M.Sc. Microbiology Revised Autonomous Syllabus

Semester I and Semester II for the Academic Year

2020-2021

PREAMBLE

In order to assist students in developing research skills in general and in specific area of their interest/ specialization in particular, research proposal & research project component has been introduced in the revised syllabus. This component will provide students with an opportunity to conduct independent research in the subject of Microbiology at their own P.G. centers and if the research project demands, in Conjunction with relevant industries/ research institutes.

In order to enable students to be competitive for pursuing higher titles in advance courses in Genetics, Biochemistry, Medical Microbiology, Immunology, Environmental microbiology and Evolution have been included in the revised syllabus. As mentioned in the syllabus, all the 12 courses of theory & practical's are compulsory to M.Sc. Microbiology (By Papers) students (Semester I, II, and III). In Semester IV students will carry out a research project or undergo an internship on which they will be evaluated.

Note: The syllabus for Semester III and Semester IV can subject to change depending upon the Covid-19 pandemic scenario.

SEMESTER	PAPER TITLE	Credits	Theory classroom hours (L)
SEMESTER I			
PSMI 101	**EVOLUTION AND CELL BIOLOGY**	4	15
PSMI 102	**BIOMOLECULES AND BIOCHEMISTRY**	4	15
PSMI 103	**IMMUNOLOGY AND MEDICAL MICROBIOLOGY**	4	15
PSMI 104	**MOLECULAR BIOLOGY**	4	15
SEMESTER II			
PSMI 201	**MICROBIAL GENETICS**	4	15
PSMI 202	**ENVIRONMENTAL MICROBIOLOGY**	4	15
PSMI 203	**MICROBIAL BIOCHEMISTRY**	4	15
PSMI 204	**FOOD MICROBIOLOGY**	4	15

Course Code	PRACTICALS	Credits	Practical hours/week
SEMESTER I			
PSMI 101	**EVOLUTION AND CELL BIOLOGY**	2	4
PSMI 102	**BIOMOLECULES AND BIOCHEMISTRY**	2	4
PSMI 103	**IMMUNOLOGY AND MEDICAL MICROBIOLOGY**	2	4
PSMI 104	**MOLECULAR BIOLOGY**	2	4
SEMESTER II			
PSMI 201	**MICROBIAL GENETICS**	2	4
PSMI 202	**ENVIRONMNENTAL MICROBIOLOGY**	2	4
PSMI 203	**MICROBIAL BIOCHEMISTRY**	2	4
PSMI 204	**FOOD MICROBIOLOGY**	2	4

M.Sc. Microbiology Syllabus Revised for Credit Based and Grading System.
Semester-I Detailed Syllabus

Course -PSMI-101

PSMI 101	EVOLUTION AND CELL BIOLOGY	Theory classroom hours
	Module I: EVOLUTION	15L
1.1	History and development of evolutionary theories. Neo-Darwinism and its importance in prokaryote evolution.	1L
1.2	Spontaneous mutation controversy, evolution of rates Of mutation.	2L
1.3	Types and levels of selection, Neutral evolution and molecular clocks, phylogeny and molecular distances	2L
1.4	Co-evolution. Molecular evolution.	5L
1.5	Speciation in sexual and asexual organisms, origin and stability of diversity, diversity of secondary metabolites.	5L
	Module II: MEMBRANE STRUCTURE AND TRANSPORT AND INTERNAL STRUCTURE OF CELLS	15L
2.1	Cell membrane structure: Spectrins, Glycophorin,	2L
2.2	Intracellular Compartments and protein sorting: Compartmentalization of cells, transport of molecules between the nucleus and cytosol, peroxisomes, Endoplasmic reticulum.	3L
2.3	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.	5L
2.4	Cytoskeleton: Cytoskeletal filaments, Microtubules, Actin regulation, molecular motors, cell behaviour.	2L

2.5	Cell study: Study of cells under the microscope, Phase contrast, Fluorescence microscopy, Confocal microscopy. Atomic Force Microscopy and Radioisotopes as Tracers-Techniques like Pulse-Chase.	3L
	Module III: CELL CYCLE	15L
3.1	Mechanism of cell division: M-phase, Mitosis, Cytokines.	5L
3.2	Germ cells and fertilization, Meiosis, sex determination in mammals, eggs, sperm, fertilization.	5L
3.3	Cell cycle and Programmed cell death: Control system, intracellular control of cell cycle events, Apoptosis, extracellular control of cell growth and apoptosis.	5L
	Module IV : CELL COMMUNICATION AND SIGNALLING	15L
4.1	Cell Junctions, Cell Adhesion and the Extracellular Matrix: Cadherins and Cell-Cell Adhesion, Tight Junctions, Gap junctions, Basal Lamina, Integrin and Extracellular Matrix.	3L
4.2	Cell communication: Extracellular signal molecules, nitric oxide gas signal, classes of cell-surface receptor proteins.	2L
4.3	Signaling through enzyme linked cell surface receptors: Docking sites, Ras, MAP kinase, Pl-3 kinase, TGF.	5L
4.4	Signaling in plants: Serine / Threonine kinases, role of ethylene, Phytochromes.	5L

REFERENCES:

Module I

1) Ridley Mark (2004). Evolution. Blackwell Science Limited.

Module II, III and IV

2) Strickberger M.W. (2000) Evolution. Jones and Bartelette Publications.
3) Molecular Biology of The Cell – Albert, Johnson, Lewis, Raff, Roberts &Walter.
4) Molecular Cell Biology. Lodish , Birk, and Zipursky. Freeman

PRACTICALS: PSMIP101

1. Study of cell cytology using Phase contrast Microscopy- Demonstration.
2. Study of Cell structure using Confocal Microscopy- Demonstration.

3. Study of Cell structure using Fluorescence Microscopy- Demonstration.
4. Study of Cell Structure using Atomic force Microscopy-Demonstration.
5. Study of Mitosis.
6. Study of Meiosis.
7. Estimation of NO (Nitric Oxide) produced by Macrophages.
8. Study of Phagocytosis using bacterial culture / yeast cells.
9. Study of Cell membrane integrity using uptake of neutral red.
10. Cultivation of macrophage cell lines and study of cell viability.

Course II - PSMI 102

PSMI 102	BIOMOLECULES AND BIOCHEMISTRY	Theory classroom hours
	Module I BIOORGANIC MOLECULES	15L
1.1.	Amino acids: Classification. Titration curve of glycine.	2L

	Amino acid sequencing.	
1.2.	Structure and function of Proteins: Structure of peptide bond, stability of formation of peptide bond, Ramchandran plot, protein structure, factors determining secondary , tertiary: quaternary structures amino acid sequence, thermodynamics of folding, role of disulphide bonds, dynamics of globular protein folding, chaperonins motifs and domains, protein families, 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
	Module II METABOLISM OF ONE AND TWO CARBON COMPOUNDS	15L
2.1	**Metabolism of one carbon compounds:**	
	i Carbon dioxide fixation systems- The Calvin cycle	1L
	Acetyl-CoA pathway in *Clostridium thermoaceticum* and methanogens.	2L
	ii Acetogens: autotrophic pathway of acetate synthesis and CO_2 fixation	1L
	iii Methanogens: Methanogenesis form H_2, CO_2, acetate CH_3OH, HCOOH, methylamines, energy coupling and biosynthesis in methanogenic bacteria. Incorporation of acetyl-CoA into cell carbons by methanogens	2L
	Reductive TCA pathway	1L
	iv Methylotrophs: Oxidation of methane, methanol, methylamines and carbon assimilation in methylotrophic bacteria and yeasts	1L
	v Serine pathway	1L
	vi Ribulose-monophosphate cycle	1L
	Metabolism of two- carbon compounds	
2.2.	i Glyoxylate cycle, modified citric acid cycle, carbon monoxide dehydrogenase pathway	2L
	ii Ethanol- acetic acid bacteria.	1L
	iii Glyoxylate and glycollate- dicarboxylic acid cycle, glycerate pathway, beta hydroxyaspartate pathway.	1L 1L

	iv Oxalate- as carbon and energy source	
	Module III: TRANSFER OF BIOMOLECULES	15L
3.1.	Protein transport: extracellular protein secretion, drug export system	7L
3.2.	Folding of periplasmic proteins, translocation of folded proteins	
3.3	Protein Translocation Sec dependent protein Translocation: Sec system, Model for protein export. Sec independent protein translocation: Translocation of membrane bound proteins, *E. coli* SRP system, and translocation of folded proteins: TAT system. Extracellular protein secretion: type I pathway (hemolysin secretion by E. coli, type II, type III, type V, aurotransporter (type IV),Chaperone usher pathway Folding of periplasmic proteins: importance of disulphide bonds in Folding of periplasmic proteins. Role of thiol redox enzymes in catalysing the formation of disulphide bonds in the periplasm.	8L
	Module IV: SPECTROSCOPIC AND CHROMATOGRAPHIC TECHNIQUES	15L
4.1	NMR spectroscopy: Principles, Instrumentation, operation and applications.	7L
4.2	Mass spectroscopy: Principles, Instrumentation, operation and applications	
4.3	Atomic Absorption Spectroscopy: Principles, Instrumentation, operation, and applications	
4.4	Principles, Instrumentation, operation, calibration, accuracy and applications of High Performance Liquid Chromatography, Gas Chromatography ,Ion Exchange Chromatography	8L
4.5	Supercritical Liquid Chromatography: Properties of SFE/SFC, Instrumentation, operation, advantages and applications	

REFERENCES:

Module I:

1) Biochemistry 3rd edition, Mathew, Van Holde and Ahern, Pearson Education.

2) Principles of Biochemistry, 4th edition, Zubay, G., Wm.C. Brown Publishers, 1998

3) Principles of Biochemistry, Lehninger A.L., Cox and Nelson, CBS publishers and Distributors Pvt. Ltd. 1994.

Module II:

1) Microbial Biochemistry by GN Cohen- 2011, Springer

2) Biotechnology H.J. Rehm and G. Reed (ed.), Volume 6a. Biotransformations, Verlag and Chemie, 1984

3) Bacterial metabolism by Gottschalk, Springer- Verlag, 1985

Module III

1) Biochemistry, 4th edition, Voet D. and Voet J.G., John Willey and Sons Inc., 1995.

Module IV:

1) Persing, H.D. et al. 2004, Molecular Microbiology: Diagnostic principles and practice, Washington D.C., ASM press.

2) Chandler D.E. and Roberson R.W. 2009, Bioimaging: current concepts in light and electron microscopy, Singapore, Jones and Bartlett Publishers

3) Muralidharan V.S. and Subramania A. 2010, Nanoscience and Technology, New Delhi Ane Books Pvt Ltd.

PSMIP-102: PRACTICALS

1. Extraction of total lipids.
2. Isolation of cholesterol and lecithin from egg yolk.
3. Identification of fatty acids and other lipids by TLC.
4. Determination of degree of unsaturation of fats and oils.
5. Isolation of lactose from bovine milk.
6. Estimation of total sugars by phenol-sulphuric acid method.
7. Isolation of glutamic acid from gluten.
8. Estimation of polyphenols/ tannins by Folin- Denis method.
9. Enrichment, isolation and identification of *Methylobacterium*.
10. Diffusion studies of molecules across sheep RBCs.
11. Preparation of liposomes.
12. Visit to Common facility centre for Demonstration of HPLC and GC.

Course III - PSMI 103

PSMI 103	IMMUNOLOGY AND MEDICAL MICROBIOLOGY	Theory classroom hours
	Module I: ADVANCES IN MEDICAL MICROBIOLOGY	15L
1.1	Emerging and Parasitic diseases:- Detailed study of following infections including Etiology, Transmission, Pathogenesis, Clinical Manifestations, Lab Diagnosis, Prophylaxis and Treatment-	7L
	A.Dengue, Listeriosis, VRE (Vancomycin Resistant enterococci) Leptospirosis, Hepatitis non A, Chikungunya, Swine flu, conditions caused by Campylobacter. B. AIDS, MOTT (Mycobacteria other than TB), Legionellosis, Conditions caused by Helicobacter pylori, Amoebic dysentery (*Entamoeba histolytica*)	8L
	Module II: PUBLIC HEALTH AND EPIDEMIOLOGY OF INFECTIOUS DISEASES	15L
2.1	Descriptive Epidemiology-aims and uses.	
2.2	Host parasite interactions in the cause of diseases.	1L
2.3	Epidemiological principle in prevention and control of Diseases.	5L
2.4	Measures of risks : frequency measures, morbidity frequency measures, mortality frequency measures natality (birth) measures, measures of association, measures of public health impact.	6L
2.5	Public health surveillance: purpose and characteristics identifying health problems for surveillance, collecting data for surveillance, analysing and interpreting data, disseminating data and interpretation, evaluating and improving surveillance.	4L
	Module III:RECENT ADVANCES IN IMMUNOLOGY	15L
3.1	Molecular basis of diversity of immunoglobulin molecules.	2L
3.2	Multigene organization of Ig genes.	2L

3.3	Variables-Region Gene Rearrangements.	2L
3.4	Mechanism of Variable-Region DNA Rearrangements.	2L
3.5	Generation of antibody diversity.	2L
3.6	Manipulations of the immune response.	2L
3.7	Antibody genes and antibody engineering.	3L
	Module IV: IMMUNE SYSTEM AND HEALTH	15L
4.1	Recent advances in immune tolerance a) –Central Tolerance b) –Peripheral Tolerance c) –Tolerance Induction d) –T-cell Tolerance e) –B-cell Tolerance f) –Incomplete Tolerance g) –Duration of Tolerance	4L
4.2	Recent advances in autoimmunity a)–Interplaying Factors b)–Triggering Factors c)–Mechanisms of Damage d)–Organ Specific Autoimmune Diseases e)–Systemic Autoimmune Diseases f)–Animal Models for Autoimmune Diseases g)–Proposed Mechanisms for Induction of Autoimmunity h)–Treatment of Autoimmune Diseases	4L
4.3	Transplantation & Transfusion Immunology a)–Antigens Involved in Graft Rejection b)–Allorecognition c)–Graft Rejection-Role of APC's & Effector Cells d)–Graft v/s Host Diseases e)–Immunosuppressive Therapies –Blood Transfusion:-- i. ABO & Rh Blood Groups ii. Potential Transfusion Hazards iii. Transfusion Alternatives	7L
4.4	Immuno exhaustion and immunosenescence	

REFERENCES:

Module I

1. Clinics in laboratory medicine, Emerging Infections and their causative agents. September 2004vol. 24 no. 3.

2. Textbook of Microbiology 8th edition 2009-Ananthnarayan & Paniker-University press.

Module II

1. Principles of epidemiology in public health practices 3rd edition (www.cdc.gov/training/products/ss1000)
2. Basic lab methods in medical bacteriology, WHO Geniva.
3. Handbook of Epidemiology- W. Ahrens, I. Pigeot Springer- Verlag Berlin Herdelberg (2005).
4. Epidemiology for Public Health Practice- Robert H Friis & Thomas A. Sellers 3rd edition-Jones & Bartlett publishers.
5. Infectious disease surveillance by Nikuchia Nikanatha Blackwell Publishing 2005.

Module III

1. Immunology – Essential and Fundamental, Sulabha Pathak and Urmi Palan. 3rd edition Capital publishing company.
2. Immunology- Kuby 6th edition W. H. Freeman and company- New York.
3. The Elements of immunology- Fahim Halim Khan- Pearson Education.
4. Immunology an introduction- 4th edition- Ian R. Tizard-Thomson.

Module IV

1. Immunology – Essential and Fundamental, Sulabha Pathak and Urmi Palan. 3rd edition Capital publishing company.
2. Immunology- Kuby 6th edition W. H. Freeman and company- New York.
3. The Elements of immunology- Fahim Halim Khan- Pearson Education.
4. Immunobiology –the immune system in health and disease 6th ed.-Janeway.Travers.GS.

PSMIP -103: PRACTICALS

1. Problem solving exercises in medical microbiology based on diseases caused by HIV, MOTT, Chikungunya, Helicobacter.
2. SRID
3. Diagnosis for HIV

a. CD4 lymphocyte count for AIDS
b. ELISA for AIDS

4. Diagnosis for MOTT.
5. Preparation of LJ medium.
6. Wet mount of stool sample.
7. Detection of dengue by kit method.
8. Heamagglutination studies to detect swine flu.

9. Acid fast staining for MOTT.
10. Mono - Spot Test for diagnosis of Chikungunya (Demonstration expt.)
11. Case study for epidemiology of the diseases included in unit I (Theory)- students have to collect data and interpret. This can be done from Net or approaching NGOs “SEHAT”. Collection of data, criteria, methodology etc. Assignment to be submitted.

Course IV-PSMI 104

PSMI 104	MOLECULAR BIOLOGY	Theory classroom hours
	Module I: GENE EXPRESSION	15L
1.1	GENE EXPRESSION A. Transcription i. Transcription process in eukaryotes B. 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. ii. Small RNA molecules- RNA interference, types, processing & function of micro RNAs. C. Translation Mechanism of translation- charging of tRNA molecules, initiation, elongation and termination, mRNA surveillance. ii. Post translational modification of proteins	7L
1.2	Regulation of gene expression- A. Control of gene expression in prokaryotes Genes & regulatory Element. ii. Levels of gene regulation. iii. DNA binding proteins: Leucine zipper and zinc fingers, homeodomain, helix turn helix motif. iv. Antisense RNA molecules. v. Riboswitches B. Control of gene expression in eukaryotes. Regulation through modification of gene structure- DNase I hypersensitivity, histone modifications, chromatin remodelling, DNA methylation. ii. Regulation through transcriptional activators, Co-activators & repressors, enhancers and insulators. iii. Regulation through RNA processing & degradation iv. Regulation through RNA interference.	8L
	Module II: Gene regulation and Repair of DNA	15L
2.1	Recombination	4L

	A. Homologous recombination in eukaryotes B. Mating type switching C. Genetic consequences of the mechanism of Homologous recombination	3L
2.2	DNA repair mechanisms A. Types of repair mechanisms: I. Base-excision II. Direct reversal III. Nucleotide excision IV. Recombination repair V.SOS repair VI. Translation DNA synthesis B. Inherited human diseases with defects in DNA repair.	6L 2L
	Module III: CYTOPLASMIC INHERITANCE AND CHROMOSOMAL REARRANGEMENT	15L
3.1	Cytoplasmic Inheritance (Organelle Genetics) A. mt-DNA i. Mitochondrial genome structure ii. Mitochondrial DNA of Human, yeast and flowering plants iii. Mitochondrial DNA replication, transcription & translation iv. Codon usage in Mitochondria v. Damage to Mitochondrial DNA and aging. vi. Evolution of Mitochondrial DNA vii. mt DNA analysis for study of evolutionary relationships B. cp DNA i. Gene structure and organization ii. General features of replication, transcription and translation of cp DNA. iii. Human genetic diseases.	8L
3.2	Chromosomal Rearrangements and effects on gene expression C. Transpositions that alter gene i. Expression antigenic variation in Trypansomes ii. Mating type switching in yeast iii. Phase variation in *Salmonella spp.*	7L
	Module IV : MOLECULAR TOOLS FOR GENETICS AND POPULATION GENETICS	15L

4.1	Molecular tools for genetics A. Molecular tools for studying genes and gene activity B. Use of recombinant DNA technology to identify human genes (Huntington's diseases, Cystic fibrosis), molecular diagnosis of Human diseases, Gene therapy: Concept, vectors, gene targeting, tissue specific expression. E. Mapping and quantifying transcripts (S1 mapping, primer extension, run-off transcription). F. Measuring transcription rates in vivo (Nuclear run – on transcription, reporter gene transcription), Assaying DNA – protein interactions (filter binding, gel mobility shift, DNAase and DMS foot printing knockouts).	8L
4.2	Population genetics A. Population and gene pool B. Genotypic and Allelic frequencies C. Calculation of Genotypic frequencies and Allelic frequencies for autosomal and X linked loci D. Problems –calculation of alleleic and genotypic frequencies E. Hardy-Weinberg Law, genotypic frequencies at HWE. F. Implications of the H-W Law , G. H-W proportions for multiple alleles, H. X-linked alleles. I. Testing for H-W proportions and problems J. Genetic ill effects of in-breeding. K. Changes in the genetic structure of populations: i. Mutation ii. Migration and gene flow iii. Genetic drift iv. Natural selection v. Simple problems based on the natural forces	7L

REFERENCES:

Module I –

1. Genetics: A Conceptual Approach, 3rd Edition by Benjamin Pierce. **Unit II -**
1. Gene X – Lewin. Jones and Bartlett Publishers.
2. Molecular biology of the gene Vth edi. Watson.
3. Lewin, B., "Genes-IX", Jones and Bartlett Publishers.
4. Principles of Genetics, Third edition by D. Peter Snustad & Michael J. Simmons

Module III

1. Genetics: A Conceptual Approach, 3rd Edition by Benjamin Pierce.
2. Russell, P.J., "iGenetics- A Molecular Approach", Third Edition.

3. Gene X – Lewin Jones and Bartlett Publishers.

Module IV

1. Molecular Biology by R. F. Weaver.
2. Principles of Genetics, Third edition by D. Peter Snustad & Michael J. Simmons .
3. Genetics: A Conceptual Approach, 3rd Edition by Benjamin Pierce.
4. Russell, P.J., "iGenetics- A Molecular Approach", Third Edition,
5. Klug & Cummings, "Concepts of Genetics", Seventh Edition, Pearson.

PSMIP- 104: PRACTICALS

1. β galactosidase assay.
2. UV mutagenesis.
3. Acridine orange mutagenesis.
4. Isolation of mutants by Replica plate technique.
5. Penicillin enrichment technique.
6. Southern hybridization technique [Demonstration].
7. Northern Blotting technique [Demonstration].
8. Restriction mapping [Demonstration].
9. Design of primer & PCR.
10. Protein electrophoresis (Native and PAGE).
11. Problems on population genetics.

M.Sc. Microbiology Syllabus Revised for Credit Based and Grading System Semester-II Detailed Syllabus

Course I - PSMI 201

PSMI 201	MICROBIAL GENETICS	Theory classroom hours
	Module I: VIRAL GENETICS AND GENE TRANSFER	15L
1.1	Viral genetics A. Mapping the Bacteriophage genome. i. Phage phenotypes ii. Genetic recombination in phages iii. Genetic fine structure mapping iv. Deletion mapping B. Genes within genes : Bacteriophage F X174 C. Constructing phage vectors- phage display vectors, suicide vectors, combining phage vectors and transposons	8L
1.2	Gene Transfer A. Drug resistance and gene transfer in Bacteria. B. Gene exchange in bacteria. C. Mutant phenotypes in bacteria. E. Mapping	7L
1.3	Viral cell interaction: Cellular receptors and virus entry, Virus morphogenesis, mechanism Of host cell damage, cellular gene expression *E.coli* Phage T7 and Lambda: Organization of the T7 genes, Growth Cycle, Regulation of transcription of T7 phage.	
	Module II: TRANSPOSABLE GENE ELEMENTS AND GENETIC BASIS OF CANCER	15L
2.1	Transposable genetic elements A. Elements in Maize P Elements and Hybrid Dysgenesis in Drosophila Mariner, an Ancient and Widespread Transposon B Retrotransposons Retrovirus like Elements Retrotransposons	7L

	C. The Genetic and Evolutionary Significance of Transposable Elements Transposons and Genome Organization Transposons and Mutation ,Rearrangement of Immunoglobulin Genes Evolutionary Issues Concerning Transposable Elements 2.2 Genetic basis of cancer A. A Common Killer B. Cancer: A Genetics Disease The Many Forms of Cancer Cancer and the Cell Cycle A Genetics Basis for Cancer B. Oncogenes C .Tumour-Inducing Retroviruses and Viral Oncogenes Cellular Homologs of Viral Oncogenes: The Proto-oncogenes Mutant Cellular Oncogenes And Cancer Chromosome Rearrangement and Cancer D. Tumor Suppressor Genes Inherited Cancers And Knudson's Two-Hit Hypothesis Cellular Roles of Tumor Suppressor Proteins E. Genetic Pathways to Cancer. Malignant Transformation) –Oncogenes & Cancer Inducted) –Tumors of the Immune System) –Tumor Antigens F. –Tumor Evasion of the Immune system) –Cancer Immuno Therapy G. New re-emerging viruses, Evolution and adaptation, ecological factors, climate variability, human factors- social behaviour, exposure to zoonotic diseases, human movement.	8L
3.1	**Module III: DEVELOPMENTAL GENETICS** Developmental genetics A. Cloning Experiments B. The Genetics of Pattern Formation in *Drosophila.* C. Homeobox Genes in other Organisms. D. Programmed Cell Death in Development	15L 7L

3.2	The genetic control of animal development. A. Stem Cell Therapy: (Lineages) B. The Process of Development in Animals i. Oogenesis and fertilization. ii. The Embryonic Cleavage Divisions and Blastula Formation. iii. Gastrulation and Morphogenesis. C. Genetic Analysis of Development in Model Organisms. i. Drosophila as a Model Organism. ii. Caenorhabditis as a model organism. D. Genetic Analysis of Development Pathways. i. Sex Determination in Drosophila. ii. Sex Determination in *Caenorhabditis.* E. Molecular Analysis of Genes Involved in Development. F. Zygotic Gene Activity in Development. i. Body Segmentation ii. Specification of Cell types iii. Organ Formation	8L
	Module IV: PLANT AND ANIMAL VIRUSES	15L
4.1	Plant virus life cycles, Plant satellite viruses and satellite Nucleic acids.	2L 2L
4.2	Citrus Tristeza Virus (CTV), : Viral structure, Genome, Host range, Transmission, Symptom and Control. Diagnosis of viral infections in plants Viroids, -	
4.3	Pox virus; Clinical features, Structure of virus, replication, Vaccinia, orthopox virus, variola virus.	3L
4.4	Herpes Virus: Clinical signs and symptoms, varicella Zoster virus.(Life cycle,lab diagnosis and treatment)	3L
4.5	Control of viruses and emerging viruses: viral vaccine, antivirals, virus control, interferon, novel chemotherapeutic Viruses and Cancer – retrovirus, DNA tumour virus, adenovirus, HCC.	5L

REFERENCES:

Module I, II and III:

1. Principles of Genetics, Third edition by D. Peter Snustad & Michael J. Simmons
2. Fundamental Bacterial Genetics by Nancy Trun and Janine Trempy
3. Snustad and Simmons 3rd edition
4. Principles of Genetics, Third edition by D. Peter Snustad & Michael J.

Simmons
5. Genetics, Second edition by Benjamin A. Pierce
6. Principles of Genetics, Third Edition by D. Peter Snustad & Michael J. Simmons
7. Concept of Genetics, Seventh Edition by William S. Klug & Michael R. Cummings.
8. Recombinant DNA by J.D. Watson (2nd edition).
9. Russell, P.J., "iGenetics- A Molecular Approach", Third Edition,
10. Snustad & Simmons, "Principals of Genetics", Third Edition, John Wiley & Sons Inc.
11. Watson, Gilman, Witkowski, Zoller, "Recombinant DNA", Second Edition, Scientific American Books.
12. Klug & Cummings, "Concepts of Genetics", Seventh Edition, Pearson.

Module IV

1) Pierce, B.A., "Genetics- A Conceptual Approach", Second Edition, W. H. Freeman
2) Lewin, B., "Genes-IX", Jones and Bartlett Publishers
3) General Virology – Luria
4) Introduction to Plant Virology – BOS, I. Longman, London, NY.
5) Animal Virology – Fenner and White. Academic Press. NY 6) Chemistry of Viruses – Knight C. Springer Verlag. NY
7) Virology – Delbecco and Giasberg. Harper and Ravi Pub. NY.
8) Bacterial and Bacteriophage Genetics – Edward Birge
9) Microbial and Plant Protoplasts – Perberely
10) Principles of Virology – Flint, Enquist, Racaniello & Skalka, Vol I and II. ASM, 11) Understanding Viruses – Teri Shors. Jones and Bartlett pub.

PSMIP-201: PRACTICALS

1) Transformation
2) Conjugation
3) Transduction
4) Curing of plasmids.
5) Study of transposable elements.
6) Isolation of host range mutants.
7) Problems on gene transfer mechanisms.
8) Problems on viral genetics.
9) Isolation and Purification of coliphages from sewage.
10) Study of One Step Growth Curve of Lambda phage / T4Phage.
11) Assignment on Virology – Research Paper.
12) Isolation of Lysozyme from egg white.

13) Preparation of protoplast using Lysozyme.
14) Egg inoculation and cultivating animal virus in embryonated egg. Demonstration
15) Cultivation of macrophage cell lines and study of cell viability. Demonstration
16) Assignment on Animal viruses – Epidemiology, Transmission.
18) Egg inoculation and cultivating animal virus in embryonated egg. Demonstration
19) Cultivation of macrophage cell lines and study of cell viability. Demonstration

Course II-PSMI 202

PSMI 202	ENVIRONMENTAL MICROBIOLOGY	Theory classroom hours
	Module I: EXOBIOLOGY	15L
1.1	Extra-terrestrial life detection studies.	5L
1.2	Evaluation of microorganisms in space.	4L
1.3	Monitoring of astronaut microbial flora.	3L
1.4	The Martian environment: Antarctica as a model of Mars.	3L
	Module II: BIOREMEDIATION AND BIODEGRADATION	15L
2.1	Engineering and bioremediation process its needs and limitations. Molecular technique in Bioremediation	2L
2.2	Petroleum contamination, Nitroaromatic compounds.	3L
2.3	Degradation of polymers (e.g. cellulose, lignin and Lignocelluloses) and xenobiotics.	2L
2.4	Degradation of aromatic and alicyclic compounds- important organisms, use of mixed cultures common pathways of aromatic degradation, aerobic and anaerobic degradation of aromatic compounds	3L
2.5	Biotransformation of polycyclic aromatic hydrocarbons (PAHs)-Naphthalene, anthracene, hydrocarbons, halogenated aliphatics	5L
	Module III: ECOLOGY	15L
3.1	Introduction and concept of ecology	1L
3.2	Ecosystem concept and function	1L
3.3	Energy flow /food chains, food web	2L
3.4	Concept of biomes	1L
3.5	Population ecology	2L
3.6	Species diversity	2L
3.7	Competition between different species	2L
3.8	Succession & its types	2L
3.9	Behavioural ecology	2L

	Module IV :ENVIRONMENT MANAGEMENT AND SAFETY CONCERNS	15L
4.1	Solid waste management: Biodegradable waste from Kitchen, abattoirs and agricultural fields and their recycling by aerobic composting or bio-methanation. Non biodegradable waste like plastics, glass metal scrap and Building materials and plastic recycling, metal recycling	4L 3L
4.2	Hazardous waste management: Hazardous waste from paint, pesticides and chemical industries and their composition, Probable means to reduce these waste through Common Effluent Treatment Plants.	
4.3	Biomedical and electronic waste management, recovery of precious metals from electronic waste resources. Biohazards: Introduction, levels of biohazards, Risk assessment, proper cleaning procedures	2L
4.4	Biosafety: Historical background and introduction, need of biosafety levels, biosafety guidelines for GMOs and LMOs.	2L
4.5	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 labelling, IS 22000, Generally Recognized as Safe (GRAS)	

REFERENCES:

Module I:

1. Microbial Research NASA – Jayant Narlikar.
2. Space Microbiology- NCBI, NIH Journals.

Module-II

1. Principles and Applications by Ronald L. Crawford and Don L Crawford.

2. Biotechnology: B.D.Singh
3. A textbook of Biotechnology: R.C.Dubey
4. Environmental Biotechnology by Allan Scragg, 2nd ed.

Module –III

1. Fundamentals of Ecology- Eugene Odum. 2nd Edition.
2. Ecology- Global insights and investigation- Peter Stiling, 1st Edition.

Module - IV

1. Resource ecology. S. K. Agarwal
2. Environmental management. H. V. Jadhav, Vipul Prakashan , 2002
3. Environmental management. R.K. Jain and others
4. Modern trends in ecology and environment. R. S. Ambasht
5. Industrial hygiene and safety. M. H. Fulekar

PSMIP -202: PRACTICALS

1. Analysis of review and research papers in exobiology.
2. Presentation on Prof. Jayant Narlikars research.
3. Assignment on exobiology.
4. Isolation of Psychrophiles.
5. Ecology problems.
6. Enrichment and isolation of cellulose, lignin & xylanase degraders from mangrove soil.
7. 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.
8. 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.
9. Preparation/ drafting of an EIA report. Case studies: sustainable agricultural practices, coastal zone management, MEOR, management of monuments, air pollution episodes, oil spills.

Course III: PSMI 203

PSMI 203	MICROBIAL BIOCHEMISTRY	Theory classroom hours
	Module I: ENZYMOLOGY I	15L
1.1	General methods of extraction: salting out, use of organic solvents and solving of problems.	3L
1.2	Basic Enzyme terminologies, basic aspects of working of enzymes: Principles governing catalytic power and enzyme specificity, Binding energy and weak interactions and solving of problems.	3L
1.3	Mechanisms of enzyme catalysis: General acid-base, Covalent and Metal Ion catalysis and solving of problems.	2L
1.4	Role of pH on enzyme activity.	1L
1.5	Enzyme kinetics: Basic concepts of chemical kinetics, kinetics of enzyme catalysed reactions, Michaelis-Menten, Lineweaver-Burk equation derivation and plots.	3L
1.6	Kinetic parameters used to compare enzyme activities, enzymes which catalyse reactions with two or more substrates and solving of problems.	3L
	Module II:SIGNALLING AND STRESS PHYSIOLOGY	15L
2.1	Introduction to two-component signalling systems:	
2.2	Response by facultative anaerobes to anaerobiosis, nitrate and nitrite, nitrogen supply.	10L
2.3	Effect of oxygen and light on the expression of photosynthetic genes in purple photosynthetic bacteria, response to osmotic pressure and temperature, response to potassium ion and external osmolarity, response to carbon sources	
2.4	Synthesis of virulence factors in response to temperature, pH, nutrient, osmolarity and quorum sensors, chemotaxis, photoresponses, aerotaxis	

2.5	Bacterial response to environmental stress- heat-shock response, repairing damaged DNA, oxidative stress.	
2.6	Bacterial development and quorum sensing: Myxobacteria, Caulobacter, bioluminescence, systems similar to LuxR/LuxI in nonluminescent bacteria, biofilms.	5L
2.7	VBNC	
	Module III:ENZYMOLOGY II	15L
	Enzyme inhibition	
3.1	Reversible inhibition, three types and solving of problems: a)Competitive inhibition b)Uncompetitive inhibition c)Mixed inhibition	3L
3.2	Irreversible inhibition and Suicide inactivators HIV enzyme inhibitors	1L
3.3	Example of enzymatic reactions: a) Chymotrypsin b) Lysozyme	3L
3.4	Regulatory enzymes: Allosteric enzymes-mechanism and kinetic properties, reversible covalent modification and solving of problems.	4L
3.5	Enzyme action by X-ray crystallography	1L
3.6	Basic concept of Drug design and catalytic antibodies	3L
	Module IV: NANOBIOTECHNOLOGY	15L
4.1	4.1 Nanoscale systems, nanomaterials, nanoparticles, quantum dots, nanowires, nanotubes, thin films and multilayers; Properties of nanomaterials.	4L
4.2	Synthesis of nanostuctures – physical method (Physical vapour Deposition method), chemical method (colloids as nanoparticles and their synthesis) , biological and microbiological methods.	4L
4.3	Applications: a. Nano medicine -- Biosensors, --drug and gene delivery systems,	2L

	--Nano imaging, -- Cancer diagnostics and treatment. b. Nano medicine -- Biosensors, --drug and gene delivery systems, --Nano imaging, -- Cancer diagnostics and treatment c. Nano medicine -- Biosensors, --drug and gene delivery systems, --Nano imaging, -- Cancer diagnostics and treatment. d. Nanotechnology and environment -- Environmental pollution and of nanotechnology -- Effect of nanotechnology on human Health c. Agriculture and food	
4.4	Scanning Probe Microscopes - scanning tunnelling microscope (STM),atomic force microscope (AFM), magnetic force microscope (MFM), scanning near field microscope (SNOM) Photoluminescence Spectroscopy: X-ray and UV photoelectron Spectroscopies (XPS)/Auger electron spectroscopy.	5L

References

Module I

1) Biochemistry 3rd edition, Mathew, Van Holde and Ahern, Pearson Education
2) Principles of Biochemistry, 4th edition, Zubey
3) Principles of Biochemistry, Horton and Moran, Scrimgeour Pears Rawn
4) Principles of Biochemistry, Lehninger A.L., Cox and Nelson, CBS publishers and

Module II

1) Principles of Biochemistry, Lehninger A.L., Cox and Nelson, CBS publishers and Distributors Pvt. Ltd. 1994
2) Biochemistry by Conn and Stumph

Module III

1) The physiology and biochemistry of prokaryotes , White D., Oxford University Press, 2000

2) Biotechnology H.J. Rehm and G. Reed (ed.), Volume 6a. Biotransformations, Verlag and Chemie, 1984
3) Introduction to bacterial metabolism Doelle H.W., Academic Press, 1975
4) Microbial ecology, Atlas RM and Bartha, Addison Wesley Longman Inc. 1998.

Module IV

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, 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.

PSMIP-203: PRACTICALS

1) Purification of an extracellular enzyme(ß- amylase) by salting out and dialysis.
2) Enzyme kinetics-effect of enzyme concentration, substrate concentration, pH temperature and inhibitors on enzyme activity.
3) Demonstration of proteolytic activity.
4) Determination of glucose isomerase present intracellularly in Bacillus sp.
5) Chemotaxis of *Pseudomonas*.
6) Effect of temperature and water activity on swarming of Proteus
7) Different bacteriolytic response associated with addition of lysozyme and salt.
8) Microbial degradation of polycyclic aromatic hydrocarbons (PAHs) enrichment, isolation and screening of bacteria.
9) PAH degradation studies.
10) Plasmid curing and determination of chemotaxis by drop assay method
11) Preparation of Nanosilver By Wet reduction Method (Chemical), using Neem Extract(plants) & Bacteria(Microbiological).
12) Characterisation of Nanosilver by UV spectrometry and microscopic methods.
13) Antimicrobial effect of Ionic silver and Nanosilver prepared by above methods.
14) Study of Nanosilver coated Gauze/textiles for antimicrobial effect on different bacteria.

PAPER IV-PSMI 204

PSMI 204	FOOD MICROBIOLOGY	Theory classroom hours
	Module I: GOOD MANUFACTURING PRACTICES	15L
1.1	Principles –Application and Definitions	1L
1.2	The concept of Quality and regulatory factors in Pharma	2L
1.3	QA,QC and GMP	2L
1.4	Quality assurance beyond GMP,	2L
1.5	Quality control and GCLP	2L
1.6	QC using microbiological control in food a) Control at source b) Codes of GMP c) HACCP d) Laboratory accreditation	6L
	Module II: DETECTION AND CONTROL OF MICROBES IN FOOD	15L
2.1	Control by physical removal, heat, low temperature, Reduced aw, low pH and organic acids, modified atmosphere, antimicrobial preservatives, irradiation, canning, Control to access of microorganism	5L
2.2	Conventional methods of detection of Microbes a) Bacterial toxins b) Fungal toxins c) Rapid methods d) Biosensors	5L
2.3	Novel emerging techniques of food preservation	3L
2.4	Control by combination of methods (Hurdle concept)	3L
	Module III: ADVANCES IN FOOD MICROBIOLOGY	15L
3.1	Sampling sample processing approaches for analysis of foods implicated in outbreaks with measurement of uncertainty for mycotoxic fungi, pathogenic bacteria (Entero pathogenic *E.coli,*	5L

	Vibrio spp., Salmonella spp.) and viruses (Hepatitis A, Norwalk) in meat/fish products as per BIS/ISO/APHA standards.	
3.2	Use of enzymatic / thermal techniques for food analysis	2L
3.3	Food additives and ingredients: Food additives – definitions, classification and functions (antioxidant, colours, emulsifiers, sequesterants, natural and microbial flavours)	1L
3.4	Applications of fibres from food sources, microbial fructoligosaccharides.	2L
3.5	Nutraceuticals and health foods: Introduction to nutraceuticals - Definitions, basis of claims for a compound as a nutraceuticals, regulatory issues for nutraceuticals Microbes and production of nutraceuticals like lycopene, isoflavonoids, prebiotics and probiotics, glucosamine, phytosterols. Formulation of functional foods containing neutraceuticals – stability and analytical issues, labelling issues.	4L
	Module IV :QUALITY CONTROL OF FOOD AND WATER	15L
4.1	Controlling the Microbiological quality of food	2L
4.2	Drinking water risk assessment and its safety: bottled water – legislation, types of bottled water. BIS regulations regarding the production of bottled water w.r.t final quality of the product. Potential chemical and microbiological hazards in the bottles depending on the type of water, the type of bottle and the bottling procedure. The application of HACCP in the bottling plants: Water quality attained from point of use water purifier units, types of water purifiers.	8L
4.3	Microbiological specification and methods used to certify water purifiers, international standards regulating quality of water purifiers.	5L

REFERENCES

Module I

1. Bibek Ray and Arun Bhunia (2008) Fundamental Food Microbiology 4th Ed. CRC Press.
2. Srilakshami B (2010) Food Science. 5th Ed. New Age International Publishers.
3. James Jay, M Loessner and D Golden (2005) Modern Food Microbiology 7th Ed.

4. Adams M R and Moss M O (2008) Food Microbiology 3rd Ed. RSC Publishing.
5. J Maud Kordylas (1991) Processing and Preservation of tropical and subtropical foods. ELBS Macmillan.
6. Gerald Reed (2004) Prescott and Dunn's Industrial Microbiology 4th Ed. CBS Publishers.

Module II

1. Adams M R and Moss M O (2008) Food Microbiology 3rd Ed. RSC Publishing.
2. Aylward F (2001) Food Technology Processing and Laboratory Control. Agrobios (India)
3. Bibek Ray and Arun Bhunia (2008) Fundamental Food Micro
4. Harrigan W F and McCance M F (1976) Laboratory methods in food and dairy microbiology. Academic Press.
5. N Shakuntala Manay and Shadaksharaswamy M (1985) Foods facts and Principles. New Age International.

Module III

1. AOAC International. 2003. Official methods of analysis of AOAC International. 17th Ed. Gaithersburg, MD, USA, Association of Analytical Communities.
2. Kirk RS & Sawyer R. 1991. Pearson's Chemical Analysis of Foods. 9th Ed. Longman Scientific & Technical.
3. Leo ML. 2004. Handbook of Food Analysis. 2nd Ed. Vols. I-III.
4. Linden G. 1996. Analytical Techniques for Foods and Agricultural Products. VCH.
5. Macleod AJ. 1973. Instrumental Methods of Food Analysis. Elek Sci.Marcel Dekker
6. Nielsen S. (Eds.). 1994. Introduction to Chemical Analysis of Foods. Jones & Bartlett.

Module IV

1. Bibek Ray and Arun Bhunia (2008) Fundamental Food icrobiology 4 Press.
2. N Shakuntala Manay and Shadaksharaswamy M (1985) Foods Facts and Principles. New Age International
3. AOAC International. 2003. Official methods of analysis of AOAC International. 17th Ed. Gaithersburg, MD, USA, Association of Analytical Communities.
4. Leo ML. 2004. Handbook of Food Analysis. 2nd Ed. Vols. I-III.

PSMIP-204: PRACTICALS

1 Microbiological study of fermented foods (Idli batter and sauerkraut
2 Microbiological load in carrot and apple juice, salad, mayonese.
3 Quality Assessment and Analysis of food : i) Milk (Raw, Packed) ii) Ice- Cream iii)Yoghurt
4. Report to be written in journal on Novel detection methods for food borne pathogens/ toxins.
5. Estimation of anti-oxidants and anti-nutritional factors (tannin/phytic acid) by spectrometric method.

6. Microbiological analysis of fish samples wrt sample processing for recovery and detection of Enteropathogenic *E.coli, Vibrio ,Salmonellae* as per BIS/ISO/APHA standards and computation of measure of uncertainty
7. Assessment of point of use water purifiers (Zero B) for removal of bacteria.
8. Visit to a dairy plant or food industry - Report to be written in journal