Department of Microbiology
Master of Science in Microbiology (Semester wise structure 2019-2021)

Semester-I (Total credits - 24)

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

Semester-II (Total credits - 30)

Course code	Course title	L	T	P	Type of course	Credit
SIAL BC 1 2 02 C 4004	Immunology	4	0	0	Core	4
SIAL MB 1 2 02 C 3003	Biosafety, Bioethics and IPR	3	0	0	Core	3
SIAL MB 1 2 03 C 4004	Microbial Diversity	4	0	0	Core	4
SIAL MB 1 2 04 C 4004	Microbial Physiology and Metabolism	4	0	0	Core	4
SIAL MB 1 2 05 C 4004	Soil and Agriculture Microbiology	4	0	0	Core	4
SIAL MB 1 2 06 C 00105	Practical-II	0	0	10	Core	5
SIAL SC 1 2 03 DCEC 2002	**Research Methodology and Scientific Communication Skills***	2	0	0	DCEC	2
SIAL SC 1 2 04 DCEC 2002	**Bio-entrepreneurship***	2	0	0	DCEC	2
SIAL MB 1 2 01 DCEC 4004	Food and Dairy Microbiology#	4	0	0	DCEC	4
SIAL MB 1 2 02 DCEC 4004	Environmental Microbiology#	4	0	0	DCEC	4

*One of the courses will be opted by the student.
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Semester-III (Total credits - 30)

Course Code	Course Title	L	T	P	Type of Course	Credit
SIAL SC 1 3 05 C 4004	**Biostatistics and Bioinformatics**	**4**	**0**	**0**	**Core**	**4**
SIAL MB 1 3 07 C 4004	Microbial Genetics and Genomics	4	0	0	Core	4
SIAL MB 1 3 08 C 4004	Industrial Microbiology	4	0	0	Core	4
SIAL MB 1 3 09 C 4004	Medical Microbiology and Virology	4	0	0	Core	4
SIAL MB 1 3 10 C 0084	Practical-III	0	0	8	Core	4
SIAL MB 1 3 11 C 0202	Seminar	0	2	0	Core	2
SIAL MB 1 3 03 DCEC 4004	Microbial Ecology#	4	0	0	DCEC	4
SIAL MB 1 3 04 DCEC 4004	Plant Pathology#	4	0	0	DCEC	4
	Generic Elective Course (to be opted from other Department)	4	0	0	GEC	4

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

Semester-IV (Total credits - 20)

Skill Enhancement Course

Course Code	Course Title	Type of Course	Credit
SIAL MB 1 4 01 SEEC 0020	Dissertation	Core	20
	Total credits of the Program		**104**

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

Credit Summary of Courses Offered by Department of Microbiology

(Academic Session 2019-21)

Total Credits: 104

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

Generic Elective Course (GEC): Offered by Department of Microbiology to students from other Departments of University.

Semester	Core/ Elective	Paper Code	Title of the Paper	Credit
I	GEC	SIAL MB 1 1 01 GEC 4004	Biofertilizer and Compost Technology	4
	GEC	SIAL MB 1 1 02 GEC 4004	Techniques in Microbiology	
III	GEC	SIAL MB 1 3 03 GEC 4004	Applied Microbiology	4
	GEC	SIAL MB 1 3 04 GEC 4004	Microbes and Diseases	

SEMESTER-I

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

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

Learning Outcomes:

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

Unit-I

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

Unit-II

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

Unit-III

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

Unit-IV

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

Suggested readings:

1. The Cell: A Molecular Approach (2018) 8th ed., Cooper, GM, Sinauer Associates is an imprint of Oxford University Press, ISBN: 1605357073.

2. Molecular Cell Biology (2016) 8th ed., Lodish H, Berk A, Zipursky SL, Matsudaira P, Baltimore D and Darnell J, W.H. Freeman &Company (New York), ISBN: 978-1-4641-0981-2 / ISBN:10: 1464183392.
3. Molecular Biology of the Cell (2008) 6th ed., Alberts B, Johnson A. Lewis J and Enlarge M, Garland Science (Princeton), ISBN: 0-8153-1619-4 / ISBN:0-8153-1620-8.
4. Lehninger Principles of Biochemistry (2017) 7th ed., Nelson DL, Cox MM, W.H. Freeman and Company, New York, USA. ISBN-10: 1-4641-2611-9.
5. Biochemistry (2019) 9th ed., Stryer L, Berg JM, Tymoczko JL, Gatto, Jr. GJ, W.H. Freeman and Company, New York, USA. ISBN-10: 1-319-11467-9
6. Genes XII, (2017) 12th Revised edition ed., Lewin B, Krebs J, Kilpatrick ST, Goldstein ES, Jones and Bartlett Publishers, Inc. Sudbury, Massachusetts, USA. ISBN No. 9781284104493.
7. Molecular Biology of the Gene (2013) 7th ed., Watson JD, Baker TA, Bell SP, Gann A, M, Levin RL and Cumming B, San Francisco, ISBN: 0321905377.

SEMESTER-I

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

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

Learning outcomes:

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

Unit-I

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

Unit-II

Building blocks of lipids - fatty acids, glycerol, ceramide. Storage lipids - triacyl glycerol and waxes. Structural lipids in membranes-phospholipids, glycerophospholipids, galactolipids, sulpholipids, sphingolipids and sterols. β-oxidation of fatty acids. Fatty acid synthase complex. Synthesis of fatty acids.

Unit-III

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

Unit-IV

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

Suggested readings:

1. Lehninger: Principles of Biochemistry (2017) 7th ed., Nelson, DL and Cox, MM, WH Freeman and Company (New York), ISBN: 978-1319108243.
2. Biochemistry (2017) 6th ed., Garrett RH and Grisham CM, Brooks/Cole, ISBN: 9781305577206.
3. Harper's Illustrated Biochemistry (2018) 7th ed., Rodwell VW, Bender DA, Botham KM, Kennelly, PJ and Weil PA, McGraw-Hill, ISBN: 9781259837937.

4. Lippincott's Illustrated Reviews Biochemistry (2017) 7th ed., Ferrier, Wolters Kluwer India Pvt. Ltd., ISBN: 978-9351297949.
5. Biochemistry (2019) 9th ed., Stryer L, Berg JM, Tymoczko JL, Gatto Jr. GJ, W.H. Freeman and Company, New York, USA. ISBN-10: 1-319-11467-9.

SEMESTER-I

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

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

Learning outcomes:

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

Unit-I

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

Unit-II

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

Unit-III

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

Unit-IV

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

Suggested readings:

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

SEMESTER-I

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

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

Learning outcomes:

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

Unit-I

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

Unit-II

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

Unit-III

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

Unit-IV

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

Suggested readings:

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

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

SEMESTER-I

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

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

Learning outcomes:

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

Unit-I

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

Unit-II

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

Unit-III

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

Unit-IV

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

Suggested readings:

1. Principles and Techniques of Biochemistry and Molecular Biology (2018) 8th ed. Wilson K and Walker J, Cambridge University Press, ISBN No. 131661476X.
2. Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D., Wiley Blackwell (West Sussex), ISBN: 978-0-470-85602-4 / ISBN: 978-0-470-85603-1.
3. Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982) 2nd ed., Freifelder D, W.H. Freeman and Company (New York), ISBN:0-7167-1315-2 / ISBN:0-7167-1444-2.

SEMESTER – I

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

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

Suggested readings:

1. Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D, Wiley Blackwell (West Sussex), ISBN: 978-0-470-85602-4 / ISBN: 978-0-470-85603-1.
2. An Introduction to Practical Biochemistry (2017) 3rd ed., Plummer, D.T., McGraw Hill Education, ISBN: 978-0070994874.
3. Principles and Techniques of Biochemistry and Molecular Biology (2018) 8th ed. Wilson K, and Walker J, Cambridge University Press. ISBN: 131661476X.
4. Microbes in Action: A Laboratory Manual of Microbiology (1990) 4th Addition, Harry W, Seeley, Paul JV, John J, W. H. Freeman ISBN: 978-0716721000.

5. Genetics: A Laboratory Manual, (2009) 2nd ed., American Society of Agronomy; Lab Manual edition, ISBN: 978-0891185611.
6. Infant, Child and Adolescent Nutrition: A Practical Handbook (2013) 1st ed., More J, CRC Press, ISBN: 9781444111859.
7. Laboratory Manual of Microbiology and Biotechnology (2014) 1sted.Aneja KR, Scientific International Pvt., Ltd. ISBN: 9789381714553.
8. Microbiology: A Laboratory Manual (2017), 11th ed., Cappuccino, JH, Sherman, N., Pearson Education Inc, ISBN: 9780134298597.
9. An introduction to Practical Biochemistry (2017) 3rd ed., Plummer, DT, McGraw Hill Education, ISBN: 978-0070994874.

SEMESTER – I

Course title: Biofertilizer and Compost Technology **Credit: 4**
Course code: SIAL MB 1 1 01 GEC 4004 **Lectures: 60**

Course objective: To familiarize the students with the basic concepts regarding the use of microorganisms as biofertilizers and compost inoculants, their mass production and quality assurance.

Learning outcomes:

- Understanding the use of microorganisms as biofertilizer and compost inoculant
- Understanding various applications of microbial inoculants in agriculture and solid waste management

Unit-I

Principles of crop inoculation with microbial agents, organic farming-role of biofertilizers and organic manures; overview of microbial inoculants-types and their mode of application, types of formulation- advantages and disadvantages.

Unit-II

Carriers for inoculants: types and their characteristics, strain selection of bacteria and cyanobacteria for biofertilizer production and quality control, mass multiplication: methodology and constraints/benefits, bulk production (small scale and commercial scale), setting up of pilot scale inoculant production plants.

Unit-III

Rhizobium: Isolation, characterization and formulation; *Azotobacter*: isolation, characterization and formulation; phosphate solubilizing microorganisms: isolation, characterization and formulation; am fungi- types, multiplication methods and formulations; ecology of inoculants/ microorganisms in soil, cyanobacteria as biofertilizer for paddy cultivation.

Unit-IV

Composting- microbiology, types and quality testing; vermi-compost: types of earthworms, production technology and its evaluation; biocontrol agents: evaluation and formulations; biogas production technology; silage production.

Suggested Readings:

1. Sustainable Green Technologies for Environmental Management (2019). 1st ed. Shachi SV and Venkatramanan, RP, Springer (Singapore) ISBN 9789811327711.
2. Solid Waste as a Renewable Resource: Methodologies (2015) 1st ed. Albanese, JAF and Ruiz, MP CRC Press. ISBN 9781771882439.
3. Biofertilizer Technology (2013) 1st ed., Kannaiyan, S, Kumar, K and Govindarajan K Scientific Publisher. ISBN 9789386102485.
4. Compost Science and Technology, Vol 8. (2011) 1st ed. Diaz LF, De Bertoldi M and Bidlingmaier W, Elsevier, ISBN 9780080439600
5. Microbes for Sustainable Agriculture (2010) Tilak, KVBR, Pal, KK and De, R. I.K. International Publishing House Private Ltd. (New Delhi) ISBN 9789380026886

SEMESTER – I

Course title: Techniques in Microbiology **Credit: 4**
Course code: SIAL MB 1 1 02 GEC 4004 **Lectures: 60**

Course objective: To familiarize with General Microbiological techniques and understand their principles and to learn the applications of various techniques in identification and application of microorganisms.

Learning outcomes:

- Know-how of the basic microbiological tools and techniques
- Understanding of applications of techniques for exploitation of microbes
- Ability to grow and identify specific microorganisms

Unit-I

Isolation and cultivation of pure cultures- microbiological culture media; Maintenance of asepsis - Autoclave, Hot air oven, Filtration, Laminar air flow; Isolation of bacteria (streak plate, spread plate, pour plate, serial dilution methods) screening and enrichment techniques; preservation and maintenance of microbial cultures, general setup of microbiological laboratory.

Unit-II

Principle and applications of bright field and dark field microscopy; Microscopic measurements, Phase contrast, Interference, Differential Interference Contrast Microscopy; Fluorescence, Immunofluorescence and Confocal Microscopy; Specimen preparation in Light and Electron Microscopy; Simple staining, differential staining, acid fast staining, staining for visualization of specific microbial cell structures; SEM, TEM, and STEM.

Unit-III

Factors affecting microbial growth, Estimation of microbial growth - direct and indirect methods for determination of numbers - viable (plate) count and total (Haemocytometer) count, Estimation of microbial biomass, determination of bacterial growth rate and generation time by turbidometry method, estimation of microbial protein and enzyme activities.

Unit-IV

Tools and techniques for microbial identification and characterization – morphological characterization of microbial cells and colonies, phenotypic methods (biochemical and physiological properties); molecular biology tools for identification and characterization of microbes, measurement of microbial metabolism; detection of non-culturable microbes and metagenomics.

Suggested readings:

1. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology (2018), 8th ed., Hofmann A and Clokie S, Cambridge University Press (NY), Online ISBN: 9781316677056.

2. Experiments in Microbiology, Plant Pathology and Biotechnology (2009), 1st ed., Aneja KR, New Age International Publishers (New Delhi), ISBN-13: 978-8122414943.
3. Microbiology: A Laboratory Manual (2017), 11th ed., Cappuccino JH and Sherman N, Pearson Education Inc, ISBN: 9780134298597.
4. An introduction to Practical Biochemistry (2017) 3rd ed., Plummer DT, McGraw Hill Education, ISBN-13: 978-0070994874.

SEMESTER-II

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

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

Learning outcomes:

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

Unit-I

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

Unit-II

Structure and distribution of classes and subclasses of immunoglobulins (Ig), Ig fold, effector functions of antibody, antigenic determinants on Ig and Ig super family**.** Multigene organization of Ig locus, mechanism of V region DNA rearrangement, ways of antibody diversification. Antigen independent phase of B cell maturation and selection, humoral response – T-dependent and T-independent response.

Unit-III

Complement activation by classical, alternate and MB lectin pathway, biological consequences of complement activation, regulation and complement deficiencies. General organization and inheritance of MHC, structure, distribution and role of MHC class I and class II proteins, pathways of antigen processing and presentation. Structure and role of T cell receptor, and co-receptor, T cell development, generation of receptor diversity, selection and differentiation. General properties of effector T cells, cytotoxic T cells (Tc), natural killer cells; NKT cells and antibody dependent cellular cytotoxicity (ADCC).

Unit-IV

Mechanism of tolerance, Organ specific and systemic autoimmune diseases, possible mechanisms of induction of autoimmunity, IgE mediated (Type I) hypersensitivity, antibody mediated cytotoxic (Type II) hypersensitivity, immune complex mediated (type III) hypersensitivity and delayed type (Type IV) hypersensitivity. Immunological basis of graft rejection, clinical manifestations, immunosuppressive therapy, Immunohistochemistry, Immunocytochemistry and privileged sites. Vaccines - active and passive immunization, types of vaccines.

Suggested readings:

1. Kuby Immunology (2018) 8th ed., Punt J, Stranford S, Jones P and Owen JA, W.H Freeman and Company, ISBN: 978-1319114701.
2. Janeway's Immunobiology (2017) 9th ed., Murphy KM and Beaver C, WW Norton and Company, ISBN: 978-0815345510.

3. Roitt's Essential Immunology (2017) 13th ed., Delvis PJ, Martin SJ, Burton DR and Roitt, IM, Wiley-Blackwell, ISBN: 978-1118415771.
4. Lehninger: Principles of Biochemistry (2017) 7th ed., Nelson, DL and Cox, MM, WH Freeman and Company (New York), ISBN: 978-1319108243.
5. Lippincott's illustrated Reviews Immunology (2012) 2nd ed., Doan T, Melvold R, Viselli S and Waltenbaugh, C, Wolters Kluwer India Pvt, Ltd, ISBN: 978-8184737639.

SEMESTER-II

Course title: Biosafety, Bioethics and IPR **Credit: 3**
Course code: SIAL MB 1 2 02 C 3003 **Lecture: 45**

Course objective: To introduce the concept of intellectual property rights, patenting and emphasis on biosafety and bioethics.

Learning outcomes:

- Understanding the basics of intellectual property rights
- Understand the importance and level of biosafety at laboratory and industrial levels
- Understand ethical practices and concepts appropriate to the discipline

Unit-I

Biosafety: introduction; historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals; definition of GMOs & LMOs; principles of safety assessment of transgenic plants – sequential steps in risk assessment; concepts of familiarity and substantial equivalence; risk – environmental risk assessment and food and feed safety assessment; problem formulation – protection goals, compilation of relevant information, risk characterization and development of analysis plan; risk assessment of transgenic crops vs cisgenic plants or products derived from RNAi, genome editing tools. Regulations: International regulations-Cartagena protocol, OECD consensus documents and Codex Alimentarius; Indian regulations-EPA act and rules, guidance documents, regulatory framework-RCGM, GEAC, IBSC and other regulatory bodies.

Unit-II

Bioethics: Introduction, ethical conflicts in biological sciences-interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation. Bioethics in research - cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology-Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity - biopiracy.

Unit-III

Patenting: Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application; precautions before patenting-disclosure/non-disclosure - patent application forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications: provisional and complete specifications, PCT and conventional patent applications.

Unit- IV

International patenting-requirement, procedures and costs; financial assistance for patenting, introduction to existing schemes; publication of patents-gazette of India, status in Europe and US; patent infringement- meaning, scope, litigation, case studies and examples; commercialization of patented innovations; licensing-outright sale, licensing, royalty; patenting by research students and scientists-university/organizational rules in India and abroad, collaborative research-backward and forward IP; benefit/Credits sharing among parties/community, commercial (financial) and non-commercial incentives.

Suggested readings:

1. Office of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/
2. World Trade Organisation. http://www.wto.org
3. World Intellectual Property Organisation. http://www.wipo.int
4. International Union for the Protection of New Varieties of Plants. http://www.upov.int
5. National Portal of India. http://www.archive.india.gov.in
6. IPR, Biosafety and Bioethics (2013) Parashar S, Goel D, Pearson Publishing India, ISBN: 9788131774700.
7. An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology (2017) Nambisan P, Academic Press, ISBN: 9780128092316.
8. http://dbtindia.gov.in/guidelines-biosafety

SEMESTER-II

Course title: Microbial Diversity **Credit: 4**
Course code: SIAL MB 1 2 03 C 4004 **Lectures: 60**

Course objectives: To make the students understand the basic structure, classification and importance of different microbial groups.

Learning outcome:

- Understanding the diversity of microbial world and their implications
- Understanding the characteristics and significances of different microbial groups

Unit-I

Organization of Bacterial Cell - Structure and function of cell wall, cell membrane, cytoplasm, flagella, endoflagella, fimbriae, glycocalyx, capsule, endospore; bacterial classification, important archaeal group, Archaebacteria, Eubacteria- General characteristics, ecological significance and economic importance

Unit-II

Cellular organization of algal and fungal cells; algae - occurrence and distribution, thallus structure, characteristics, classification and reproduction; lichens and mycorrhiza - occurrence, structure, types and importance; fungi – occurrence, distribution and classification, fungal metabolites and their potential applications in food, agriculture, industry and environment.

Unit-III

Discovery and general characteristics of viruses; capsid symmetry; enveloped and non-enveloped viruses; classification and nomenclature of different groups (animal viruses and plant viruses) of viruses; viroids, virusoids, satellite viruses and prions; bacteriophages; lytic and lysogenic phages (lambda phage); phage therapy.

Unit-IV

Protozoan general characteristics and classification based on flagellate or mastigophora, rhizopoda, ciliophora, and sporozoa; detailed study of euglena, monocystis, entameoba, paramecium and trypanosoma; role of protozoan in environment and health implication.

Suggested readings:

1. An Introduction to Microbiology (2019), 3rded., Tauro P, Kapoor KK, Yadav KS and Sequeira MG. New Age International Publishers. ISBN: 0852268785.
2. Principles of Microbial Diversity (2015), Brown JW, ASM Press, Washington DC, ISBN-10: 9781555814427.
3. Microbial Diversity in the Genomic Era (2018) 1sted., Das S and Dash H, Academic Press, ISBN: 9780128148501.
4. Virology: Principles and Applications (2013) 2nded, Carter J and Saunders V, John Wiley & Sons, ISBN: 9781119991434.
5. Prescott's Microbiology (2017) 10th ed., Willey J, Sherwood L, and Woolverton CJ. McGraw-Hill Education, ISBN-1259281590.

6. The Fungi (2015) 3rd ed., Watkinson S, Boddy L and Nicholas M. Academic Press. ISBN: 978012382035.
7. Algae: Anatomy, Biochemistry, and Biotechnology (2014), 2nd ed., Barsanti L,Gualtieri P. CRC Press, ISBN: 1439867321.

SEMESTER-II

Course title: Microbial Physiology and Metabolism **Credit: 4**
Course code: SIAL MB 1 2 04 C 4004 **Lectures: 60**

Course objective: The course is designed to describe metabolic and physiological diversity among prokaryotes.

Learning outcome:

- Learning of principles of microbial catabolic and anabolic pathways
- Understanding the transport systems and the mechanisms of energy conservation in microbial metabolism
- Identifying various physiological groups of bacteria with their special features

Unit-I

Nutritional categories of microorganisms based on carbon and energy sources; Metabolite transport - passive and facilitated, primary and secondary active transport, group translocation (phosphotransferase system), symport, antiport and uniport, electrogenic and electroneutral transport, transport of iron; Microbial Growth - Definition balanced and unbalanced growth, growth curve, the mathematics of growth, generation time, specific growth rate, batch and continuous culture, synchronous growth, diauxic growth curve; Effect of physical and chemical factors on growth.

Unit-II

Brief account of photosynthetic and accessory pigments - chlorophyll, bacteriochlorophyll, rhodopsin, carotenoids, phycobiliproteins; Autotrophy - oxygenic, anoxygenic photosynthesis; Autotrophic generation of ATP; Fixation of CO_2; Calvin cycle pathway. Chemolithotrophy - Sulphur, iron, hydrogen, nitrogen oxidations, methanogenesis, Bioluminescence.

Unit-III

Respiratory metabolism - Embden-Mayer Hoff pathway, Entner Doudroff pathway, Pentose phosphate pathway, Krebs cycle, Branched TCA cycle, Reverse TCA cycle, glyoxalate pathway, oxidative and substrate level phosphorylation,, gluconeogenesis, pasteur effect; fermentation of carbohydrates - homo and heterolactic fermentations; halophiles and atp synthesis.

Unit-IV

Biosynthesis of peptidoglycan, polysaccharides, major amino acids, polyamines, lipids, nucleotides - purines and pyrimidines; assimilation of nitrogen; dormancy and germination; microbial differentiation, sporulation and morphogenesis, cell division cycle in *e. coli* and yeast.

Suggested readings:

1. An Introduction to Microbiology (2019), 3rd ed., Tauro P, Kapoor KK, Yadav KS, and Sequeira MG, New Age International Publishers. ISBN: 0852268785

2. Microbial Biochemistry (2014) Cohen GN, 3rd edition. Springer Netherlands. ISBN 978-90-481-9437-7
3. The Physiology and Biochemistry of Prokaryotes. (2011) White D, Dummond J and Fuqua, C, 4th edition. Oxford University Press. ISBN: 9780195393040
4. Prescott's Microbiology (2017) 10th ed., Willey J, Sherwood L and Woolverton CJ. McGraw-Hill Education, ISBN: 1259281590
5. A text book of Microbiology (2013), Dubey RC and Maheswari, DK Revised S. Chand and Company Ltd, New Delhi. ISBN: 9788121926201

SEMESTER-II

Course title: Soil and Agriculture Microbiology **Credit: 4**
Course code: SIAL MB 1 2 05 C 4004 **Lectures: 60**

Course objective: To teach the basic concepts related to soil environment in relation to microbes and plant-microbe interaction including pathogens

Learning outcome:

- Understanding the role of microorganisms in the biogeochemical cycles of nutrients
- Understanding the role of microbes in degradation of solid organic waste and other organic pollutants.
- Understanding the different types of interactions between plants and microbes

Unit-I

History of development of soil microbiology; soil microorganisms: major groups, their diversity, abundance, characteristics; direct and indirect methods of studying soil microorganisms and their activities; microorganisms and their enzymes in soil fertility; influence of soil and environmental factors on microflora; soil health-major microbial indicators and their significance

Unit-II

Microorganisms in biogeochemical cycles of carbon, nitrogen, phosphorus, sulphur, iron and manganese; biodegradation of starch, cellulose, hemicellulose, pectin and lignin in soil; biodegradation of pesticides and other xenobiotics; production of biogas; composting-microbiology, types and factors affecting composting; vermicomposting, green manuring

Unit-III

Plant-microbe interactions, Concepts of Rhizosphere, R:S ratio, Rhizoplane, spermosphere, phyllosphere microorganisms; Biological Nitrogen fixation - symbiotic, non-symbiotic, associative symbiotic and endophytic organisms, process of nitrogen fixation; Molecular biology of Nitrogen fixation

Unit-IV

Biofertilizers – Types (Bacterial, fungal and algal), mass production and quality assurance; Microbial Biocontrol agents for insects and diseases- development and their significance. Mycorrhizae, Types of mycorrhizae and their interactions with plants

Suggested readings:

- Rhizotrophs: Plant Growth Promotion to Bioremediation (2017) vol 2. Mehnaz S, Springer, ISBN: 9789811048616.
- Plant, Soil and Microbes Vol-1 Implications in Crop Science (2016) 1st ed., Hakeem KR, Akhtar MS and Abdullah SNA, Springer Cham, ISBN: 9783319274539.

- Principles of plant-microbe interactions (2016) Lugtenberg B, Springer Cham, ISBN 3319381857.
- Soil Microbiology, Ecology and Biochemistry (2017) 4th ed. Paul EA, Academic Press, New York, USA. ISBN: 9780124159556.
- Principles and Applications of Soil Microbiology (2005) 2nd ed., Sylvia D, Fuhrmann J, Hartel P and Zuberer D Pearson Education, USA. ISBN: 9780130941176.
- Introduction to Soil Microbiology (1985) 3rd ed., Alexander M, Wiley Eastern, New Delhi. ISBN: 9780894645129.

SEMESTER-II

Course title: Practical-II **Credit: 5**

Course code: SIAL MB 1 2 06 C 00105 **Lectures: 150**

1. Morphological, physiological and biochemical characterization of bacterial cultures.
2. Isolation and identification of fungi and algae from different environmental samples;
3. Study of virus architecture using electron microphotographs of TMV, poliovirus and adenovirus;
4. Discussion on cultivation and cytopathic effects of animal viruses;
5. Bacteriophage assay using the plaque technique
6. Determination of bacterial growth by turbidity measurements (Bacterial growth curve);
7. To study the types of growth (synchronous/ diauxic, batch);
8. To study the effect of incubation temperature, pH, salts on the growth of microorganisms;
9. Isolation of different bacterial and fungal organisms important in recycling of C, N, P in soil;
10. Measurement of CO_2 evolution rate to study decomposition in soil,
11. Estimation of different Soil enzymes- (dehydrogenase/ FDA hydrolase/ β-glucosidase)
12. Determination of Microbial biomass carbon
13. Determination of RS ratio of soil
14. Determination of quality of milk by methylene blue reductase test (MBRT) and SPC;
15. Microbiological examination of different food samples;
16. Determination of antibacterial activity of lactic acid bacteria
17. Screening of microorganisms from soils and industrial effluents for bioremediation applications
18. Microbiological quality control tests for water;
19. Agglutination and Precipitation based assays
20. Immunodiffusion assays by Ouchterlony method;
21. Demonstration of Immunoelectrophoresis; Dot-ELISA and Western blotting

Suggested readings:

1. Microbiology: A laboratory Manual (2017) 11th ed. Cappuccino JG and Welsh C, Pearson Education, Inc. ISBN: 9780134098630.
2. Laboratory Manual of Microbiology and Biotechnology (2014) 1st ed. Aneja KR., Scientific International Pvt. Ltd. ISBN: 9789381714553.

SEMESTER-II

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

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

Learning outcomes:

- Understanding the existence of scientific knowledge in ancient times
- Acquiring the skills of scientific reading, writing and presentations
- Appreciating the scientific ethics through case studies

Unit-I

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

Unit-II

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

Unit-III

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

Unit-IV

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

Suggested readings:

1. Research Methodology: Methods And Techniques (2019) 4th ed., Kothari CR and Garg G, New Age International Publishers, ISBN: 978-9386649225.
2. Communicate Science Papers, Presentations, and Posters Effectively (2015) Patience GS, Boffito DC, Patience P, Academic Press, ISBN: 978-0128015001.
3. Successful Scientific Writing: A Step-by-Step Guide for the Biological and Medical Sciences (2014) 4th ed., Matthews JR and Matthews RW, Cambridge University Press ISBN: 978-1107691933.
4. Doing Science: Design, Analysis, and Communication of Scientific Research. (2001) Valiela I, Oxford: Oxford University Press, ISBN 10:019538573X.
5. On Being a Scientist: a Guide to Responsible Conduct in Research. (2009) 3rd ed., Washington DC, National Academies Press.

SEMESTER-II

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

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

Learning Outcomes:

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

Unit-I

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

Unit-II

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

Unit-III

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

Unit-IV

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

Suggested readings:

1. Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge, Routledge Studies in Innovation,

Organizations and Technology (2018) 1st ed. Onetti, A, & Zucchella, A, CRC press, Taylor and Francis group. ISBN: 9781138616905.
2. Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies. Shimasaki, CD (2014) Amsterdam: Elsevier. Academic Press is an imprint of Elsevier, ISBN: 0124047300.
3. Innovation, Commercialization, and Start-Ups in Life Sciences. (2014) 1st ed. Jordan, JF, CRC Press. Taylor and Francis group, ISBN: 9781482210125.
4. The Dynamics of Entrepreneurial Development and Management. (2011) 6th ed., Desai V, New Delhi: Himalaya Pub. House, ISBN: 9350244543.
5. Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences (2008) Adams, DJ, Sparrow JC, Bloxham, Scion, ISBN:1904842364.

SEMESTER-II

Course title: Food and Dairy Microbiology **Credit: 4**

Course code: SIAL MB 1 2 01 DCEC 4004 **Lectures: 60**

Course Objectives: This course is designed to provide information on role of microbiology in Food processing sector. The major objective of this course will be comprehensive understanding of role of microorganisms in: food production, spoilage preservation, quality and safety and the recent technological interventions in these areas of Food.

Learning outcomes:

- Understanding the interactions between microorganisms and the food environment
- Understanding different bioprocesses involved in production and preservation of foods
- Understanding the importance of microbiological quality and preventive measure for food borne diseases

Unit-I

Natural flora and source of contamination of foods; intrinsic and extrinsic factors that affect growth and survival of microbes in foods; microbial spoilage of vegetables, fruits, meat, eggs, milk, bread, butter, and canned foods.

Unit-II

Principles of food preservation; physical methods of food preservation - temperature (low, high, canning, and drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging; chemical methods of food preservation - salt, sugar, organic acids, so2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins; food sanitation - HACCP, indices of food sanitary quality and sanitizers.

Unit-III

Fermented foods - dairy starter cultures and fermented dairy products (yogurt, acidophilus milk, curd, kefir, kumiss, cheese, dosa, sauerkraut, soy sauce and tempeh); probiotics and prebiotics - health benefits, types of microorganisms used, probiotic foods available in the indian market.

Unit-IV

Food-borne diseases (causative agents, foods involved, symptoms and preventive measures) - Food intoxications caused by *Staphylococcus aureus*, *Clostridium botulinum* and mycotoxins; Food infections caused by *Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, *Salmonella*, *Shigella*, *Yersinia enterocolitica*, *Listeria monocytogenes* and *Campylobacter jejuni*; Conventional and recent methods for detection of food-borne pathogens. Indian and International regulations of food quality and safety.

Suggested readings:

1. Fundamental Food Microbiology (2014). 5th ed.. Ray B and Bhunia A CRC Press, Taylor and Francis Group. ISBN 9781466564435.

2. Food Microbiology**:** Principles into Practice. Microorganisms related to foods, foodborne diseases and food spoilage, (2016) Volume 1 and 2, Erkman O and Bozoglu TF, John Wiley & Sons, Inc. ISBN: 9781119237761.
3. Food Microbiology (2016) 4th ed., Adams MR, Moss M and McClure P, Royal Society of Chemistry. ISBN: 978-1849739603.
4. Microbiology in Dairy Processing: Challenges and Opportunities (2017) Poltronieri P, John Wiley & Sons Ltd and the Institute of Food Technologists ISBN: 1119114802.
5. Food Microbiology (2002) 4th ed. Frazier WC and Westhoff DC, Tata McGraw-Hill Publishing Company Ltd, New Delhi, India. ISBN: 9780070219212.

SEMESTER-II

Course title: Environmental Microbiology **Credit: 4**
Course code: SIAL MB 1 2 02 DCEC 4004 **Lectures: 60**

Course objectives: To understand the role of microorganisms in environmental processes and also to learn principles and applications of microbiology in bioremediation of pollutants and wastewater treatment.

Learning outcomes:

- Know-how of the effect of environmental condition on microbes
- Understanding the interactions between microorganisms and their environment
- Understanding of applications of microorganisms in solving environmental problems

Unit-I

Historical developments and contributions of scientists in environmental microbiology; introduction and scope of environmental microbiology; environmental factors affecting microbial growth; impacts of GMOs on environment; role of microorganisms in mitigating global climate change; tools and techniques for studying microbial interactions with their environment.

Unit-II

Microbiology of natural environments: terrestrial environments; rhizosphere; aquatic environments (freshwater, marine and estuarine habitats); ground water; aeromicroflora and dispersal of microbes; human microbiomics; microbial interactions in rumen.

Unit-III

Microbiology of extreme environments: microbial growth and survival under hot environments, cold environments, alkaline environments, acidic environments, saline environments, environments rich in heavy metal, low nutrient environments, environments with high hydrostatic pressure, organic solvents and radiation; polyextremophiles. Space microbiology.

Unit-IV

Microbial indicators of environmental pollution; bioremediation of recalcitrant organic pollutants; microbial technology for waste management and treatment- solid waste management, landfills, utilization of solid wastes for production of food and feed, fuel and fertilizer; wastewater microbiology: microbiology of sewage and industrial effluents (paper and pulp, distillery etc.) - aerobic (trickling filters, activated sludge, oxidation ponds etc.) and anaerobic processes in wastewater treatment; enhanced recovery of metals, petroleum and bioenergy from natural resources. Biodegradation and biodeterioration.

Suggested readings:

1. Manual of Environmental Microbiology (2016), 4th ed., Yates, MV, Nakatsu CH, Miller RV and Pillai RV, ASM Press (USA), Print ISBN: 9781555816025, e-ISBN : 9781555818821.
2. Environmental Microbiology for Engineers (2016), 1st ed., Ivanov V, ISBN: 9780429109003.
3. Environmental Microbiology: From Genomes to Biogeochemistry (2015), 2nd ed., Madsen EL, John Wiley & Sons, Inc., ISBN: 978-1-118-43963-0.

4. Environmental Microbiology: Fundamentals and Applications (2015), 1st ed., Bertrand JC, Caumette P, Lebaron, P, Matheron R, Normand P and Sime-Ngando T, Springer Netherlands, eBook ISBN: 978-94-017-9118-2, Hardcover ISBN: 978-94-017-9117-5.
5. Environmental Microbiology (2016-17), 1st ed., Sharma, PD, Rastogi Publications (India), ISBN: 978-93-5078-140-1.

SEMESTER-III

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

Course objective: To introduce the students in the field of bioinformatics and enables them to understand the concepts of statistics in biology.

Learning outcomes:

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

Unit-I

Definition of selected terms scale of measurements related to statistics; Methods of collecting data, Presentation of data statistical Tables, Need for reduction of data measures of averages and location, Measures of dispersion: Range, quartile deviation, mean deviation and relative deviation. Probability: basic concepts; basic theorems of probability addition and multiplication theorems; conditional probability of Bayes Theorems. Probability mass function, probability density function, cumulative distribution function.

Unit-II

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

Unit-III

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

Unit-IV

Similarity, identity and homology. Alignment-local and global alignment, pairwise and multiple sequence alignments, alignment algorithms, amino acid substitution matrices (PAM and BLOSUM), BLAST and CLUSTAL omega. Identification of open reading frames (ORF), Concept of orthology, paralogy and homology in gene and protein sequences. Methods and tools for phylogenetic analysis, maximum parsimony, maximum likelihood and distance methods; creation, evaluation and interpretation of evolutionary trees phylogenetic tree.

Suggested Readings:

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

SEMESTER-III

Course title: Microbial Genetics and Genomics **Credit: 4**
Course code: SIAL MB 1 3 07 C 4004 **Lectures: 60**

Course objectives: This course is designed to provide a comprehensive details on microbial genomes, their regulatory and transfer mechanisms.

Learning outcomes:

- Understanding the structure and functions of genomes of different microbial groups
- Understanding the processes behind mutations and other genetic changes
- Identifying and distinguishing genetic regulatory mechanisms at different levels

Unit-I

Molecular basis of mutations - induced *versus* spontaneous mutations; gene mapping by recombination and complementation; fine gene structure analysis; cloning genes by complementation and marker rescue; DNA repair mechanisms; mutation and microbial evolution.

Unit-II

Gene transfer in bacteria - conjugation, transformation and transduction; Regulation of gene transfer by conjugation; Mapping the bacterial genomes using Hfr strains; transfer systems in gram positive bacteria; Ti plasmid and applications; transformation - molecular basis of natural transformation; transduction- generalized *versus* specialized transduction; mapping bacterial genes by transduction; tetrad analysis in fungi; positive and negative gene regulation and attenuation in different operons; riboswitches.

Unit-III

Genes involved in the lytic and lysogenic cycle of lambda phage; Replication and packaging of filamentous phages M13; Benzer's experiments to construct phage genetic linkage maps; Transposons and gene regulation; Yeast Ty -1 transposon; methods of gene cloning and sequencing; genome transplantation (Synthetic genome).

Unit-IV

Sequencing of microbial genomes; database of microbial genomes; understanding microbial genomes; house keeping genes, essential genes; cluster of orthologous genes; minimal genome; microbiome analysis through genetic tools; metagenome and advances of metagenomics; application of crispr-cas9 system based genome editing.

Suggested readings:

1. Lewin's GENES XII (2017) 12th ed. Krebs JE, Elliott S and Goldstein. Jones and Bartlett Publishers. ISBN: 9781284104493.
2. Concepts of Genetics (2016) 10th ed. Klug, Cummings and Spencer. Pearson Education India. ISBN: 9332577463.
3. Molecular Genetics of Bacteria (2013) 4th ed. Snyder L, Peters, Henkin and Champness... ASM Press; ISBN: 9781555816278.
4. Principles of Genetics (2010) 8thed. Gardner, Simmons and Snustad, Wiley India Pvt Ltd ISBN: 9788126510436.

5. Mining of Microbial Wealth and MetaGenomics (2017) 1st ed. Kalia VC, Shouche Y, Purohit HJ and Rahi P. Springer Nature Singapore Pte Ltd. ISBN: 9789811057076.
6. Microbial Diversity in the Genomic Era (2018) 1st ed. Das S and Dash HR. Academic Press, ISBN: 9780128148495.

SEMESTER-III

Course title: Industrial Microbiology **Credit: 4**
Course code: SIAL MB 1 3 08 C 4004 **Lectures: 60**

Course objectives: To familiarize about principles of fermentation, fermentation equipment and their control and applications of microbes and their improvement for commercial production of valuable products.

Learning outcomes:

- Know-how of the industrial microbes and their improvement strategies
- Understanding the concepts and practices of industrial fermentation processes
- Understanding of applications of microorganisms in different industrial sectors

Unit-I

History of fermentation and Industrial Microbiology; Scope of Industrial Microbiology; Definition, types and examples of fermentation processes. Industrially important microorganisms- their characteristics, Screening and selection, biology and metabolism. Maintenance and Preservation of Industrial Strains, Microbial Culture collections. Microbial Strain Improvement- mutagenesis, protoplast fusion and genome shuffling, parasexual reproduction and recombinant DNA approach.

Unit-II

Fermentation media used in industrial fermentations - characteristic features of substrates and nutrients; formulation and optimization of media for industrial fermentations, media sterilization. Inoculum development. Kinetics of substrate utilization, biomass production and product formation in batch, fed-batch and continuous cultivations. Characteristics of solid substrate and submerged fermentations.

Unit-III

Laboratory fermenter – design and types (stirred tank reactor, bubble column reactor, airlift reactor, packed bed reactor, fluidized bed reactor), solid state reactors. Instrumentation and control of bioprocesses. Scale-up and scale-down principles. Downstream processes for product recovery (cell disruption, precipitation, filtration, centrifugation, extraction, chromatography, membrane process, drying, crystallization, packaging). Fermentation process economics.

Unit-IV

Types of microbial products; production of microbial biomass -baker's yeast, mushroom and single cell proteins, biofertilizers, biopesticides. production of primary metabolites -ethanol, organic acids (citric acid and lactic acid), amino acids (glutamic acid, lysine), vitamins (vit b_2 and vit b_{12}), nucleotides, industrial enzymes (amylases, proteases, streptokinases, tyrosinase), production of secondary metabolites - antibiotics (penicillin, cephalosporins, streptomycin), pigments. Designer's microbes for health, food and energy applications. Production of metabolites of non-microbial origin (insulin, interlukins, cytokines). Fermentative production of probiotics and prebiotics. Microbial transformations.

Suggested readings:

1. Industrial Microbiology (2016), 2nd ed., Casida, LEJR, New Age International (P) Ltd., New Delhi, India., ISBN: 9788122438024.

2. Modern Industrial Microbiology and Biotechnology (2017), 2nd ed., Okafor N and Okeke, BC, CRC Press, ISBN: 9781138550186.
3. Biotechnology: A Test Book of Industrial Microbiology (2017) 2nd ed., Crueger W, Crueger A and Aneja KR, Panima Publishing corporation (New Delhi), ISBN: 9789385998638.
4. Manual of Industrial Microbiology and Biotechnology (2010), 3rd ed., Baltz RH, Demain AL, Davies JE, ASM Press, ISBN-13: 978-1555815127.
5. Industrial Microbiology (2015), 2nded., Patel AH, Laxmi Publications (P) Ltd. (New Delhi), ISBN-13: 9789385750267.
6. Principles of Fermentation Technology (2016), 3rd ed. Stanbury PF, Whitaker A and Hall SJ, Butterworth-Heinemann, eBook ISBN: 9780444634085, Paperback ISBN: 9780080999531.

SEMESTER-III

Course title: Medical Microbiology and Virology **Credit: 4**
Course code: SIAL MB 1 3 09 C 4004 **Lectures: 60**

Course objectives: An advanced understanding and applied knowledge in the theory and practice of recent advances and research methodology related to infectious diseases of Humans, Plants and Animals.

Learning outcomes:

- Understanding the role of native microbial flora of human body
- Understanding microbial virulence mechanisms
- Demonstrations of techniques and antimicrobial used to identify the cause and to treat infections

Unit-I

Normal microflora of the human body and its importance: normal microflora of skin, throat and gastrointestinal tract; Collection, transport and culturing of clinical samples (sputum, urine, blood, stools) for microbiological analysis; Human microbiome.

Unit-II

Causative agents, symptoms, mode of transmission and control of diseases caused by staphylococcus aureus, streptococcus pyogenes, Haemophilus influenzae, Mycobacterium tuberculosis, Escherichia coli, Salmonella typhi, Vibrio cholerae, Helicobacter pylori, Bacillus anthracis, Clostridium tetani, Treponema pallidum and torch group of pathogens; causative agents, symptoms, mode of transmission and control of diseases dermatomycoses, histoplasmosis, candidiasis, malaria and kala-azar; mechanism of action of various antimicrobial agents - inhibitors of nucleic acid synthesis, cell wall synthesis, cell membrane function and protein synthesis.

Unit-III

Concept of early and late proteins; regulation of transcription in lambda phage; salient features of viral nucleic acid - unusual bases (TMV, T4 phage), overlapping genes (ϕX174, Hepatitis B virus), alternate splicing (HIV), terminal redundancy (T4 phage), terminal cohesive ends (Lambda phage), partial double stranded genomes (Hepatitis B), long terminal repeats (Retrovirus), segmented genomes (Influenza virus), non-segmented genomes (Picornavirus), capping and tailing (TMV); modes of transmission of plant and animal viruses; viral multiplication and replication strategies: interaction of viruses with cellular receptors an entry of viruses; replication of viruses as per baltimore classification - assembly, maturation and release of virions.

Unit-IV

Causative agents, symptoms, mode of transmission and control of disease caused by human, animal and plant viruses – polio, influenza, rabies, common cold, aids, hepatitis, chikungunya, dengue, ebola, foot and mouth disease, blue tongue disease, mad cow disease, bud necrosis, tobacco mosaic disease and cauliflower mosaic disease; introduction to oncogenic viruses; types of oncogenic DNA and RNA viruses; mechanism of disease causation by plant viruses; antiviral compounds and their mode of action; interferon and their mode of action; use of viral vectors in cloning, expression, and gene therapy.

Suggested Reading:

- Medical Microbiology (2015) 8th ed. Patrick R, Murray, Ken S, Rosenthal P, Elsevier Press, ISBN: 9780323299565.
- Medical Microbiology (2016) 27th ed. Carrol KC, Morse SA, Mietzner T and Miller S. Jawetz, Melnick, & Adelberg's. McGraw-Hill Education, ISBN: 9780071824989
- Sherris Medical Microbiology (2018) 7th ed. Ryan K, Ahmad N, Alspaugh JA, Drew JL, Lagunoff M, Pottinger P, Reller LB, Reller M, Sterling and Weissman S. McGraw-Hill Education, ISBN: 9781259859809.
- Virology: Principles and Applications (2013) 2nd ed. Carter J, Saunders V, Wiley & sons, ISBN: 9781119991427.
- A Textbook Of Veterinary Special Pathology Infectious Diseases Of Livestock And Poultry (2015) 1st ed. Vegad J L Katiyar A K, CBS Publisher ISBN: 9788123927886.

SEMESTER-III

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

1. Study of resident microflora of the skin;
2. Identification of pathogens using biochemical assays
3. Identification of specific pathogens using kits (eg. Widal Test);
4. Antibiotic susceptibility testing using Kirby-Bauer method;
5. Determination of minimal inhibitory concentration (MIC) of an antibiotic using double dilution technique or E-test strips.
6. Isolation of industrially important microorganism from different sources
7. Determination of yield coefficient of *Saccharomyces cerevisiae* on various substrates
8. To study the design of fermenter and its working;
9. Production of ethanol using different substrates by yeast
10. Production of extracellular enzymes submerged and solid state conditions;
11. Isolation of genomic DNA and RNA from bacteria;
12. Isolation of plasmid DNA from bacterial culture;
13. Transformation experiment in *E.coli* by chemical method and electroporation and determination of transformation efficiency;
14. Designing and amplification of gene of interest by Polymerase Chain Reaction
15. Isolation, characterization of bacteria fungi present in cultivated and diseased plants
16. To study occurrence of disease by inoculation with bacterial or fungal pathogens
17. Measuring plant disease intensity under controlled conditions;
18. Biochemical and physiological tests for detection of pathogens in fruits and vegetables;
19. Determination of microbial interactions such as antagonism and symbiosis
20. Calculations on the diversity indices to determine microbial diversity,
21. Demonstrations on phylogenetic analysis of microorganisms

Suggested Readings:

1. Microbiology: A laboratory Manual. (2017) 11th ed. Cappuccino JG, Welsh C. Pearson Education, Inc. ISBN: 9780134098630.
2. Laboratory Manual of Microbiology and Biotechnology (2014) 1st ed. Aneja KR, Scientific International Pvt. Ltd., ISBN: 9789381714553.
3. Laboratory Manual and Workbook in Microbiology: Applications to Patient Care (2003) 7th ed. Morello JA, Helen PA and Mizer E, McGraw Hill Publications ISBN: 0072463546.

SEMESTER - III

Course title: Seminar **Credit: 2**

Course code: SIAL MB 1 3 11 C 0202

Seminar will be of 45-minute duration during which the presentation will be followed by questions session by the audience comprising of faculty and students. Every student shall be required to submit the topic of his/her seminar in consultation with the Head of the Department/Faculty members/student advisors well in advance so that the same may be displayed on the notice board. The presenter has to write an Abstract to be distributed during Seminar in addition to two copies of write-up giving relevant details of the background of the subject, methods used and references/List of sources from where the material for presentation has been collected.

SEMESTER - III

Course title: Microbial Ecology **Credit: 4**
Course code: SIAL MB 1 3 03 DCEC 4004 **Lectures: 60**

Course objectives: To understand the habitats, diversity and role of microbial communities in different environment and to demonstrate the modern approaches to detect the diversity of microbial communities.

Learning outcomes:

- Understanding the interactions determining the development of microbial communities
- Basic knowledge for analyzing microbial ecosystems; both natural and artificial systems
- Demonstrating the role of microbial niches in different applications

Unit-I

The general principals of microbial behaviour in ecosystems. Microbial evolution and biodiversity of different microbial groups. Natural microbial ecosystems (terrestrial, deep surface, fresh water, lake and river, marine and hydrothermal vents) artificial microbial ecosystems (biological water purification systems, anaerobic digestion, gut simulation models).

Unit-II

Microbial interactions related to resource competition and predation, parasitism. Interactions among microbes, plant microbe interactions, animal-microbe interactions, syntrophy, consortia and biofilms, quorum sensing.

Unit-III

community structure and energetics, species, diversity and indices, maintenance of species diversity, origin and maintenance of communities, collection of ecological samples for community analysis, molecular techniques and microbial community ecology, methods based on DNA/RNA, Methods based on fatty acids or lipids, methods based on function/physiology.

Unit-IV

Role of microorganisms in biogeochemical cycles, biodegradation, bioremediation, biomineralization and biocontrol.

Suggested readings:

1. Environmental Microbiology and Microbial Ecology (2019) 2nded. Barton LL, McLean RJC. John Wiley & Sons, ISBN: 9781118966266.
2. An Introduction to Microbiology (2019), 3rded., Tauro P, Kapoor KK, Yadav KS, and Sequeira MG. New Age International Publishers. ISBN: 0852268785
3. Principles of Microbial Diversity (2015), Brown JW, ASM Press, Washington DC, ISBN-10: 9781555814427.
4. Microbial Ecology: Fundamentals and Applications (2008). 4thed. Atlas RM and Bartha R. Pearson Publications. ISBN: 9780805306552.
5. Soil Microbiology, Ecology and Biochemistry (2015) 4thed. Paul EA. Elsevier Inc. ISBN: 9780124159556.
6. Microbial Diversity in the Genomic Era (2018) 1st ed., Das S and Dash H, Academic Press, ISBN: 978012814850.

SEMESTER - III

Course title: Plant Pathology **Credit: 4**
Course code: SIAL MB 1 3 04 DCEC 4004 **Lectures: 60**

Course objective: To appraise the students about principles plant pathology and measure of diseases of agricultural crops.

Learning Outcomes:

- Understanding of factors responsible for diseases in the crops
- Determining the mechanisms of pathogens for causing diseases in plants
- Demonstrating the techniques for management of crop diseases

Unit-I

Introduction and history of plant pathology; definitions and concepts of plant diseases; biotic and abiotic factors responsible for plant diseases; Interaction of microorganisms with plants and their effect on plant growth.

Unit-II

Growth, reproduction, survival and dispersal of important plant pathogens; Production of various enzymes, toxins and other metabolites by pathogens for causing disease; Role of environment and host nutrition on disease development; diseases of some important cereals (Rice, wheat), vegetables (Tomato, Potato), commercial crops (Cotton, Sugarcane) and fruit crops (Mango, Citrus, Grapes).

Unit-III

Host-pathogen interactions - recognition and infection, symptomatology, disease development- role of enzymes, toxins, growth regulators; defense strategies,; hypersensitivity responses including oxidative burst, phenolics, phytoalexins, PR proteins, elicitors and their effects on host plants.

Unit-IV

Plant disease resistance – pathogen associated molecular patterns, pattern recognition receptors, PTI, effectors, ETI, 'R' genes; mechanism of genetic variation in pathogens; disease control in plants - physical, chemical methods; use of biocontrol agents - bacteria and fungi; Transgenic approach for plant protection - applications and constraints.

Suggested readings:

1. Introduction to Principles of Plant Pathology (2018) 5thed. Singh RS, Scientific International Pvt. Ltd. ISBN: 9739386479488.
2. Plant Pathology (2018) 1sted., Burchett, S and Burchett S CRC Press, ISBN: 9780815344834.
3. Principles of Plant Pathology (2014) Jagtap G, Dhutraj D and Dey U. Agrobios (India), ISBN-978-8177544916.
4. Plant Pathology, (2005) 5thed., Agrios GN, Academic Press (New York) ISBN: 9780120445653.
5. Molecular Plant Pathology (2003) 1st ed., Dickinson M, Sheffield Annual Plant Reviews, CRC Press. ISBN: 9781841271088.

SEMESTER - III

Course title: Applied Microbiology **Credit: 4**
Course code: SIAL MB 1 3 03 GEC 4004 **Lectures: 60**

Course objective: To understand the role of microorganisms and microbial processes in welfare of humankind and too correlate the traditional microbiological techniques to microbial applications and their control.

Learning outcomes:

- Understanding of basic applications of microorganisms
- Know-how of the beneficial and harmful roles played by microbes
- Understanding of the roles of microbes in medical, environmental, industrial and food processes

Unit-I

History, applications and scope of microbiology- introduction to microscopic and pure culture techniques, microbial cell structure and functions, Microbial Growth and Control, balanced and unbalanced growth, growth curve.

Unit-II

Microbial Interactions with humans –normal microflora of human body, nosocomial infections, some common examples of food, air, water borne diseases, and their causative agents, antibiotics and Vaccines; Introduction to immunodiagnostics – RIA, ELISA.

Unit-III

Role of microorganisms in environment and agriculture, biogeochemical cycles (N, C, P), plant growth promoting bacteria, beneficial associations and interactions of microbes with microbe themselves, plant and animals, biodegradation, biodeterioration, biomineralization, bioremediation.

Unit-IV

Industrial and food applications of microbes, food fermentations (sauerkraut, tofu, tempeh, cheese, fermented milk), starter cultures, probiotics and prebiotics, industrial production of microbial biomass (baker yeast and SCP), primary (alcohol, vitamins and enzymes) and secondary metabolites (antibiotics).

Suggested readings:

1. Kuby Immunology (2018) 8th ed., Punt J, Stranford S, Jones P and Owen JA, W.H Freeman and Company, ISBN: 978-1319114701.
2. Manual of Environmental Microbiology (2016), 4th ed., Yates MV, Nakatsu CH, Miller, RV and Pillai RV, ASM Press (USA), Print ISBN: 9781555816025, e-ISBN : 9781555818821
3. Environmental Microbiology: Fundamentals and Applications (2015), 1st ed., Bertrand, JC, Caumette P, Lebaron P, Matheron R, Normand P and Sime-Ngando T, Springer Netherlands, eBook ISBN: 978-94-017-9118-2, Hardcover ISBN: 978-94-017-9117-5.
4. Environmental Microbiology (2016-17), 1st ed., Sharma, PD, Rastogi Publications (India), ISBN: 978-93-5078-140-1
5. Industrial Microbiology (2016), 2nd ed., Casida LEJR, New Age International (P) Ltd., New Delhi, India., ISBN: 9788122438024

6. Modern Industrial Microbiology and Biotechnology (2017), 2nd ed., Okafor N and Okeke, BC, CRC Press, ISBN: 9781138550186
7. Biotechnology: A Test Book of Industrial Microbiology (2017) 2nd ed., Crueger W, Crueger A and Aneja KR., Panima Publishing corporation (New Delhi), ISBN: 9789385998638

SEMESTER - III

Course title: Microbes and Diseases **Credit: 4**
Course code: SIAL MB 1 3 04 GEC 4004 **Lectures: 60**

Course objectives: The course is designed to provide a comprehensive details on different infectious agents and their implications.

Learning outcomes:

- Fundamental understanding of ecological factors that affect the transmission of infectious diseases
- Understanding the virulent determinants and social implications of infectious agents

Unit-I

Bacterial Pathogenesis: Types of Bacterial Pathogens (Primary Pathogens; Opportunistic Pathogens); Pathogen Classification (BSL-1-4); Pathogenicity; Virulence factor; Transmission of Pathogens (Aerosol, Oral, Direct contact, Fomite, Vector-borne, Zoonoses); Koch's Postulates (Modified).

Unit-II

Penetration of Host Defenses: Capsules; Cell Wall Components; Enzymes, (Exoenzymes, Coagulases, Kinases, Hyaluronidase, Collagenase, IgA proteases); Antigenic Variation. Penetration into Host Cytoskeleton: Invasins, Cadherin Damage to Host Cells: Using Hosts Nutrients, Direct Damage to Colonized Area, Production of Toxins (Exotoxins, Endotoxins) Bacterial Secretion System.

Unit-III

Regulation of Virulence Factors: Sigma Factors, Two Component System, Evolution of Bacterial Pathogens: Horizontal Gene Transfer, Pathogenicity Island, Antibiotic Resistance, Plasmids, Lysogeny and Pathogenicity, Pathogenic Properties of Virus, Eukaryotic Pathogens (Fungi; Protozoa; Algae).

Unit-IV

Microbes and Human Life: Medical and Pharmaceutical benefits of Microbes; Emerging and Reemerging Infectious Diseases; Bioterrorism.

Suggested readings:

1. Basic Medical Microbiology (2017) 1st ed. Murray PR. Elsevier. ISBN: 978032347676
2. Medical Microbiology (2016) 27th ed. Carrol KC, Morse SA, Mietzner T and Miller S. Jawetz, Melnick, & Adelberg's.. McGraw-Hill Education. ISBN: 9780071824989
3. Sherris Medical Microbiology (2018) 7th ed. Ryan K, Ahmad N, Alspaugh JA, Drew JL, Lagunoff M, Pottinger P, Reller LB, Reller M, Sterling C, Weissman S. McGraw-Hill Education. ISBN: 9781259859809
4. Kuby Immunology (2007) 6th ed. Kindt, Thomas J., Goldsby, Richard A. and Osborne, Barbara A. W.H. Freeman and Co. Publishers.
5. Textbook of Microbiology (2017) 10th ed. Ananthanaryan and Paniker, Universities Press, ISBN: 9789386235251

SEMESTER-IV

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

Guidelines for Project File

Research experience is as close to a professional problem-solving activity as anything in the curriculum. It provides exposure to research methodology and an opportunity to work closely with a faculty guide. It usually requires the use of advanced concepts, a variety of experimental techniques, and state-of-the-art instrumentation.

Research is genuine exploration of the unknown that leads to new knowledge which often warrants publication. But whether or not the results of a research project are publishable, the project should be communicated in the form of a research report written by the student.

Sufficient time should be allowed for satisfactory completion of reports, taking into account that initial drafts should be critiqued by the faculty guide and corrected by the student at each stage.

The file is the principal means by which the work carried out will be assessed and therefore great care should be taken in its preparation.

In general, the File should be comprehensive and include

- A short account of the activities that were undertaken as part of the project;
- A statement about the extent to which the project has achieved its stated goals.
- A statement about the outcomes of the evaluation and dissemination processes engaged in as part of the project;
- Any activities planned but not yet completed as part of the project, or as a future initiative directly resulting from the project;
- Any problems that have arisen that may be useful to document for future reference.
- The guidelines and format for dissertation is given below:

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Dissertation Guidelines

1. **GENERAL :**

The manual is intended to provide broad guidelines to the M.Sc. candidates in the preparation of the dissertation report. In general, the project report shall report, in an organised and scholarly fashion an account of original research work of the candidate leading to the discovery of new facts or techniques or correlation of facts already known.

2. NUMBER OF COPIES TO BE SUBMITTED:

Students should submit three copies to the Head of the Department concerned on or before the specified date.

3. ARRANGEMENT OF CONTENTS OF DISSERTATION:

Dissertation material should be arranged as follows:

1. Cover Page & Title page
2. Declaration
3. Certificate
4. Abstract (Hindi and English)
5. Acknowledgements
6. Table of Contents
7. List of Tables
8. List of Figures
9. List of Symbols, Abbreviations and Nomenclature (Optional)
10. Chapters
11. References
12. Appendices
13. One page CV

The Tables and Figures shall be introduced in the appropriate places.

4. PAGE DIMENSIONS AND MARGIN:

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

5. MANUSCRIPT PREPARATION:

The general text of thesis shall be typed in font style Times New Roman and font size 12. Same quality of paper should be used for the preparation of the entire report/thesis; except figure, photos are shown.

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

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

5.3 **Abstract**: Abstract should be an essay type (HINDI and ENGLISH) of narration not exceeding 500 words outlining the research problem, the methodology used for tackling it and a summary of the findings, typed in 1.5line spacing.

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

5.5 **Table of contents** - The table of contents should list all material following it as wellas any material which precedes it. The title page, Bonafide Certificate and Acknowledgment will not find a place among the items listed in the Table of Contents but the page numbers in lower case Roman letters are to be accounted for them. One and a half spacing should be adopted for typing the matter under this head. A specimen copy of the Table of Contents for report / thesis is given in Annexure III.

5.6 **List of Table** - The list should use exactly the same captions as they appear above thetables in the text and the caption shall follow 'sentence case'. One and a half spacing should be adopted for typing the matter under this head.

5.7 **List of Figures** - The list should use exactly the same captions as they appear belowthe figures in the text and the caption shall follow 'sentence case'. One and a half spacing should be adopted for typing the matter under this head

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

5.9 **Chapters** - The chapters may include

Chapter I – Introduction

Chapter II - Literature Review

Chapter III –Materials and Methods

Chapter IV- Results and Discussion

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

1.11. List of References - Any works of other researchers, if used either directly orindirectly, should be indicated at appropriate places in the report/thesis. The citation may assume any one of the following forms**. APA Style.**

APA in-text citation style uses the author's last name and the year of publication, for example: (Field, 2005).

Example:

Derwing, T. M., Rossiter, M. J., & Munro, M. J. (2002). Teaching native speakers to listen to foreign-accented speech. *Journal of Multilingual and Multicultural Development*, 23(4), 245-259.

Thomas, H. K. (2004). *Training strategies for improving listeners' comprehension of foreign-accented speech* (Doctoral dissertation). University of Colorado, Boulder.

6. TYPING INSTRUCTIONS

6.1 General

This section includes additional information for final typing of the thesis. Some information given earlier under 'Manuscript preparation' shall also be referred. The impressions on the typed/duplicated/printed copies should be black in colour. Corrections, interlineations and crossing out of letters or words will not be permitted in any of the copies of the report/thesis intended for submission. Erasures, if made, should be neatly carried out in all copies. A sub-heading at the bottom of a page must have at least two full lines below it or else it should be carried over to the next page. The last word of any page should not be split using a hyphen. One and a half spacing should be used for typing the general text. The general text shall be typed in Font Style Times New Roman and Font Size 12.

Single spacing should be used for typing:

(i) Long Tables

(ii) Long quotations
(iii) Foot notes

(iv) Multilane captions
(v) References

6.2 Chapters The format for typing chapter headings, division headings and sub division headings shall be same as given in Table of Contents.

7. BINDING SPECIFICATIONS

Thesis should be spiral or soft cover book bound, the cover of thesis should be of dark greencolor, printed with golden ink and the text for printing should be identical as prescribed for the title page.

APPENDIX I A:(A typical Specimen of Cover Page & Title Page–**DISSERTATION**)

<Font Style Times New Roman - Bold>

TITLE OF DISSERTATION

<Font Size 18><1.5 line spacing>

DISSERTATION

<Font Size 14>

Submitted by

<Font Size 14><Italic>

NAME OF THE CANDIDATE

<Font Size 16>

Under the Supervision of

NAME OF THE SUPERVISOR

in partial fulfillment for the award of the degree of

<Font Size 14><1.5 line spacing>

MASTER OF SCIENCE IN

NAME OF THE PROGRAMME

<Font Size 16>

DEPARTMENT OF

SCHOOL OF ……..

CENTRAL UNIVERSITY OF HARYANA

MAHENDERGARH-HARYANA

<Font Size 14><1.5 line spacing>

MONTH AND YEAR

DECLARATION

I ……, student of the School of Interdisciplinary and Life Sciences, Central University of Haryana, Mahendergarh hereby declare and certify with my signature that my thesis entitled

…… submitted to the Department of ……., Central University of Haryana, India in partial fulfillment of the requirements for the award of the Degree of Master of Science is a record of original research work done by me and the dissertation has not been the basis for the award of any degree/diploma/associateship/fellowship or similar title of any candidate of any University. I have faithfully and accurately cited all my sources, including books, journals, handouts and unpublished manuscripts, as well as any other media, such as the Internet, letters or significant personal communications.

I understand the concept of "plagiarism" and declare that while drafting this dissertation I have refrained from plagiarism. I know that plagiarism not only includes direct copying, but also the extensive use of other's ideas without proper referencing or acknowledgement (which includes the proper use of references and quotation marks).

If my dissertation found to be plagiarized at any point of time, I'll be solely responsible and will be ready to accept any decision taken by the competent authority including rejection of my dissertation.

(Supervisor) (Signature of student)

For example

(A typical Specimen of Table of Contents)

<Font Style Times New Roman, Font Size 14>

TABLE OF CONTENTS

ANNEXURE II

Curriculum vitae

<Font Style Times New Roman, Font Size 14>

Personal Details

Name :

Date of birth : DD Month, YYYY

Place of birth :

Nationality : Indian

Permanent Address :

Email Id :

Mobile No. :

Education

M.Sc. (Subject) : YYYY Central University of Haryana, India

B.Sc. (Subject). : YYYY (Name of the University) with …. % of marks

Higher Secondary : YYYY (Name of the board) with …. % of marks

Secondary : YYYY, (Name of the board) with …. % of marks