Course: Microbiology

(Choice based Credit System with effect from the Academic year 2023–2024)

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Syllabus - M.Sc. Microbiology Semester I

Semester	Course Number	Course Title	Course code	Credits	Hour	Period (1 hr)	Unit/ Module	Lectures per / module	Examination		
I									Internal Marks	External Marks	Total Marks
THEORY											
Core courses											
I	I	Cell Biology	**23PS1MBCC1 CBI**	2	30	30	2	15	20	30	50
I	II	Protein Biochemistry	**23PS1MBCC2 PBC**	2	30	30	2	15	20	30	50
I	III	Medical Microbiology and Immunology	**23PS1MBCC3 MMI**	2	30	30	2	15	20	30	50
I	IV	Evolutionary Biology	**23PS1MBCC4 EVB**	2	30	30	2	15	20	30	50

Discipline Specific Electives (any one)											
I	I	Developmental Biology	**23PS1MBDS1 DVB**	2	30	30	2	15	20	30	50
I	II	Nanobiotechnology	**23PS1MBDS2 NAN**	2	30	30	2	15	20	30	50
I	III	Advanced techniques in Biology	**23PS1MBDS3 ATB**	2	30	30	2	15	20	30	50
PRACTICALS											
Core courses											
I	I TO IV	Practicals	**23PS1MBCCP**	6	180	180	8	-	75	75	150
Discipline Specific Electives (any one)											
I	I/II/III	Practicals	**23PS1MBDSP1/ 23PS1MBDSP2/ 23PS1MBDSP3**	2	60	60	2	-	25	25	50

M. Sc. (MICROBIOLOGY) SEMESTER I

Course – I Cell Biology

COURSE CODE: 23PS1MBCC1CBI **CREDITS: 02**

Course Learning Outcomes: After the successful completion of the Course, the learner will be able to:

1. Analyze the functions of cell membrane and cytoskeleton in transport.
2. Exemplify various strategies of cell communication and signaling in plants and animals.

MODULE	TITLE AND CONTENT	NO OF LECTURES
1	**Module Title: Membrane structure and transport** **Learning Objectives:** 1. To describe the structure of cell membrane and cytoskeleton. 2. To explore the proteins involved in transport of molecules between different organelles. 3. To implement the techniques used to study cell membranes. **Learning Outcomes:** After the successful completion of the module, the learner will be able to: 1. Explain the structure and components of cell membrane. 2. Describe the process of protein sorting. 3. Critique the techniques used to study cell structure.	
1.1	**Cell membrane structure**: Spectrins, Glycophorin, Intracellular Compartments and protein sorting.	2L
1.2	**Transport between cellular organelles**: Compartmentalization of cells, transport of molecules between the nucleus and cytosol, peroxisomes Endoplasmic reticulum. Intracellular vesicular traffic: Endocytosis, exocytosis, transport from the ER through the Golgi apparatus and transport from trans Golgi network to Lysosomes. Transport of proteins in mitochondria and Chloroplast.	3L
1.3	**Cytoskeleton**: Cytoskeletal filaments, Microtubules, Actin regulation, molecular motors, cell behavior.	5L
1.4	**Cell study**: Study of cells under the microscope, Phase contrast, Fluorescence microscopy, Confocal microscopy, and Radioisotopes as Tracers-Techniques like Pulse-Chase.	5L

2	**Module Title: Cell communication and signaling** **Learning Objectives:** 1. To illustrate the different types of cell junctions and their functions. 2. To explore signal transduction pathways **Learning Outcomes**: After the successful completion of the module, the learner will be able to: 1. Analyze the importance of cell junctions and extracellular matrix in maintaining tissue structure and function. 2. Compare and contrast between different types of receptors involved in cell signaling. 3. Discuss signal transduction pathways in mammals and plants.	
2.1	**Cell Junctions, Cell Adhesion and the Extracellular Matrix**: Cadherins and Cell-Cell Adhesion, Tight Junctions, Gap junctions, Basal Lamina, Integrin and Extracellular Matrix.	5L
2.2	**Cell communication**: Extracellular signal molecules, nitric oxide gas signal, classes of cell-surface receptor proteins.	2L
2.3	**Signaling through enzyme linked cell surface receptors**: Docking sites, Ras, MAP kinase, Pl-3 kinase, TGF.	5L
2.4	**Signaling in plants**: Serine / Threonine kinases, role of ethylene, Photoreceptors (phytochromes, cryptochromes and phototropins).	3L

References:

1. Albert, Johnson, Lewis, Raff, Roberts & Walter. Molecular Biology of The Cell. 5th Edition.
2. Lodish, Birk and Zipursky, Freeman. Molecular Cell Biology, 8th Edition.
3. Alberts, Bray, Hopkin, Johnson, Lewis, Walter. Essential Cell Biology.3rd Edition.
4. Geoffrey M. Cooper and Robert E. Hausman. The Cell: A Molecular Approach. 4th Edition.

M. Sc. (MICROBIOLOGY) SEMESTER I

Course – II Protein Biochemistry

COURSE CODE: 23PS1MBCC2PBC **CREDITS: 02**

Course Learning Outcomes: After the successful completion of the Course, the learner will be able to:

1. Analyze the factors that influence protein stability and folding.
2. Identify the molecular components and machineries involved in protein transport.

MODULE	TITLE AND CONTENT	NO OF LECTURES
1	**Module Title: Protein folding and Protein Engineering** **Learning Objectives:** 1. To elaborate on the features of amino acid and protein structure and folding. 2. To discuss approaches used in protein engineering. **Learning Outcomes:** After the successful completion of the module, the learner will be able to: 1. Describe the various structural features of amino acid and proteins 2. Evaluate the role of different forces and interactions involved in protein folding. 3. Apply various methods for protein engineering.	
1.1	**Amino acids**: Classification. Titration curve of glycine.	2L
1.2	**Structure of Proteins**: Structure of peptide bond, stability of formation of peptide bond, Ramchandran plot, protein structure, factors determining secondary, tertiary, quaternary structures, thermodynamics of folding, role of disulphide bonds, dynamics of globular protein folding, chaperonins motifs and domains, Protein folding diseases: amyloid diseases and prions.	7L
1.3	**Protein Engineering**: Adding disulphide bonds, changing asparagine to other amino acids, Reducing the number of free sulfhydryl residues, increasing enzymatic activity, Modifying metal cofactor requirement, Decreasing protease sensitivity, Modifying protein specificity, Increasing enzyme stability and specificity, altering multiple properties.	6L

2	**Module Title: Protein transport** **Learning Objectives:** 1. To familiarize the learner with signaling and sorting of proteins. **Learning Outcomes**: After the successful completion of the module, the learner will be able to: 1. Comprehend different protein transport pathways and their specific functions within the cell.	
2.1	**Protein transpor**t: extracellular protein secretion, drug export system	2L
2.2	**Protein folding:** Folding of periplasmic proteins, translocation of folded proteins	2L
2.3	**Protein Translocation:** Sec dependent protein Translocation: Sec system, Model for protein export.	2L
2.4	**Sec independent protein translocation:** Translocation of membrane bound proteins, *E. coli* SRP system and translocation of folded proteins: TAT system.	3L
2.5	**Extracellular protein secretion**: Type I pathway (hemolysin secretion by *E. coli*, type II, type III, type V, autotransporter (type IV), Chaperone usher pathway and protein transport across Gram positive bacteria (overview).	4L
2.6	**Folding of periplasmic proteins**: Importance of disulphide bonds in folding of periplasmic proteins. Role of thiol redox enzymes in catalyzing the formation of disulphide bonds in the periplasm.	2L

References:

1. Mathew, Van Holde and Ahern, Biochemistry 3rd edition. Pearson Education.
2. Zubay, G., Wm. C. 1998. Principles of Biochemistry. 4th edition. Brown Publishers.
3. Lehninger A.L. Cox and Nelson. 1994. Principles of Biochemistry. CBS publishers and distributors Pvt. Ltd.
4. Voet D. and Voet J.G.John Willey and Sons Inc. 1995. Biochemistry, 4th edition
5. Pugsley A, 1989. Protein Targeting, Academic press 1st edition.
6. Forster BM, Marquis H. Protein transport across the cell wall of monoderm Gram-positive bacteria. Mol Microbiol. 2012 May;84(3):405-13. doi: 10.1111/j.1365-2958.2012.08040.x.

M. Sc. (MICROBIOLOGY) SEMESTER I

Course – III Medical Microbiology and Immunology

COURSE CODE: 23PS1MBCC3MMI CREDITS:02

Course Learning Outcomes: After the successful completion of the Course, the learner will be able to:

1. Investigate various microbial infections.
2. Describe the fundamental mechanisms underlying disorders of the immune system.

MODULE	TITLE AND CONTENT	NO OF LECTURES
1	**Module Title: Microbial Infections** **Learning Objectives**: 1. To explore strategies for prevention and control of microbial infection. 2. To correlate disease symptoms with causative agents, isolate and identify pathogens. **Learning Outcomes**: After the successful completion of the module, the learner should be able to: 1. Evaluate the diagnostic methods to detect and identify microbial infections. 2. Develop critical thinking skills in the management of microbial infections.	
	Microbial Diseases Detailed study of following infections including Etiology, Transmission, Pathogenesis, Clinical Manifestations, Lab Diagnosis, Prophylaxis and Treatment.	
1.1	**Viral Diseases** Dengue, Hepatitis non-A, Chikungunya, Swine-flu	6L
1.2	**Bacterial Diseases** Listeriosis, VRE (Vancomycin Resistant enterococci) Leptospirosis, Campylobacter, MOTT (Mycobacteria other than TB), Legionellosis, Conditions caused by *Helicobacter pylori.*	5L
1.3	**Parasitic Disease** Amoebic dysentery (*Entamoeba histolytica*) Giardiasis (*Giardia lamblia)*	4L

2	**Module Title: Immune System and Health** **Learning Objectives**: 1. To elaborate on the concept of Immune tolerance and autoimmunity. 2. To analyze the effects of hyperactive immune response in transplant rejection. **Learning Outcomes**: After the successful completion of the module, the learner should be able to: 1. Explain the different types of Immune tolerance. 2. Evaluate the factors contributing to autoimmunity. 3. Describe the role of the immune system in transplantation.	
2.1	**Immune tolerance** Central Tolerance, Peripheral Tolerance, Tolerance Induction, T-cell Tolerance, B-cell Tolerance, Incomplete Tolerance, Duration of Tolerance	4L
2.2	**Autoimmunity** Interplaying Factors, Triggering Factors, Mechanisms of Damage, Organ Specific Autoimmune Diseases, Systemic Autoimmune Diseases, Animal Models for Autoimmune Diseases, Proposed Mechanisms for Induction of Autoimmunity, Treatment of Autoimmune Diseases	4L
2.3	**Transplantation & Transfusion Immunology** Antigens Involved in Graft Rejection, Allorecognition, Graft Rejection-Role of APC's & Effector Cells, Graft v/s Host Diseases, Immunosuppressive Therapies. Blood Transfusion: ABO & Rh Blood Groups, Potential Transfusion Hazards, Transfusion Alternatives.	6L
2.4	**Immune-exhaustion and immunosenescence-** Alzheimer's disease	1L

References:

1. Osborne, B. A., Kindt, T. J., Kuby, J., Goldsby, R. A. 2007. Kuby Immunology. United Kingdom: W. H. Freeman.
2. Sulabha Pathak and Urmi Palan, 2011. Immunology-Essential and Fundamental. 3rd edition-Capital publishing company.
3. Ananthanarayan & Paniker. 2009. Textbook of Microbiology, 8th edition, University press
4. Fahim Halim Khan, 2004. Elements of Immunology. India: Pearson India.

M. Sc. (MICROBIOLOGY) SEMESTER I

Course – IV Evolutionary Biology

COURSE CODE: 23PS1MBCC4EVB **CREDITS: 02**

Course Learning Outcomes: After the successful completion of the Course, the learner will be able to:

1. Discuss different theories of evolution.
2. Apply the various principles of population genetics.

MODULE	TITLE AND CONTENT	NO OF LECTURES
1	**Module Title: Theories of Evolution** **Learning Objectives:** 1. To discuss the principles, processes and patterns of evolution. **Learning Outcomes:** After the successful completion of the module, the learner will be able to: 1. Explain the role of variation in evolutionary processes. 2. Apply evolutionary principles to understand the emergence of new species and patterns of biodiversity.	
	History and development of evolutionary theories.	
1.1	**Natural Selection:** Charles Darwin and Alfred Wallace, Types and levels of natural selection, Co-evolution Natural evolution (Kimura theory) and Molecular clocks	3L
1.2	**Neo-Darwinism** and its importance in prokaryote evolution **Modern Synthesis**, Controversy (Selectionists Vs Neutralists)	4L
1.3	**Molecular Evolution**: Spontaneous mutation controversy, evolution of rates of mutation, phylogeny and molecular distances	4L
1.4	**Speciation**: Sexual and asexual organisms, origin and stability of diversity.	4L

2	**Module Title: Population Genetics & Experimental Evolution** **Learning Objectives:** 1. To elaborate concepts of population genetics. **Learning Outcomes**: After the successful completion of the module, the learner will be able to: 1. Appreciate the importance of population genetics in the fields of evolutionary biology. 2. Comprehend the concept of experimental evolution and its importance.	
2.1	**Biological species:** Concept, Mendelian population, models of population growth and variation.	3L
2.2	**Population Genetics**: Natural Selection, Mutations, Hardy Weinberg equilibrium, Genetic drift, Gene flow, non-random mating, Fitness landscape (Sewall wright – RA Fisher controversy).	7L
2.3	**Experimental evolution**: Long term evolution experiment – *E. coli* (Richard Lenski), Multicellularity experiments – Will Ratcliff, designing evolution experiments.	5L

References:

1. Scott Freeman, Jon C. Herron. 2007. Evolutionary analysis.
2. Daniel L. Hartl and Andrew G. Clark. 2006. Principles of Population Genetics. 4th Edition.
3. Charles Darwin. Origin of species
4. Ridley Mark (2004). Evolution. Blackwell Science Limited.

SEMESTER II - Practicals

Core Courses-I to IV
COURSE CODE: 23PS1MBCCP **CREDITS: 06**

Experiment Sr. no.	Title and Number of Credits	Number of hours total 180/ 4 courses Approx 45hr per course
	Course I	
1	Study of cell cytology using Phase contrast Microscopy- Demonstration	5
2	Study of Cell structure using Confocal Microscopy- Demonstration	5
3	Study of Cell structure using Fluorescence Microscopy- Demonstration	5
4	Study of Cell membrane integrity using uptake of neutral red	15
5	Estimation of NO (Nitric Oxide) produced by Macrophages	15
	Course II	
1	Titration curve of glycine	10
2	Estimation of amino acids by ninhydrin method	5
3	Estimation of protein by Bradford method.	5
4	To investigate the effect of temperature on protein denaturation (Demonstration)	10
5	Use of PDB/Pymol/ other databases to study protein structure	10
6	Preparation of liposomes (Demonstration)	5
	Course III	
1	Problem solving exercises in medical microbiology based on diseases caused by HIV, MOTT, Chikungunya, *Helicobacter*	2
2	Diagnosis for HIV a. CD4 lymphocyte count for AIDS b. ELISA for AIDS	5
3	Diagnosis for MOTT -Acid Fast staining method	5
4	Preparation of LJ medium.	5
5	Diagnosis of parasites - wet mount of stool sample	5
6	Detection of dengue by kit method.	5
7	MonoSpot Test for diagnosis of Chikungunya (Demonstration experiments.)	5

8	SRID	5
9	Coombs Test	5
10	Detection of Rheumatoid arthritis (Kit experiment)	3
	Course IV	
1	Problems on population genetics	15
2	Problems on constructing phylogenetic tree and molecular clock	15
3	Case studies on evolution	15

M. Sc. (MICROBIOLOGY) SEMESTER I

Course – DSE I Developmental Biology

COURSE CODE: 23PS1MBDS1DVB CREDITS: 02

Course Learning Outcomes: After the successful completion of the Course, the learner will be able to:

1. Explain the mechanisms of cell development and its significance
2. Analyze the genetics of embryonic development of model organisms.

MODULE	TITLE AND CONTENT	NO OF LECTURES
1	**Module Title: Basics of cell development** **Learning Objectives:** 1. To introduce fundamental concepts of embryonic development. **Learning Outcomes:** After the successful completion of the module, the learner will be able to: 1. Comprehend the different types of cell lineages and stem cells. 2. Illustrate the mechanisms of developmental pathways.	
1.1	**Terminology**: Cell potency, commitment, specification, induction, competence, determination and differentiation, Cell lineages, stem cells.	3L
1.2	**Mechanism of developmental commitment**: Autonomous, Conditional and Syncytial specification. Morphogen gradient and morphogenic field, Pattern formation and compartments.	4L
1.3	**Morphogenesis and cell adhesion**: Differential cell affinity, cadherins and catenin, sorting out of embryonic tissues and cell recognition	5L
1.4	**Aging**: Senescence, life span and causes of aging.	3L
2	**Module Title: Developmental genetics of model organisms** **Learning Objectives:** 1. To describe the genetic basis of embryonic development. **Learning Outcomes**: After the successful completion of the module, the learner will be able to: 1. Describe the processes involved in early embryonic development. 2. Analyze the differences in molecular mechanisms involved in sex determination of *D. melanogaster* and *C. elegans.* 3. Explain the different morphogenetic processes involved in the formation of	

	various organs and tissues.	
2.1	**Cloning Experiments**	1L
2.2	**Early embryonic development in Animals:** Oogenesis and fertilization, The Embryonic Cleavage Divisions and Blastula Formation, Gastrulation and Morphogenesis. Stem Cell Lineages.	3L
2.3	**The Genetics of Pattern Formation in *Drosophila*.** Body Segmentation, Homeobox Genes	3L
2.4	**Programmed Cell Death in Development**.	1L
2.5	**Characteristics of Model Organism** *Drosophila* and *Caenorhabditis*	1L
2.6	**Genetic Analysis of Developmental Pathways**. Sex Determination in *Drosophila* and *Caenorhabditis*	3L
2.7	**Molecular Analysis of Genes Involved in Development**. Specification of cell types Organ Formation (eye in *Drosophila*)	2L
2.8	**Genetics of whorl development in *Arabidopsis thaliana***	1L

References:

1. Michael J.F. Barresi, Scott F. Gilbert. Developmental Biology. 12th Edition.
2. D. Peter Snustad & Michael J. Simmons. Principles of Genetics. 3rd Edition.
3. Albert, Johnson, Lewis, Raff, Roberts & Walter. Molecular Biology of The Cell. 5th Edition.
4. Benjamin Pierce. Genetics: A Conceptual Approach. 3rd Edition

Practicals

Course-DSE I
COURSE CODE: 23PS1MBDSP1 CREDITS: 02

Experiment Sr. no.	Title and Number of Credits	Number of Hours Total 60
1	Observation of morphogenetic movements in chick embryo (Demonstration)	30
2	Cultivation of model organism: *Caenorhabditis elegans*	20
3	Cultivation of macrophage cell line and study of cell viability by trypan blue dye exclusion technique	10

M. Sc. (MICROBIOLOGY) SEMESTER I

Course – DSE II Nanobiotechnology

COURSE CODE: 23PS1MBDS2NAN **CREDITS: 02**

Course Learning Outcomes: After the successful completion of the Course, the learner will be able to:

1. Describe the different methods of synthesis of nanomaterials and their applications.
2. Explore different techniques for analysis of nanomaterials.

MODULE	TITLE AND CONTENT	NO OF LECTURES
1	**Module Title: Synthesis and applications of nanomaterials** **Learning Objectives:** 1. To describe various methods of synthesis of nanomaterials. 2. To explore the applications of nanomaterials in various fields. **Learning Outcomes:** After the successful completion of the module, the learner will be able to: 1. Synthesize nanomaterials physical, chemical and biological methods. 2. Apply nanomaterials for different applications.	
1.1	**Introduction to nanomaterials and their properties**: Nanoscale systems, nanomaterials, nanoparticles, quantum dots, nanowires, nanotubes, thin films and multilayers.	5 L
1.2	**Synthesis of nanomaterials** Physical method (Physical vapour deposition method), Chemical method (colloids as nanoparticles and their synthesis), Biological and microbiological methods.	5 L
1.3	**Applications**: Nanotechnology and Health: Biosensors, Drug and gene delivery systems, Nano-imaging, Cancer diagnosis and treatment. Nanotechnology and environment Nanotechnology and Agriculture	5 L

2	**Module Title: Analytical Techniques in Nanobiotechnology** **Learning Objectives:** 1. Explain the principle and working of instruments employed for characterizing nanoparticles. **Learning Outcomes**: After the successful completion of the module, the learner will be able to: 1. Employ microscopic, spectroscopic and diffraction techniques for the analysis of Nanoparticles	
	Principle and working of:	
2.1	**Scanning Probe Microscopes** Scanning tunneling microscope (STM), Atomic force microscope (AFM), Scanning near field microscope (SNOM), Magnetic force microscope (MFM).	5L
2.2	**Spectroscopy Techniques** Optical (Ultraviolet-Visible-Near Infrared), Absorption Spectrometer, UV-Vis-NIR Spectrometer, Infrared Spectrometers, Fourier Transform Infrared Spectrometer, Auger Electron Spectroscopy	6L
2.3	**Diffraction Techniques** X-Ray Diffraction (XRD) Atomic Scattering Factor Bragg's Law of Diffraction Diffraction from different types of samples Crystal Structure Factor Diffraction from nanoparticles X-ray Diffractometer Dynamic Light Scattering	4L

References:

1. Sharon, Madhuri and Maheshwar. 2012. Bio-Nanotechnology: concepts and applications. New Delhi, Ane books Pvt. Ltd.
2. Scott R. P.W. 2012, Principles and Practice of Chromatography. Chrom-Ed Book Series. Reese-Scott Partnership.
3. McNair H. M. and Miller J. M. 2009 Basic Gas Chromatography. Wiley International
4. Kulkarni Sulabha. 2011. Nantotechnology- Principles and Practices. 3rd edition. New Delhi Capital Publishing Company.
5. Chattopadhyay K.K. and Banerjee A.N. 2012. Introduction to Nanoscience and Nanotechnology. New Delhi PHI Learning Pvt. Ltd.

Practical

Course-DSE II

COURSE CODE: 23PS1MBDSP2 **CREDITS:02**

Experiment Sr. no.	Title and Number of Credits	Number of Hours Total 60
1	Preparation of Nanosilver by Wet reduction Method (Chemical), using Neem Extract (plants) & Bacteria (Microbiological)	15
2	Characterisation of Nanosilver by UV spectrometry and microscopic methods	10
3	Antimicrobial effect of Ionic silver and Nanosilver prepared by above methods	10
4	Study of Nanosilver coated Gauze/textiles for antimicrobial effect on different bacteria	15
5	Visit to Instrumentation laboratories	10

M. Sc. (MICROBIOLOGY) SEMESTER I

Course- DSE III Advanced techniques in Biology

COURSE CODE: 23PS1MBDS3ATB **CREDITS: 02**

Course Learning Outcomes: After the successful completion of the Course, the learner will be able to:

1. Explain different molecular biology methods for isolation, quantification and characterization of proteins and nucleic acids.
2. Comprehend chromatographic and spectrophotometric methods for characterization of proteins and nucleic acids

MODULE	TITLE AND CONTENT	NO OF LECTURES
1	**Module Title: Methods in Molecular Biology and Protein Characterization** **Learning Objectives:** 1. To discuss the principles and methods used for protein purification and analysis. **Learning Outcomes:** After the successful completion of the module, the learner will be able to: 1. Perform basic molecular biology techniques. 2. Apply various methods for protein purification.	
1.1	**Introduction:** Studies related to DNA, RNA and Protein Principles underlying isolation of biomacromolecules from biological samples.	3L
1.2	**Electrophoresis**: analysis of DNA, RNA and Protein	4L
1.3	**Molecular cloning** Isolation of DNA/RNA fragments Introduction to cloning and expression vectors Vector designing	5L
1.4	**Recombinant protein:** Expression and purification	3L
2	**Module Title: Advanced Instrumentation:** **Liquid Chromatography-Mass Spectrometry** **Learning Objectives:** 1. To explain principles and applications of LC-MS. **Learning Outcomes:** After the successful completion of the module, the learner	

	will be able to: 1. Develop the skills required to operate an LC-MS system. 2. Develop the ability to interpret the data of LC-MS. 3. Explore a wide range of application.	
2.1 2.2	**Principle and working:** Liquid Chromatography Mass Spectrometry **Applications** Analysis of Proteins Analysis of Peptides Analysis of Proteomes	6L 3L 3L 3L

References:

1. Wilfred M. A. Neissen. Liquid Chromatography- Mass Spectrometry. 3rd edition Taylor and Francis group (Chromatographic Science Series, Volume 97).
2. Marie-Isabel Aguilar. HPLC of Peptides and Proteins- Methods and Protocols. Humana Press (Methods in Molecular Biology, Volume 251).
3. Sandie Lindsay. High Performance Liquid Chromatography. 2nd Edition. Wiley India edition (Analytical Chemistry by Open Learning).
4. John R. Chapman. Mass Spectrometry of Proteins and Peptides. Humana Press (Methods in Molecular Biology, Volume 146).
5. Sambrook and Russell. Molecular cloning- A Laboratory manual. 3rd edition, Volume 1, CSHL Press.

Practical

Course-DSE III

COURSE CODE: 23PS1MBDSP3 **CREDITS:02**

Experiment Sr. no.	Title and Number of Credits	Number of Hours total 60
1	Agarose gel electrophoresis	15
2	Polyacrylamide gel electrophoresis	15
3	Vector Designing	15
4	Practice with proteomics data set	15

Evaluation Pattern: Theory

External Evaluation – Semester End Examination 30 M
Duration: 1 hours Paper Pattern

Question No	Module	Marks with Option	Marks without Option
1	I	20	15
2	II	20	15

Internal Evaluation - 20 M
Objective-MCQ, Short answer test, Assignments

Evaluation pattern: Practicals

Core courses
External evaluation: 75 Marks practical examination at the end of each semester
Internal evaluation: 75 Marks practical CIE

DSE courses
External evaluation: 25 Marks practical examination at the end of each semester
Internal evaluation: 25 Marks practical CIE

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Syllabus -M.Sc. Microbiology Semester II

Semester	Course Number	Course Title	Course code	Credits	Hours	Periods (1 hr)	Unit/ Module	Lectures per / module	Examination		
II									Internal Marks	External Marks	Total Marks
THEORY											
Core courses											
II	I	Virology	**23PS2MBCC1 VIR**	2	30	30	2	15	20	30	50
II	II	Environmental Microbiology	**23PS2MBCC2 EVM**	2	30	30	2	15	20	30	50
II	III	Enzymology and Stress Physiology	**23PS2MBCC3 ESP**	2	30	30	2	15	20	30	50
II	IV	Molecular Biology	**23PS2MBCC4 MBI**	2	30	30	2	15	20	30	50

Discipline Specific Electives (any one)											
II	I	Industrial Microbiology	**23PS2MBDS1 IMY**	2	30	30	2	15	20	30	50
II	II	Cancer Biology	**23PS2MBDS2 CAN**	2	30	30	2	15	20	30	50
II	III	Microbial Ecology	**23PS2MBDS3 ECO**	2	30	30	2	15	20	30	50
PRACTICALS											
Core courses											
II	I TO IV	Practicals	**23PS2MBCCP**	6	180	180	8	-	75	75	150
Discipline Specific Electives (any one)											
II	I/II/III	Practicals	**23PS2MBDSP1/ 23PS2MBDSP2/ 23PS2MBDSP3**	2	60	60	2	15	25	25	50

M. Sc. (MICROBIOLOGY) SEMESTER II

Course – I Virology

COURSE CODE: 23PS2MBCC1VIR CREDIT: 02

Course Learning Outcomes: After the successful completion of the Course, the learner will be able to:

1. Elaborate on the various aspects of phage genetics and virus-call interactions.
2. Discuss infections caused by significant plant and animal viruses.

MODULE	TITLE AND CONTENT	NO OF LECTURES
1	**Module Title: Bacteriophage genetics** **Learning Objectives:** 1. To introduce the concept of genetic mapping in viruses. 2. To describe the life cycle and genetic regulation mechanisms in bacteriophages. **Learning Outcomes:** After the successful completion of the module, the learner will be able to: 1. Infer results of mapping experiments to locate relative positions of genes. 2. Explain the life cycle of T7 phage.	
1.1	**Life cycle of phage T7 and Lambda** Virus-cell interaction, Cellular receptors and virus entry, Virus morphogenesis, mechanism of host cell damage, cellular gene expression. Phage T7: Organization of the T7 genes (overview), life cycle, Regulation of transcription. Developmental regulation of lambda.	5L
1.2	**Bacteriophage genome**: Phage phenotypes Genetic recombination in phages, Genetic fine structure mapping, Deletion mapping Genes within genes: Bacteriophage ΦX174 Constructing phage vectors- phage display vectors, suicide vectors, combining phage vectors and transposons	7L
1.3	**Gene Transfer in Bacteria** Drug resistance, transduction and Mapping.	3L

2	**Module Title - Plant and animal viruses** **Learning Objectives:** 1. Discuss the structure and life cycle of plant and animal viruses. 2. Describe the medical significance and control of plant and animal viruses. **Learning Outcomes**: After the successful completion of the module, the learner should be able to: 1. Analyze the various aspects of plant and animal viral infections. 2. Describe the various control measure for infections by plant and animal viruses.	
2.1	**Introduction**: Plant virus life cycles, Plant satellite viruses and satellite Nucleic acids, Viroids	2L
2.2	Structure, genome, Lifecycle, pathogenesis, transmission, symptoms and diagnosis of **Citrus Tristeza Virus (CTV)** . **Pox virus**: Vaccinia, orthopox virus, variola virus. **Herpes Virus**: varicella Zoster and simplex virus	6L
2.3	**Control of viruses and emerging viruses**: viral vaccine, antivirals, virus control, interferon, novel chemotherapeutics.	3L
2.4	**Viruses and Cancer**: retrovirus, DNA tumour virus, adenovirus, HCC.	4L

References

1. D. Peter Snustad & Michael J. Simmons, 2012. Principles of Genetics 6th edition.
2. Pierce, B.A.2012. Genetics- A Conceptual Approach. 4th Edition. W. H. Freeman.
3. Lewin, B. 2007. Genes-IX. Jones and Bartlett Publishers.
4. Luria. General Virology. 3rd edition.
5. BOS, I. Longman, Introduction to Plant Virology. London.
6. BOS, I. Longman. Animal Virology. Academic Press.
7. Knight C. Springer Verlag, Chemistry of Viruses.
8. Dulbecco and Giasberg, Virology. Harper and Ravi Publications.
9. Edward Birge. Bacterial and Bacteriophage Genetics
10. Teri Shors. 2009. Understanding Viruses. Jones and Bartlett publications.

M. Sc. (MICROBIOLOGY) SEMESTER II

Course – II Environmental Microbiology

COURSE CODE: 23PS2MBCC2EVM CREDITS:02

Course Learning Outcomes: After the successful completion of the Course, the learner will be able to:

1. Describe applications of microorganisms in bioremediation.
2. Summarize various approaches used in solid waste management

MODULE	TITLE AND CONTENT	NO OF LECTURES
1	**Module Title: Bioremediation and Biodegradation** **Learning Objectives:** 1. To describe the role of microorganisms in degradation of recalcitrant compounds, 2. To summarize the degradation pathways for aromatic compounds and polymers. **Learning Outcomes:** After the successful completion of the module, the learner will be able to: 1. Evaluate the roles of microorganisms in bioremediation. 2. Illustrate the degradation pathways of aromatic compounds.	
1.1	**Bioremediation**: Types, processes, importance and its limitations. Technique in Bioremediation.	2 L
1.2	**Recalcitrant compounds**: Petroleum contamination, Nitroaromatic compounds.	3 L
1.3	**Degradation of polymers**: cellulose, lignin and lignocelluloses and xenobiotics.	2 L
1.4	**Degradation of aromatic and alicyclic compounds** Important organisms, use of mixed cultures, common pathways of aromatic degradation (catechuate and protocatechuate), aerobic and anaerobic degradation of aromatic compounds.	3 L
1.5	**Biotransformation of polycyclic aromatic hydrocarbons (PAHs)**: Naphthalene, anthracene, hydrocarbons, halogenated aliphatics (pathways).	5 L

2	**Module Title: Environment Management and Safety Concerns** **Learning Objectives:** 1. To elaborate on various technological applications for food processing of waste and their disposals. 2. To classify various wastes based on source and type. 3. To comprehend biosafety guidelines. **Learning Outcomes:** After the successful completion of the module, the learner should be able to: 1. Discuss various waste management approaches from the perspective of sustainable development. 2. Perform risk assessment for biohazardous materials.	
2.1	**Solid waste management:** Biodegradable waste from kitchen, abattoirs and agricultural fields and their recycling by aerobic composting or biomethanation. Non-biodegradable waste like plastics, glass, metal scrap and Building materials Plastic recycling, metal recycling.	4L
2.2	**Hazardous waste management:** Hazardous waste from paint, pesticides and chemical industries and their composition, Probable means to reduce these wastes through Common Effluent Treatment Plants.	3L
2.3	**Electronic waste management**: Recovery of precious metals from electronic waste resources.	1L
2.4	**Biomedical waste management**	1L
2.5	**Biohazards**: Introduction, levels of biohazards, Risk assessment, proper cleaning procedures.	2L
2.6	**Biosafety**: Historical background and introduction, need of biosafety levels, biosafety guidelines for GMOs and LMOs. Role of Institutional biosafety committee. RCGM, GEAC, etc. for GMO applications in food and agriculture. Environmental release of GMOs. Overview of national regulations and relevant international agreements. Eco- labeling, ISO 22000, Generally Recognized as Safe (GRAS)	3L
2.7	Introduction to Biocatalysis	1L

References

1. Ronald L. Crawford and Don L Crawford. 2005. Principles and Applications by 6th ed.
2. B.D. Singh. 2010. Environmental Biotechnology. 4th ed. Kalyani publications
3. R.C. Dubey.2007. A textbook of Biotechnology. 5th ed. S. Chand & Company Pvt. Ltd.
4. Allan Scragg. 2008. Environmental Biotechnology. 2nd ed. Pearson education.
5. H. V. Jadhav. 2002. Environmental management. Vipul Prakashan.
6. R. S. Ambasht. 1998 Modern trends in ecology and environment. Backhuys Publishers.
7. M. H. Fulekar. 2013. Industrial hygiene and safety. I K International Publishing House Pvt. Ltd.

M. Sc. (MICROBIOLOGY) SEMESTER II

Course – III Enzymology and Stress Physiology

COURSE CODE: 23PS2MBCC3ESP **CREDITS:02**

Course Learning Outcomes: After the successful completion of the Course, the learner will be able to:

1. Analyze the kinetic parameters of enzyme catalysis and enzyme inhibitions.
2. Describe the molecular mechanisms of responses to different stress signals.

MODULE	TITLE AND CONTENT	NO OF LECTURES
1	**Module Title: Enzymology** **Learning Objectives:** 1. To analyze the kinetic parameters of enzyme catalysis. 2. To evaluate different types of enzyme inhibitions. **Learning Outcomes:** After the successful completion of the module, the learner should be able to: 1. Apply the principles of enzyme kinetics to understand the behavior of enzymes. 2. Evaluate different types of enzyme inhibitions.	
1.1	**Principles of enzymology:** Factors governing catalytic power and enzyme specificity, catalytic efficiency. Binding energy and weak interactions and solving of problems.	2L
1.2	**Mechanisms of enzyme catalysis:** General acid-base, Covalent and Metal Ion catalysis	1L
1.3	**Enzyme kinetics:** Michaelis-Menten, Lineweaver-Burk equation derivation, plots and solving of problems. Introduction to Adair equation	3L
1.4	**Kinetic parameters:** Comparison of enzyme activities and solving problems.	1L
1.5	**Multisubstrate enzymes:** Properties and reactions: Random, ordered and Ping-pong	2L
1.6	**Enzyme inhibition**: Reversible inhibition (Competitive inhibition, Uncompetitive inhibition, Mixed inhibition), equation derivation, solving of problems Irreversible inhibition and Suicide inactivators, HIV enzyme inhibitors Example of enzymatic reactions: Chymotrypsin and Lysozyme	4L

1.7	**Reversible covalent modification:** Concept and solving of problems.	1L
1.8	**Drug design and catalytic antibodies:** Basic concept and applications	1L
2	**Module Title: Signaling and Stress Physiology** **Learning Objectives:** 1. To evaluate the adaptations of microbes to various environmental stresses. 2. To comprehend the mechanisms involved in cell-to-cell communication and stress response. **Learning Outcomes**: After the successful completion of the module, the learner should be able to: 1. Describe the two-component signaling system. 2. Assess the impact of stress physiology on the behavior of cells.	
2.1	**Introduction to two-component signaling systems:** Response by facultative anaerobes to anaerobiosis, nitrate and nitrite, nitrogen supply.	3L
2.2	**Effect of oxygen and light**: Response to oxygen and light in purple photosynthetic bacteria, response to osmotic pressure and temperature, response to potassium ion and external osmolarity, response to carbon sources.	4L
2.3	**Synthesis of virulence factors:** response to temperature, pH, nutrient, osmolarity and quorum sensors, chemotaxis,	3L
2.4	**Bacterial response to environmental stress**- heat-shock response, oxidative stress.	2L
2.5	**Bacterial development and quorum sensing:** Myxobacteria, bioluminescence, systems similar to LuxR/LuxI in non-luminescent bacteria, biofilms.	2L
2.6	**VBNC**	1L

References:

1. White, David. 2000. The Physiology and Biochemistry of Prokaryotes. United Kingdom: Oxford University Press.
2. Nelson, D. L., Cox, M. M., Lehninger, A. L. 2000. Principles of Biochemistry. New York: Worth Publishers.
3. Doelle, H. W. 1975. Bacterial Metabolism. India: Academic Press.
4. Atlas, R. M., Bartha, R. 1993. Microbial ecology: fundamentals and applications. Austria: Benjamin/Cummings Publishing Company.

M. Sc. (MICROBIOLOGY) SEMESTER II

Course – IV Molecular Biology

COURSE CODE: 23PS2MBCC4MBI CREDITS:02

Course Learning Outcomes:

After the successful completion of the course, the learner will be able to:

1. Describe the mechanisms under gene expression and its regulation.
2. Explain the role of various proteins and enzymes involved in DNA repair.

Module	TITLE AND CONTENT	NO OF LECTURES
1	**Module Title: Gene expression** **Learning Objectives**: 1. To discuss the process of transcription and translation in eukaryotes. 2. To explain control of gene expression in prokaryotes and eukaryotes. **Learning Outcomes**: 1 Explain the control of gene expression at various levels. 2 Elaborate on the different factors in eukaryotic transcription 3 Describe the mechanisms of RNA modification.	
1.1	**Molecular mechanism of Transcription in eukaryotes:** RNA molecules and processing. Post transcriptional processing- structure of mRNA, pre –mRNA processing, addition of 5'cap, addition of Poly (A) tail, RNA splicing, RNA editing. Small RNA molecules: RNA interference, types, processing and function of sn, si and miRNAs. **Molecular mechanism of Translation in eukaryotes:** **Post translational modification of proteins**	7L
1.2	**Regulation of gene expression**; **Control of gene expression in prokaryotes**: Genes & regulatory elements, Levels of gene regulation. DNA binding proteins: Leucine zipper and zinc fingers, homeodomain, helix-turn-helix motif. Antisense RNA molecules, Riboswitches **Control of gene expression in eukaryotes**: Regulation through modification of gene structure- DNase I hypersensitivity, histone modifications, chromatin remodeling. DNA methylation.	8L

	Regulation through transcriptional activators, Co-activators, repressors, enhancers and insulators. Regulation through RNA processing & degradation Regulation through RNA interference.	
2	**Module Title: Gene recombination and repair** **Learning Objectives**: 1. To discuss the molecular mechanism of recombination. 2. To explain various repair mechanisms in prokaryotes and eukaryotes. 3. To describe the diseases caused due to defects in DNA repair mechanisms. **Learning Outcomes:** After the successful completion of the module, the learner should be able to 1. Summarize the process of homologous recombination. 2. Justify the role of DNA repair mechanisms. 3. Correlate the defects in DNA repair with inherited dis	
2.1	**Recombination** Homologous recombination in eukaryotes. Mating type switching. Genetic consequences of the mechanism of Homologous recombination.	7L
2.2	**DNA repair mechanisms**: Base-excision, Direct reversal, Nucleotide excision, Recombination repair, SOS repair, Translesion DNA synthesis	6L
2.3	**Inherited human diseases with defects in DNA repair**.	2L

References:

1. Benjamin Pierce. 2012. Genetics: A Conceptual Approach. 4th Edition
2. Russell, P.J. 2014. iGenetics- A Molecular Approach,3rd Edition.
3. Watson. 2004. Molecular biology of the gene 5th edition.
4. Lewin, B. 2007. Genes-IX, Jones and Bartlett Publishers.
5. D. Peter Snustad & Michael J. Simmons. 2012. Principles of Genetics, 6th edition.

SEMESTER II - Practical
Core Courses-I to IV
COURSE CODE: 23PS2MBCCP CREDITS: 06

xperiment Sr. no.	Title and Number of Credits	Number of hours total 180/ 4 courses Approx 45hr per course
	Course I	
1	Transduction	8
2	Isolation of host range mutants.	8
3	Problems on gene transfer mechanisms.	7
4	Problems on viral genetics.	7
5	Study of One Step Growth Curve of Lambda phage / T4Phage.	7
6	Assignment on plant and animal viruses.	3
7	Egg inoculation and cultivating animal virus in embryonated egg. Demonstration	5
	Course II	
1	Enrichment and isolation of cellulose from mangrove soil	5
2	Enrichment and isolation of lignin degraders from mangrove soil.	5
3	Enrichment and isolation of xylanase producers from mangrove soil.	5
4	Microbial degradation of polycyclic aromatic hydrocarbons (PAHs) enrichment, isolation and screening of bacteria.	10
5	PAH degradation studies.	5
6	Analysis of sludge: sewage and industrial for the following parameters: sludge volume index (SVI), Mixed liquor suspended solids (MLSS), Mixed liquor volatile suspended solids (MLVSS), F/M ratio.	5
7	Study tour/ academic visit to any large scale industry (environmental health and safety aspects) Food/ Pharma/chemical, environmental consultancy, research centres OR Study tour/ academic visit to Sewage treatment plant/ ETP of any industry /water purification unit/ Pollution Control Board Lab, CETP, landfill, etc.	10
	Course III	
1	Purification of an extracellular enzyme (ß- amylase) by salting	10

	out and dialysis.	
2	Enzyme kinetics-effect of enzyme concentration, substrate concentration, pH temperature and inhibitors on enzyme activity.	10
3	Demonstration of proteolytic activity.	5
4	Determination of glucose isomerase present intracellularly in *Bacillus* sp.	5
5	Chemotaxis of *Pseudomonas*.	5
6	Effect of temperature and water activity on swarming of *Proteus*	5
7	Different bacteriolytic response associated with addition of lysozyme and salt.	5
	Course IV	
1	Beta galactosidase assay	10
2	Problems on recombination	10
3	Effect of light and dark repair	10
4	Assignment on inherited genetic disorders	15

M. Sc. (MICROBIOLOGY) SEMESTER II

Course – DSE I Industrial Microbiology

COURSE CODE: 23PS2MBDS1IMY CREDITS: 02

Course Learning Outcomes: After the successful completion of the Course, the learner will be able to:

1. Explain the role of QC, QA as GMP parameters in Industrial productions.
2. Comprehend various methods for the isolation, detection and identification of microorganisms in foods.
3. To substantiate the importance of functional foods in human health.

MODULE	TITLE AND CONTENT	NO OF LECTURES
1	**Module Title: Good Manufacturing Practices** **Learning Objectives:** 1. To discuss the importance of GMP in the manufacturing and pharmaceutical industries. 2. To comprehend the concept of HACCP in the manufacturing industry. **Learning Outcomes:** After the successful completion of the module, the learner will be able to: 1. Describe the importance of QA and QC in GMP. 2. Explain the regulatory factors involved in the pharma industry. 3. To elaborate the principles of HACCP.	
	Good Manufacturing Practices:	
1.1	**Quality Control**: Definition, Principle and its application.	2L
1.2	**Quality Assurance:** Definition, Principle and its application, GMP, Quality assurance beyond GMP Inter-relationship between QA, QC & GMP	3L
1.3	**Concept of Quality and regulatory factors in Pharma**	1L
1.4	**QC using microbiological control:** Control at source, Codes of GMP	3L
1.5	**HACCP:** Principles and application	4L
1.6	**Laboratory accreditation:** NABL guidelines	2L

2	**Module Title: Advances in Food Microbiology** **Learning Objectives**: 1. To discuss the sampling processes for detection of microbes in food. 2. To distinguish between Functional food and supplements. 3. To elaborate on the characteristics and significance of food additives. **Learning Outcomes**: After the successful completion of the module, the learner should be able to: 1. Elaborate on spoilage causing microorganisms and food preservation methods. 2. Evaluate the food products as per BIS/ISO/APHA standards 3. Describe the functional foods and nutraceuticals.	
2.1	**Control and detection of Microorganisms:** Conventional methods of detection of Microbes Fiber optic and surface plasmon resonance biosensors Novel emerging techniques of food preservation Control by combination of methods (Hurdle concept)	4L
2.2	**Sample processing approaches for detection of:** Mycotoxic fungi, pathogenic bacteria (Enteropathogenic *E.coli*, *Vibrio*, Salmonellae) and Viruses (Hepatitis A, Norwalk) in meat/fish products as per BIS/ISO/APHA standards.	2L
2.3	**Food additives and ingredients**: Definitions, classification and functions of antioxidant, colors, emulsifiers, sequestrants, natural and microbial flavors	2L
2.4	**Applications of fibers** : Food sources, microbial Fructo-oligosaccharides.	1L
2.5	**Nutraceuticals and health foods**: Introduction to nutraceuticals - Definitions, basis of claims for a compound as a nutraceutical, regulatory issues for nutraceuticals.	2L
2.6	**Microbes and production of nutraceuticals:** Lycopene, isoflavonoids, prebiotics and probiotics,	3L
2.7	**Formulation of functional foods containing nutraceuticals** – stability and analytical issues, labelling issues.	1L

References

1. Pharmaceutical Microbiological Quality Assurance and Control: Practical Guide for Non-Sterile Manufacturing. 2020. United Kingdom: Wiley
2. Sao, R. B. 2016. Perfect: Quality Assurance and Quality Control. CreateSpace Independent Publishing Platform.
3. Bhunia, A., Ray, B. 2008. Fundamental food microbiology. United Kingdom: Taylor & Francis.
4. Srilakshmi, B. 2006. Nutrition Science. India: New Age International.
5. Jay, J. M. 2000. Modern food microbiology. Netherlands: Springer US.
6. James Jay, M Loessner and D Golden. 2005. Modern Food Microbiology. 7th Edition.
7. Adams, M. R., Moss, M. O. 1995. Food Microbiology. United Kingdom: Royal Society of Chemistry

Practical

Course-DSE I

COURSE CODE: 23PS2MBDSP1 **CREDITS: 02**

Experiment Sr. no.	Title and Number of Credits	Number of Hours Total 60
1	Microbiological study of fermented foods (Idli batter and sauerkraut)	10
2	Microbiological load in carrot and apple juice, salad, mayonnaise.	10
3	Quality Assessment and Analysis of food: i) Milk (Raw, Packed) ii) Ice- Cream iii)Yogurt	10
4	Report to be written in journal on Novel detection methods for food borne pathogens/toxins	10
5	Estimation of anti-oxidants and anti-nutritional factors (tannin/phytic acid) by spectrometric method.	10
6	Microbiological analysis of fish samples w.r.t sample processing for recovery and detection of Enteropathogenic *E.coli, Vibrio,* Salmonellae as per BIS/ISO/APHA standards and computation of measure of uncertainty	10

M. Sc. (MICROBIOLOGY) SEMESTER II

Course – DSE II CANCER BIOLOGY

COURSE CODE: 23PS2MBDS2CAN CREDITS: 02

Course Learning Outcomes: After the successful completion of the Course, the learner will be able to:

1. Describe the molecular mechanisms of cell division and fertilization.
2. Evaluate the genetic basis of cancer.

MODULE	TITLE AND CONTENT	NO OF LECTURES
1	**Module Title: Cell Cycle** **Learning Objectives:** 1. To analyze the molecular mechanism of cell division. 2. To describe the events involved in fertilization in mammals. 3. To assess the various checkpoints in the cell cycle control system **Learning Outcomes:** After the successful completion of the module, the learner will be able to: 1. Describe the significant events during cell division and fertilization. 2. Compare and Contrast between the intrinsic and extrinsic pathway of apoptosis.	
1.1	**Cell division**: Mitosis- M-phase, Cytokines Meiosis	5L
1.2	**Germ cells (egg and sperm), fertilization and Sex determination in mammals**	3L
1.3	**Cell cycle and Programmed cell death**: Control system, intracellular control of cell cycle events, Apoptosis (intrinsic and extrinsic), extracellular control of cell growth and apoptosis.	7L
2	**Module Title: Transposable gene elements and genetic basis of cancer** **Learning Objectives:** 1. To analyze the genetic and evolutionary significance of transposable elements. 2. To evaluate the role of oncogenes in cancer.	

	Learning Outcomes: After the successful completion of the module, the learner will be able to: 1. Evaluate the relationship between the cell cycle and cancer. 2. Analyze the role of different genes in cancer progression.	
2.1	**Transposable genetic elements** Elements in Maize, P Elements and Hybrid Dysgenesis in Drosophila, Mariner. Retrotransposons, Retrovirus like Elements. Genetic and Evolutionary Significance of Transposable Elements, Transposons, and Genome Organization, Transposons and Mutation, Rearrangement of Immunoglobulin Genes. Evolutionary Issues Concerning Transposable Elements	7L
2.2	**Genetic basis of cancer** **Introduction**: Development of cancer, Cancer: A Genetic Disease, Types of cancer **Oncogenes**: Oncogenes in Human Cancer (ras, c-myc and abl gene) Tumour-Inducing Retroviruses and Viral Oncogenes Cellular Homologs of Viral Oncogenes: The Proto-oncogenes Mutant Cellular Oncogenes and Cancer Chromosome Rearrangement. Tumor Suppressor Genes (Rb gene) and Cell cycle (p21 and p53) Inherited Cancers and Knudson's Two-Hit Hypothesis Cellular Roles of Tumor Suppressor Proteins **Genetic Pathways to Cancer**. Malignant Transformation, Oncogenes & Cancer.	8L

References:

1. Russell, P.J. 2016. *i*Genetics- A Molecular Approach. 3rd Edition. Pearson Education India
2. Snustad & Simmons, 2006. Principles of Genetics, 6th Edition, John Wiley & Sons Inc.
3. Albert, Johnson, Lewis, Raff, Roberts & Walter. 2008. Molecular Biology of The Cell. 5th Edition.
4. Lodish, Birk, and Zipursky. Freeman. Molecular Cell Biology 8th Edition.
5. Alberts, Bray, Hopkin, Johnson, Lewis, Walter. Essential Cell Biology 3rd Edition.
6. Geoffrey M. Cooper and Robert E. Hausman. The Cell: A Molecular Approach. 4th Edition.

Practical

Course-DSE II
COURSE CODE: 23PS2MBDSP2 **CREDIT: 02**

Experiment Sr. no.	Title and Number of Credits	Number of Hours Total 60
1	Study of Mitosis	10
2	Study of Meiosis	15
3	Visit to ACTREC	20
4	Case studies on inherited cancers	15

M. Sc. (MICROBIOLOGY) SEMESTER II

Course – DSE III Microbial Ecology

COURSE CODE: 23PS2MBDS3ECO **CREDITS: 02**

Course Learning Outcomes: After the successful completion of the Course, the learner will be able to:

1. Elaborate on the concept of ecosystem.
2. Discuss the different classes of extremophiles.

Module	TITLE AND CONTENT	NO OF LECTURES
1	**Module Title: Ecology** **Learning Objectives:** 1. To analyze the factors that influence the species interactions and succession. 2. To analyze the flow of energy and matter through the ecosystem. **Learning outcome:** After the successful completion of the module, the learner should be able to: 1. Examine the role of biodiversity in the ecosystem. 2. Define key concepts in population ecology. 3. Solve problems based on species solving skills in ecological research.	
1.1	Introduction and concept of ecology	1L
1.2	Ecosystem concept and function	1L
1.3	Energy flow /food chains, food web	2L
1.4	Concept of biomes	1L
1.5	Population ecology	2L
1.6	Species diversity	2L
1.7	Competition between different species	2L
1.8	Succession & its types	2L
1.9	Behavioral ecology.	2L

2	**Module Title: Extremophiles** **Learning Objectives:** 1. To summarize the development of exobiology. 2. To describe the adaptations of extremophiles. **Learning outcomes:** After the successful completion of the module, the learner should be able to: 1. Analyze the challenges and methods involved in studying extremophiles. 2. Apply laboratory techniques for characterization of extremophiles.	
2.1	**Exobiology**: Extra-terrestrial life detection studies. The Martian environment: Antarctica as a model of Mars.	7L
2.2	**Introduction and types of extremophiles**: Habitat, cellular organization, biodiversity, survival strategy limitations and culturing protocols: Thermophiles Psychrophiles Acidophiles Alkaliphiles Halophiles Barophiles Radiation resistant microorganisms.	8L

References

1. Odum, E. P., Barrett, G. W. 2005. Fundamentals of ecology. India: Thomson Brooks/Cole.
2. Stiling, P. 2011. Ecology: Global Insights and Investigations. United Kingdom: McGraw-Hill Education.
3. Narlikar, J. V. 2003. The Scientific Edge: The Indian Scientist from Vedic to Modern Times. India: Penguin Books Limited.
4. The New Science of Metagenomics: Revealing the Secrets of Our Microbial Planet. 2007. United States: National Academies Press.
5. Extremophiles: Sustainable Resources and Biotechnological Implications. 2012. Germany: Wiley.
6. Rainey, Aharon Oren. 2006. Methods in Microbiology Vol 35- Extremophiles Edited by Academic press.

Practical

Course-DSE III

COURSE CODE 23PS2MBDSP3 CREDITS: 02

Experiment Sr. no.	Title and Number of Credits	Number of Hours total 60
1	Review writing on exobiology.	10
2	Presentation on Prof. Jayant Narlikar's research.	5
4	Isolation of Psychrophiles from milk sample	15
5	Enrichment & isolation of thermophiles from hot springs/compost heaps/Milk	15
6	Isolation of halophiles from mangrove soil.	15

Evaluation Pattern: Theory

External Evaluation – Semester End Examination 30 M
Duration: 1 hours Paper Pattern

Question No	Module	Marks with Option	Marks without Option
1	I	20	15
2	II	20	15

Internal Evaluation - 20 M
Objective-MCQ, Short answer test, Assignments

Evaluation pattern: Practicals

Core courses
External evaluation: 75 Marks practical examination at the end of each semester
Internal evaluation: 75 Marks practical CIE

DSE courses
External evaluation: 25 Marks practical examination at the end of each semester
Internal evaluation: 25 Marks practical CIE

OPEN ELECTIVE (OE)-II

Course Title: Entrepreneurial Microbiology: Mushroom cultivation

Code: 23US1MBGE2MUC

Course Learning Outcomes: After the successful completion of the course, the learner will be able to:

1. Identify various types of Mushrooms
2. Distinguish between different types of Mushrooms
3. Cultivate Mushrooms under controlled conditions.
4. Initiate a small-scale industry of Mushroom cultivation.

Module I	**Title and Content- Mushroom Classification**	**No. of Lectures 15 L**
Learning Objectives: The module is intended to: 1. Describe the different types of Mushrooms. 2. Differentiate between edible and poisonous Mushrooms. 3. Summarize the nutritional aspects of Mushrooms.		
Learning Outcomes: The learner will be able to 1. Identify different types of mushrooms. 2. Evaluate the nutritional significance of mushrooms.		
1.1	**Introduction to Mushroom:** Introduction, general history, different parts of a typical mushroom & variations in mushroom morphology. Key to differentiate edible from poisonous mushrooms. Systematic position, morphology, distribution, structure and life-cycle of *Agaricus* and *Pleurotus*.	4 L
1.2	**Edible Mushroom:** Button Mushroom (*Agaricus bisporus*), Milky Mushroom (*Calocybe indica*), Oyster Mushroom (*Pleurotus sajorcaju*) and Paddy Straw Mushroom (*Volvariella volvcea*).	4 L
1.3	**Biology of Mushrooms:** Button, Straw & Oyster- General morphology, distinguishing characteristics, spore germination and life cycle.	3 L
1.4	**Nutrient Profile of Mushroom:** Protein, amino acids, calorific values, carbohydrates, fats, vitamins & minerals	4 L

Module II	Title and Content- Cultivation Techniques and Post-Harvest Technology	No. of Lectures 15 L
Learning Objectives: The module is intended to: 1. Impart knowledge about the cultivation unit of Mushroom technology 2. Describe post-harvest technology of Mushroom cultivation		
Learning Outcomes: The learner will be able to 1. Cultivate Mushroom using different techniques. 2. Assess Health benefits of mushrooms.		
2.1	**Principles of mushroom cultivation:** - Structure and construction of mushroom house. - Spawn production -culture media preparation- production of pure culture, mother spawn, and multiplication of spawn. - Composting technology, mushroom bed preparation. Spawning, spawn running, harvesting. - Cultivation of oyster and paddy straw mushroom. - Problems in cultivation - diseases, pests and nematodes, weed moulds and their management strategies.	8 L
2.2	**Post-Harvest Technology:** - Preservation of mushrooms - freezing, dry-freezing, drying, canning, quality assurance and entrepreneurship. - Value added products of mushrooms.	5 L
2.3	**Health benefits of mushrooms:** - Nutritional and medicinal values of mushrooms. - Therapeutic aspects- antitumor effect, antiviral value, antibacterial effect, antifungal effect, haematological value, cardiovascular & renal effect, in therapeutic diets, adolescence, for aged persons & diabetes mellitus.	2 L

Practical	Title and Content Supply chain management and Field visit	No. of practicals hours
Learning Objectives: The module is intended to: 1. Expose the learners to the aspects of Mushroom cultivation set up. 2. Explain the supply chain management of Mushroom cultivation.		
Learning Outcomes: The learner will be able to 1. Initiate a Mushroom cultivation business. 2. Evaluate the aspects of supply chain management.		
3.1	- Supply chain Management for Mushroom	15 h

	- Visit to Mushroom cultivation set up	
3.2	Practicals: • Sterilization and sanitation of mushroom house, instruments and substrates • Preparation of mother culture, media preparation, inoculation, incubation and spawn production • Cultivation of oyster mushroom using paddy straw/agricultural wastes	15 h

References:

1. Pathak Yadav Gour. 2010. Mushroom Production and Processing Technology, published by Agrobios (India).

2. S. Kannaiyan & K. Ramasamy. 1980. A handbook of edible mushroom, Today & Tomorrows printers & publishers, New Delhi

3. Nita Bahl. Handbook on Mushrooms. Oxford & IBH Publishing Co.

4. Tripathi, D.P. 2005. Mushroom Cultivation, Oxford & IBH Publishing Co. Pvt. Ltd,

New Delhi.

OPEN ELECTIVE (OE-II)

Course Title: Understanding your Health Profile

Code: 23US2MBGE2UHP

Course Learning Outcomes: After the successful completion of the course, the learner will be able to:

1. Summarize blood components, their functions and significance in health and disease.
2. Describe the techniques and applications of blood profiling.
3. Evaluate the economic aspects of healthcare.

Module I	**Introduction to Basic Haematology**	**No. of Lectures: 15**
Learning Objectives: The module is intended to: 1. List the various blood components. 2. Describe the structure and function of types of blood cells.		
Learning Outcomes: After the successful completion of the course, the learner will be able to: 1. Identify different components of blood. 2. Describe the importance of blood profiling in healthcare.		
1.1	Introduction to Blood Profiling a. Overview of blood components and their functions. b. Importance of blood profiling in healthcare.	6 L
1.2	Haematological Parameters a. Red blood cells (RBCs): Structure, function, and disorders. b. White blood cells (WBCs): Structure, types, functions, and disorders. c. Platelets: Role in clotting and related disorders.	9 L
Module II	**Blood profiling and its applications**	**No. of Lectures: 15**
Learning Objectives: The module is intended to: 1. Describe techniques in blood profiling. 2. Explain the clinical applications of Blood Profiling.		
Learning Outcomes: After the successful completion of the course, the learner will be able to: 1. Interpret the blood test reports generated. 2. Give an account of the clinical applications of Blood Profiling.		

2.1	Laboratory Techniques and interpretation in Blood Profiling a. Blood collection and handling procedures b. Haematological and biochemical analysis methods c. Quality control and assurance in blood profiling d. Normal reference ranges for haematological and biochemical parameters e. Common abnormalities and their clinical significance f. Correlation between blood profiling results and disease conditions	9 L
2.2	Clinical Applications of Blood Profiling a. Use of blood profiling in disease diagnosis, monitoring, and treatment b. Role of blood profiling in preventive healthcare c. Emerging trends and technologies in blood profiling.	6 L
Module III	**Economic Aspects of Healthcare**	**No. of Lectures: 15**
Learning Objectives: The module is intended to 1. Impart knowledge about the economic aspects of healthcare 2. Explore different business opportunities.		
Learning Outcomes: After the successful completion of the course, the learner will be able to: 1. Elaborate on economical, ethical and legal considerations in blood profiling. 2. Describe marketing and business opportunities in blood profiling		
3.1	Economic Aspects of Healthcare a. Economic impact of the healthcare industry. b. Healthcare expenditure and its implications for the economy. c. Role of diagnostics and blood profiling in healthcare cost management.	3 L
3.2	Ethical and Legal Considerations a. Ethical considerations in blood profiling, including patient privacy and data protection. b. Overview of relevant laws and regulations in blood profiling. c. Impact of ethical and legal aspects on commercial applications.	4 L
3.3	a. Marketing and Branding in Blood Profiling Services b. Marketing strategies for blood profiling services.	3 L

	c. Branding considerations and value proposition in the diagnostics sector. d. Target audience identification and effective communication strategies.	
3.4	Business opportunities and financial management in Blood Profiling: a. Identification of potential business opportunities related to blood profiling. b. Market analysis, demand assessment, and competition evaluation. c. Feasibility assessment of blood profiling ventures. d. Financial planning and budgeting in blood profiling businesses. e. Funding options, investment considerations, and financial analysis. f. Performance evaluation and key financial metrics in the blood profiling industry.	5 L

References:

1. S. Chand. 2017 .Lab Manual on blood analysis and medical Diagnosis.

2. Clinical Pathology, Haematology and blood banking 6th edition, 2018.

Course – OE-I

COURSE TITLE: Microbial diversity

COURSE CODE: 23US1MBGE1MDG

[CREDITS - 02]

Course Learning Outcomes: After the successful completion of the Course, the learner will be able to:

1. Describe characteristics of various prokaryotes.
2. Describe characteristics of various eukaryotes.
3. Explore the applications of microorganisms in different fields.

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Module	Title and Content	No of Lectures 15 L
1	**Prokaryotic cell structure** **Learning Objectives:** 1. To familiarize the learner with characteristics of prokaryotic organisms **Learning Outcomes**: After successful completion of the module, the learner will be able to: 1. Describe parts of a typical prokaryotic cell. 2. Enlist the characteristics and significance of archaebacteria. 3. Explain the characteristics and significance of actinomycetes.	
	Prokaryotic cell structure	
1.1	**Members of the microbial world**	2L
1.2	**Difference between Prokaryotes and Eukaryotes**	1L
1.3	**History of Microbiology**	3L
1.4	**Bacteria** Morphology of Prokaryotic cells: cell membrane, cell wall, cytoplasm, nucleoid, capsules, endospores, flagella. Size, Shape and Arrangement with examples	5 L
1.5	**Actinomycetes** General Characteristics and Significance	2 L

1.6	**Archaebacteria** General Characteristics, examples	2 L
2	**Eukaryotic life forms** **Learning Objectives:** 1. To familiarize the learner with characteristics of various groups of eukaryotic organisms. **Learning Outcomes:** After the successful completion of the module, the learner will be able to: 1. Describe characteristics and significance of fungi. 2. Describe characteristics and significance of algae 3. Describe characteristics and significance of protozoa.	
2.1 2.2 2.3	**Eukaryotic life forms** **Fungi** Significance, characteristics,morphology, sexual and asexual reproduction and cultivation **Algae** Significance Occurrence, characteristics, morphology, reproduction, Lichen **Protozoa** Significance, occurrence, morphology, reproduction	5 L 5 L 5 L
3	**Role of microbes in human health** **Learning Objectives:** 1. To familiarize the learner with the role of microbes in air, soil water and food. **Learning Outcomes:** After the successful completion of the module, the learner will be a 1. Summarize various air-borne, water-borne and food-borne infectionscaused by microbes. 2. Explain the role of microbes in food fermentations. 3. Describe the diversity of microbes in soil.	

	Role of microbes in human health	
3.1	**Air microbiology** Number and kinds of organisms in air Common Airborne infections and their prevention Introduction to viral infections	3 L
3.2	**Antibiotic producing organisms from Soil** Fungi and Actinomycetes	3 L
3.3	**Microbiology of Potable Water** Waterborne infections and their preventions	4 L
3.4	**Microbiology of Food** Food fermentations -fermented food products, Probiotics Food borne infections and prevention	5 L

References:

1) Lansing M. Prescott, Harley and Klein. 2001. Microbiology. 5th Edition. McGraw Hill Higher Education, New York.
2) R. Y. Stainier, J. Ingraham, M. Wheelis and P.R. Painter. 2007. General Microbiology. 5th Edition. Prentice Hall. New Jersey.
3) Michael Pelczar. Microbiology. 2001. 5th Edition, Tata Mc Graw hill Education.

Course – OE-II

COURSE TITLE: HUMAN GENETICS

COURSE CODE: 23US2MBGE1HGE

[CREDITS - 02]

Course learning outcomes

After the successful completion of the Course, the learner should be able to:

1. Explain how genetic information is organized and transmitted within cells.
2. Critique the different methods to determine the mode of inheritance of genetic traits.
3. Describe the role of mutation in human genetic disorder.

Module I	**Title: DNA and Chromosome Structure**	**15 L**
Learning Objectives: 1. To recall and define the terms genes, chromosome, DNA. 2. To explain the significance and outcomes of the various experiments in the field of genetics.		
Learning Outcomes - After the successful completion of the module, the learner should be able to: 1. Apply the knowledge of the fundamental concepts and explain how genetic information is transmitted. 2. Analyze the results and significance of key experiments in the field of genetics.		
1.1	Introduction to terms like genes, chromosomes (X and Y chromosome).	2 L
1.2	DNA as the genetic material.	1 L
1.3	Griffith's experiment: Experiment to establish Transformation Principle. Avery, McCarty and MacLeod: Experiment to establish DNA as the "transforming principle". Hershey Chase Experiment: Experiment to establish DNA as a genetic material.	4 L
1.4	Double helical structure of DNA.	4 L
1.5	DNA packaging in prokaryotes and eukaryotes.	4 L
Module II	**Title: Inheritance and Variation.**	**15 L**
Learning Objectives: 1. To introduce the learner to the basic principles of inheritance and variation. 2. To evaluate basic genetic concepts of blood grouping.		

Learning Outcomes - After the successful completion of the module, the learner should be able to: 1. Describe the concepts of genetics. **2.** Analyze genetics of blood grouping.		
2.1	Introduction to terms like character, trait, factor, genes, allele, dominant and recessive.	2 L
2.2	Gregor Mendel and his experiments on pea plants. *(7 pairs of contrasting characters studies by Mendel)*	3 L
2.3	Laws of inheritance (*definition*)	2 L
2.4	Monohybrid cross (Punnett square method).	3 L
2.5	Mendelian genetics of blood grouping	5 L
Module III	**Title: Mutation and Human Genetic Disorder.**	**15 L**
Learning Objectives: 1. To recall the key concepts and theories related to Darwinism. 2. To identify different types of mutagens and their role in causing cancer. 3. To study the different types of genetic disorders.		
Learning Outcomes - After the successful completion of the module, the learner should be able to: 1. Comprehend the relation between mutation and development of new species. 2. Distinguish between different types of mutagens. 3. Interpret the causes and characteristics of genetic disorders.		
3.1	Darwinism and mutation theory.	2 L
3.2	Introduction to terms like mutation, mutagens etc.	2 L
3.3	Types of mutagens: Physical (X-ray, UV ray, radon etc), chemical and environmental mutagens (UV, Food colors and additives, pesticides, tobacco products, mutagens in cosmetics - kathon etc ***(****Mechanism not involved)*	5 L
3.4	Mutation and Cancer	1 L
3.5	Genetic disorders: Down's syndrome, Thalassemia, Turner's Syndrome and Klinefelter's syndrome.	5 L

References:

1. Peter J. Russell. iGenetics Molecular: A Molecular Approach. 3rd Edition
2. Benjamin A. Pierce. Genetics: A Conceptual Approach.

SOMAIYA VIDYAVIHAR
K J Somaiya College of Science & Commerce
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Somaiya TRUST

K. J. SOMAIYA COLLEGE OF SCIENCE AND COMMERCE,

VIDYAVIHAR, MUMBAI 400 077

AUTONOMOUS- AFFILIATED TO UNIVERSITY OF MUMBAI

Department of Microbiology

offers a

Certificate Course on

Introduction to Research and Biostatistics

for T.Y.B.Sc. students of Biological Science

from

Academic year 2023–2024

SOMAIYA VIDYAVIHAR
K J Somaiya College of Science & Commerce
Autonomous (Affiliated to University of Mumbai)

Somaiya TRUST

Course Title: Introduction to Research and Biostatistics

Number of credits: 02

Intake capacity: 30

Duration: Two months

Course Highlight: The Certificate course on "Introduction to Research and Biostatistics" has been designed with an intention to introduce the basic concepts of Research and Biostatistics" to a student from Biological sciences at an undergraduate level. The purpose is to inculcate scientific temperament and enhance critical thinking skills in the learners. Research is indispensable for the development of the entire human race and for the sustenance of life on the planet Earth. Biostatistics is required for the data analysis and validation.

Link for registration: https://forms.gle/KsY2DhxrERo6wHKB8

Pre-requisites: Learner should have:

1. An elementary knowledge of basic concepts of Biology.
2. A basic understanding of MS-Excel

Process of the Certificate course:

Register using Google Form → **Lectures and practicals will be conducted in a hybrid mode** → **Course evaluation would be of formative type during the course, in the form of Assignments, problems.**

Course Learning Outcomes: After the successful completion of the course, the learner will be able to:

1. Initiate the process of Research.
2. Design the methodology of the research.
3. Obtain data using an appropriate method.
4. Organize the data in a structed manner.
5. Apply the principles of Statistics to validate the data.

Course Coordinator: Mr. Shabib Khan
Assistant Professor in Microbiology
shabib@somaiya.edu

Dr. Lolly Jain
Head- Department of Microbiology

Course syllabus

Module I **15 Lectures**	**Basic concepts of Research**	
1	**Learning objectives:** 1. To introduce the basic concepts of Research. 2. To describe the sampling and research design. 3. To explain the methods of data collection. 4. To present data in an organized structure. **Learning outcomes:** After the successful completion of the module, the learner will be able to: 1. Initiate the process of Research. 2. Formulate a design for Research. 3.Obtain an unbiased sample from a population.	
1.1 1.2	**Basic concepts of Research** Meaning, objectives and significance of Research **Types of research** Descriptive vs Analytical Quantitative vs. Qualitative Conceptual vs. Empirical	1 L 2 L
1.3	**Research process in flowchart** Introduction to a research problem (selecting and defining a problem) and research design **Sampling:** Simple random, systematic and stratified random sampling	3 L

1.4	**Data collection and presentation** **Data Collection** Introduction: Sources of data Experiments and Surveys **Collection of primary data** Observation, interview, Questionnaire and schedules **Collection of secondary data** Internal and external sources Case-study	4 L
1.5	**Data presentation** Classification Ordered array and Tabulation Grouped data-Frequency distribution Cumulative frequency distribution Use of MS-Excel for data presentation and analysis Graphical representation: Histogram, Bar chart, Piechart	5 L

Module II 15 Lectures	Basic concepts in Biostatistics	
	Learning objectives: 1. To describe different scales used in data analysis. 2. To explain the parameters considered under descriptive statistics. **Learning outcomes:** After the successful completion of the module the learners will be able to: 1. Differentiate between types of data. 2 . Apply the principles of Statistics to validate the data.	
2.1 2.2	**Basic concepts in Biostatistics** **Terminology:** Data, Statistics, Biostatistics **Variable:** Qualitative, quantitative, random, discrete random, continuous random Population and sample **Measurement and scales** Types of Scales**:** Nominal, ordinal, interval and ratio **Descriptive Statistics** **(Theory lectures and practical using MS-Excel)** Measures of central tendency: Mean, Median Mode, Geometric and Harmonic mean Measures of dispersion: Range, Quartile, degrees of freedom, standard deviation and variance Introduction to Skewness, Kurtosis and the concept of standard error Introduction to Hypothesis and its types	3L 12 L

References:

1. C.R. Kothari (2019), Research Methodology, 4th edition New Age International publisher.
2. Fundamentals of Biostatistics- Bernard Rosner, 8th edition, Cengage Learning.
3. Wayne Daniel (2013), Biostatistics- 10th edition, John Wiley and Sons.