



**Janardan Bhagat Shikshan Prasarak Sanstha's**

**CHANGU KANA THAKUR  
ARTS, COMMERCE & SCIENCE COLLEGE, NEW  
PANVEL (AUTONOMOUS)**

**Re-accredited 'A<sup>+</sup>' Grade by NAAC  
'College with Potential for Excellence' Status Awarded by UGC  
'Best College Award' by University of Mumbai**

**Program: M. Sc. I**

**Revised Syllabus of M. Sc. I Microbiology  
Choice Based Semester Grading System (60:40)  
w.e.f. Academic Year 2019-20**

**Choice Based Semester Grading System (CBSGS)**

**M. Sc. I Microbiology Syllabus**

<b>Sr. No.</b>	<b>Heading</b>	<b>Particulars</b>
<b>1</b>	Title of Course	M.Sc.I
<b>2</b>	Course Code for Theory and Practical Semester I	PSC1MI1, PSC1MI2, PSC1MI3, PSC1MI4, PSC1MIPR1
<b>3</b>	Course Code for Theory and Practical Semester II	PSC2MI1, PSC2MI2, PSC2MI3, PSC2MI4, PSC2MIPR2
<b>3</b>	Eligibility for Admission	B. Sc. Microbiology of all recognised Boards
<b>4</b>	Passing marks	40%
<b>5</b>	Ordinances/Regulations (if any)	-
<b>6</b>	No. of Semesters	Two
<b>7</b>	Level	P. G.
<b>8</b>	Pattern	Semester (60:40)
<b>9</b>	Status	Revised
<b>10</b>	To be implemented from Academic year	2019-2020

### **Preamble of the Syllabus**

With the introduction of Autonomy in the Credit Based Semester and Grading system, the syllabus in Microbiology has been revised for M.Sc. Semester -I and Semester- II. This syllabus is implemented with effect from 2019-20. The revised syllabus has been approved by the concerned authorities of the Autonomous College, Committees formed by the college, BOS members and Head/ senior teachers from Department of Microbiology. MSc Microbiology Programme is of two years with two parts Part I and Part II. Each part has two semesters. Each semester will have four theory papers of 60 Marks and practical paper based on theory paper of 200 Marks. The syllabus has been designed in such a theory is related with the practicals thus enabling students to develop professional skillsets of a Microbiologist. The topics included will give hands on practice of microbiology experiments. Each paper has been designed emphasizing the need to develop research skills and Critical thinking/reasoning in the students. This will aid the students in their specific area of their interest/ specialization in particular. Syllabus covers various topics enlisted for entrance exams i.e. CSIR NET, SET, GATE, PET & entrance tests for other Research Institutes. This revised syllabus is aimed at equipping students with theoretical foundations and practical techniques required in R & D, quality control, regulatory function in pharmaceuticals, environmental sciences, Pharmaceutical Microbiology, Advances in Molecular Biology, Applied & Environmental Microbiology and Applied and Environmental monitoring and management. Areas covered in Semester I & Semester II will boost employability of students. As mentioned in the syllabus, all the courses of theory & practicals are compulsory to M.Sc microbiology.

**Objectives of the Course**

- To help the learners understand the depth of microbiology
- To help them succeed in competitive examination (NET, SET)
- To help them opt job and develop career in the field of microbiology

**Course Outcome: By the end of the course:**

- The learners will have hands training of various microbiology techniques which will be helpful for them to opt job in industries and research related to microbiology.
- The theory syllabus is related to various competitive examination like CSIR NET, SET, GATE, PET and it will be helpful for them to acquaint with these examination
- Learners will gain knowledge about virology, tissue culture techniques, cancer immunology, advance techniques in diagnostics, emerging infections, pathways of biochemistry

**M. Sc. I Microbiology**

For the subject of Microbiology there shall be four papers for 60 lectures each comprising of four units of 15 L each.

<b>Semester-I</b>	
Paper-I	Cell Biology
Paper- II	Microbial Genetics
Paper- III	Microbial Biochemistry
Paper- IV	Medical Microbiology & Immunology
<b>Semester-II</b>	
Paper-I	Virology
Paper- II	Microbial Genetics
Paper- III	Microbial Biochemistry
Paper- IV	Medical Microbiology & Immunology

**Scheme of Examination for Each Semester**

**Faculty of Science  
(Microbiology)**

❖ **Scheme of Examination**

The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment with 40% marks in the first part and by conducting the Semester End Examinations with 60% marks in the second part. The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below-

**A) Internal Assessment: 40 % 40 Marks**

Sr. No.	Particular	Marks
01	One periodical class test / online examination to be conducted in the given semester	20 Marks
02	One case study /review / project with presentation based on curriculum to be assessed by the teacher concerned	15 Marks
	Presentation	10 Marks
	Written Document	05 Marks
03	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	05 Marks

***Question Paper Pattern***

***(Periodical Class Test for the Courses at Post Graduate Programmes)***

Maximum Marks: 20 Duration: 40 Minutes

Questions to be set: 02

All Questions are Compulsory

Question No.	Particular	Marks
Q-1	Match the Column / Fill in the Blanks / Multiple Choice Questions/ Answer in One or Two Lines (Concept based Questions) ( 1 Marks / 2 Marks each)	10 Marks
Q-2	Answer in Brief (Attempt any Two of the Three) (5 Marks each)	10 Marks

**B) Semester End Examination: 60 % 60 Marks**

- Duration: The examination shall be of  $2\frac{1}{2}$  hours duration.

**Question Paper Pattern**

Theory question paper pattern
<ol style="list-style-type: none"> <li>1. There shall be five questions each of 12 marks.</li> <li>2. Question 1, 2, 3,4 will be subjective and based on Unit 1, 2, 3, 4 respectively</li> <li>3. Question 5 will be objective and based on all 4 units</li> <li>4. All questions shall be compulsory with internal options.</li> <li>5. Question may be subdivided into sub-questions a, b, c... and the allocation of marks depends on the weightage of the unit.</li> </ol>

**❖ Passing Standard**

The learners shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment and Semester End Examination. The learners shall obtain minimum of 40% marks (i.e. 16 out of 40) in the Internal Assessment and 40% marks in Semester End Examination (i.e. 24 Out of 60) separately, to pass the course and minimum of grade D in each project wherever applicable to pass a particular semester.

**Practical**

<b>The External examination per practical course will be conducted as per the Following scheme</b>			
<b>Sr.No.</b>	<b>Particulars</b>	<b>Marks</b>	<b>Total</b>
1.	<b>Laboratory work (Each Paper)</b>		
	<b>Major</b>	<b>20/30</b>	<b>120</b>
	<b>Minor</b>	<b>10</b>	
2.	<b>Journal (Each Paper)</b>	<b>05</b>	<b>20</b>
3.	<b>Viva (Each Paper)</b>	<b>05</b>	<b>20</b>
4.	<b>Virtual problem/Quiz (Each Paper)</b>	<b>10</b>	<b>40</b>
<b>TOTAL</b>			<b>200 Marks</b>

**Choice Based Semester Grading System (CBSGS)**

**M. Sc. I Microbiology Syllabus**

**To be implemented from the Academic year 2019-20**

**Semester I**

<b>Course Code</b>	<b>UNIT</b>	<b>TOPIC HEADINGS</b>	<b>Credits</b>	<b>L / Week</b>
<b>PSC1MI-1 Cell Biology</b>	<b>I</b>	<b>Cell Biology (Membrane Structure &amp; Transport)</b>	<b>4</b>	<b>01</b>
	<b>II</b>	<b>Cell Biology (Respiratory &amp; Photosynthetic Organelle)</b>		<b>01</b>
	<b>III</b>	<b>Cell Biology (Cell division and Cell cycle)</b>		<b>01</b>
	<b>IV</b>	<b>Cell Biology (Cell Communication)</b>		<b>01</b>

<b>PSC1MI-2 Microbial Genetics</b>	<b>I</b>	<b>Gene expression and regulation</b>	<b>4</b>	<b>01</b>
	<b>II</b>	<b>Replication, recombination, mutation and repair</b>		<b>01</b>
	<b>III</b>	<b>Cytoplasmic Inheritance &amp; Chromosomal Rearrangements</b>		<b>01</b>
	<b>IV</b>	<b>Molecular tools for genetics, Population genetics</b>		<b>01</b>

<b>PSC1MI-3 Microbial Biochemistry</b>	<b>I</b>	<b>Aqueous Solutions and Acid – Base Chemistry</b>	<b>4</b>	<b>01</b>
	<b>II</b>	<b>Bioorganic Molecules</b>		<b>01</b>
	<b>III</b>	<b>Metabolism of one &amp; two carbon compounds</b>		<b>01</b>
	<b>IV</b>	<b>Transfer of biomolecules</b>		<b>01</b>

<b>PSC1MI-4 Medical Microbiology &amp; Immunology</b>	<b>I</b>	<b>Advances in Medical Microbiology: Part I</b>	<b>4</b>	<b>01</b>
	<b>II</b>	<b>Epidemiology of infectious diseases</b>		<b>01</b>
	<b>III</b>	<b>Immune System and Health : Part I</b>		<b>01</b>
	<b>IV</b>	<b>Recent advances in Immunology: Immunobiology</b>		<b>01</b>

<b>PSC1MIPR-1</b>	<b>Cell Biology and Virology</b>	<b>2</b>	<b>04</b>
<b>PSC1MIPR -2</b>	<b>Microbial Genetics</b>	<b>2</b>	<b>04</b>
<b>PSC1MIPR -3</b>	<b>Microbial Biochemistry</b>	<b>2</b>	<b>04</b>
<b>PSC1MIPR -4</b>	<b>Medical Microbiology &amp; Immunology</b>	<b>2</b>	<b>04</b>

**Semester II**

<b>Course Code</b>	<b>UNIT</b>	<b>TOPIC HEADINGS</b>	<b>Credits</b>	<b>L / Week</b>
<b>PSC2MI-1 Virology</b>	<b>I</b>	<b>Virology(Animal Viruses)</b>	<b>4</b>	<b>01</b>
	<b>II</b>	<b>Virology in relation to human health</b>		<b>01</b>
	<b>III</b>	<b>Virology(Bacterial Viruses)</b>		<b>01</b>
	<b>IV</b>	<b>Virology(Plant Viruses)</b>		<b>01</b>

<b>PSC2MI-2 Microbial Genetics</b>	<b>I</b>	<b>Viral Genetics, Gene transfer</b>	<b>4</b>	<b>01</b>
	<b>II</b>	<b>Transposable Genetic Elements, Genetic basis of Cancer.</b>		<b>01</b>
	<b>III</b>	<b>Developmental Genetics</b>		<b>01</b>
	<b>IV</b>	<b>Applications and Ethics of Genetic Technology</b>		<b>01</b>

<b>PSC2MI-3</b> <b>Microbial</b> <b>Biochemistry</b>	<b>I</b>	<b>Analytical Biochemistry</b>	<b>4</b>	<b>01</b>
	<b>II</b>	<b>Enzymology</b>		<b>01</b>
	<b>III</b>	<b>Signalling and stress</b>		<b>01</b>
	<b>IV</b>	<b>Microbial degradation</b>		<b>01</b>

<b>PSC2MI-4</b> <b>Medical</b> <b>Microbiology</b> <b>&amp;</b> <b>Immunology</b>	<b>I</b>	<b>Advances in Medical</b> <b>Microbiology: Part II</b>	<b>4</b>	<b>01</b>
	<b>II</b>	<b>Clinical Research and Modern</b> <b>diagnostics</b>		<b>01</b>
	<b>III</b>	<b>Immune system and Health :</b> <b>Part II</b>		<b>01</b>
	<b>IV</b>	<b>Challenges in Immune System</b>		<b>01</b>

<b>PSC2MIPR-1</b>	<b>Cell Biology and Virology</b>	<b>2</b>	<b>04</b>
<b>PSC2MIPR-2</b>	<b>Microbial Genetics</b>	<b>2</b>	<b>04</b>
<b>PSC2MIPR-3</b>	<b>Microbial Biochemistry</b>	<b>2</b>	<b>04</b>
<b>PSC2MIPR-4</b>	<b>Medical Microbiology &amp; Immunology</b>	<b>2</b>	<b>04</b>

M. Sc. (Semester – I & Semester - II)

Microbiology Syllabus Revised According To Credit Based Semester Grading System to be implemented from the Academic year 2019-2020

Semester I Syllabus

PSC1MI-1 (Cell Biology)

No. of Lectures :60 Credits:04

PSC1MI-1		
<b>Unit I</b>		
<b>CELL BIOLOGY(Membrane structure and transport)</b>		
<b>1.1 Cell membrane structure : Lipid bilayer, membrane proteins, Spectrins, Glycophorin, Multipass membrane proteins</b>		
<b>Bacteriorhodopsin</b>		<b>(4L)</b>
<b>1.2 Membrane Transport : Principles of membrane transport, ion channels and electrical properties of membranes.</b>		<b>(3L)</b>
<b>1.3 Intracellular Compartments and protein sorting:</b>		
<b>Compartmentalization of cells, transport of molecules between the nucleus and cytosol, peroxisomes, Endoplasmic reticulum, transport of proteins into mitochondria and chloroplasts</b>		<b>( 5L)</b>
<b>1.4 Intracellular vesicular traffic : Endocytosis, exocytosis, transport from the ER through the Golgi apparatus</b>		<b>(3L)</b>

<p><b>Unit : II</b> (15L)</p> <p><b>CELL BIOLOGY(Respiratory &amp; Photosynthetic organelle)</b></p> <p><b>2.1 Mitochondria : Structure, Golgi apparatus, Peroxisomes Structure (3L)</b></p> <p><b>2.2 Chloroplasts : Structure, energy capture from sunlight, genetic system (3L)</b></p> <p><b>2.3 Cytoskeleton: Cytoskeletal filaments, Microtubules, Actin regulation, molecular motors, cell behavior. (5L)</b></p> <p><b>2.4 Cell study : Study of cells under the microscope, Phase contrast, Fluorescence microscopy , Confocal microscopy &amp; electron microscopy.(4 L)</b></p>	<p><b>01</b></p>
<p><b>Unit : III</b> (15L)</p> <p><b>CELL BIOLOGY(Cell division &amp; Cell Cycle)</b></p> <p><b>3.1 Mechanism of cell division : M-phase, Mitosis, Cytokines (3L)</b></p> <p><b>3.2 Cell cycle and Programmed cell death : Control system, intracellular control of cell cycle events, Apoptosis, extracellular control of cell growth and apoptosis (5L)</b></p> <p><b>3.3 Cell Junctions and cell adhesion : Anchoring, adherence junctions, Desmosomes, Gap junctions, cell-cell adhesion, Cadherins (3L)</b></p> <p><b>3.4 Development of multicellular organisms: Animal cell development, <i>Caenorhabditis elegans</i>, <i>Drosophila</i> signaling genes, gradient of nuclear gene regulatory protein, Dpp and Sog set up, Neural development (4L)</b></p>	

<p><b>Unit : IV      CELL BIOLOGY(Cell Communication) (15L)</b></p> <p><b>4.1 Germ cells and fertilization, Meiosis, sex determination in mammals, eggs, sperm, fertilization      (4L)</b></p> <p><b>4.2 Cell communication : Extracellular signal molecules, nitric oxide gas signal, classes of cell-surface receptor proteins (5L)</b></p> <p><b>4.3 Signaling through enzyme linked cell surface receptors : Docking sites, Ras , MAP kinase, PI-3 kinase, TGF      (3L)</b></p> <p><b>4.4 Signaling in plants : Serine / Threonine kinases, role of ethylene, Phytochromes      (3L)</b></p>	
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**SEMESTER I**

**PRACTICALS : PSC1MIPR-1 (60 Contact Hrs)**

- 1) Isolation and Purification of coliphages from sewage
- 2) Phage Typing of *E. coli* and *Salmonella* strains
- 3) Study of One Step Growth Curve of Lambda phage / T4 Phage
- 4) Study of Lysogeny in *E. coli*
- 5) Assignment on Virology – Research Paper
- 6) Isolation of Lysozyme from egg white
- 7) Preparation of protoplast using Lysozyme.
- 8) Writing a Research proposal.
- 9) Study of cell cytology using Phase contrast Microscopy. Demonstration
- 10) Study of Cell structure using Confocal Microscopy. Demonstration
- 11) Study of Cell structure using Fluorescence Microscopy. Demonstration
- 12) Isolation of Chloroplasts.
- 13) Isolation of Mitochondria from the cell.

**REFERENCES:**

- 1) **Molecular Biology of the Cell – Albert, Johnson, Lewis, Raff, Roberts &Walter.**
- 2) **Molecular Cell Biology. Lodish, Birk, and Zipursky. Freeman**
- 3) **The Structure and Dynamics of Cell Membrane. – Lipowsky and Sackmann. Elsevier.**
- 4) **Cell Movements: from Molecules to Motility- Bray Garland Pub. NY.**

PSC1MI-2

Course Code	Title	Credits
PSC1MI-2	Microbial Genetics (60L)	04
<b>Unit I:</b> <b>1.1 Gene Expression [05L] (15L)</b>  <b>A. Concept of Gene (allele, Multiple alleles), Mendelian genetics (principle, co-dominance, incomplete dominance)</b>  <b>B. Transcription-</b> <ul style="list-style-type: none"> <li>i. Transcription process in prokaryotes</li> <li>ii. Transcription process in eukaryotes</li> </ul> <b>C. RNA molecules and processing-</b> <ul style="list-style-type: none"> <li>iii. Post transcriptional processing- structure of mRNA, pre-mRNA processing, addition of 5' cap, addition of Poly(A) tail, RNA splicing, RNA editing.</li> <li>iv. Small RNA molecules- RNA interference, types, processing &amp; function of microRNAs.</li> </ul> <b>1.2 Regulation of gene expression- [10L]</b>  <b>A. Control of gene expression in prokaryotes-</b> <ul style="list-style-type: none"> <li>i. Genes &amp; regulatory element</li> <li>ii. Levels of gene regulation</li> <li>iii. DNA binding proteins</li> <li>iv. Antisense RNA molecules</li> <li>v. Riboswitches</li> </ul> <b>B. Control of gene expression in eukaryotes-</b> <ul style="list-style-type: none"> <li>i. Regulation through modification of gene structure- Dnase I hypersensitivity, histone modifications, chromatin remodeling, DNA methylation.</li> <li>ii. Regulation through transcriptional activators, Co-</li> </ul>		01

<p>activators &amp; repressors, enhancers and insulators</p> <p>iii. Regulation through RNA processing &amp; degradation</p> <p>iv Regulation through RNA interference</p>	
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<p><b>C.Types of repair mechanisms</b></p> <p>i.Direct repair,</p> <p>ii. Light dependent repair,</p> <p>iii. Excision repair in E. coli and mammalian cells,</p> <p>iv. Mismatch repair, controlling the direction of mismatch repair,</p> <p>v. Base flipping by methylases and glycosylases,</p> <p>vi. Recombination repair in E. coli, recombination as a mechanism to recover from replication errors,</p> <p>vii. SOS repair,</p> <p>viii. Conserved repair systems in eukaryotic cells,</p> <p>ix. Non-homologous end joining (NHEJ) pathway for repairing double stranded breaks</p> <p><b>B. Inherited human diseases with defects in DNA repair</b></p>	
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<p><b>Unit II: Replication, recombination, mutation and repair</b> (15L)</p> <p><b>2.1 Regulation of replication [3L]</b></p> <p><b>A. Bacterial replication and cell cycle</b></p> <p><b>2.2 Recombination [6L]</b></p> <p><b>A. Models for homologous recombination</b></p> <p><b>B. Homologous recombination protein machines</b></p> <p><b>C. Homologous recombination in eukaryotes</b></p> <p><b>D. Mating type switching</b></p> <p><b>E. Genetic consequences of the mechanism of Homologous recombination</b></p> <p><b>2.3 Mutation [3L]</b></p> <p><b>A. Mutation: Basic features of the process</b></p> <p><b>B. Mutations:</b></p> <p><b>i. Phenotypic effects</b></p> <p><b>ii. Mutations in humans and their effects</b></p> <p><b>iii. Conditional lethal mutations</b></p> <p><b>C. Molecular basis of mutation (Types, mutations induced by chemicals, radiation and transposable genetic elements; expanding trinucleotide repeats and inherited human diseases)</b></p> <p><b>D. Screening chemicals for mutagenicity (Ame's test)</b></p> <p><b>2.4 DNA repair mechanisms [3L]</b></p>	<p><b>01</b></p>
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<p><b>C.Types of repair mechanisms</b></p> <ul style="list-style-type: none"> <li><b>i. Direct repair,</b></li> <li><b>ii. Light dependent repair,</b></li> <li><b>iii. Excision repair in E. coli and mammalian cells,</b></li> <li><b>iv. Mismatch repair, controlling the direction of mismatch repair,</b></li> <li><b>v. Base flipping by methylases and glycosylases,</b></li> <li><b>vi. Recombination repair in E. coli, recombination as a mechanism to recover from replication errors,</b></li> <li><b>vii. SOS repair,</b></li> <li><b>viii. Conserved repair systems in eukaryotic cells,</b></li> <li><b>ix. Non-homologous end joining (NHEJ) pathway for repairing double stranded breaks</b></li> </ul> <p><b>B. Inherited human diseases with defects in DNA repair</b></p>	
<p><b>Unit III: Cytoplasmic Inheritance &amp; Chromosomal Rearrangements (15L)</b></p> <p><b>3.1 Cytoplasmic Inheritance (Organellar Genetics) [10L]</b></p> <p><b>A. mt-DNA</b></p> <ul style="list-style-type: none"> <li><b>i. Mitochondrial genome structure</b></li> <li><b>ii. Ancestral and derived mitochondrial genome</b></li> <li><b>iii. Mitochondrial DNA of Human, yeast and flowering plants</b></li> <li><b>iv. Endosymbiotic theory</b></li> <li><b>v. Mitochondrial DNA replication, transcription &amp; translation</b></li> <li><b>vi. Codon usage in Mitochondria</b></li> <li><b>vii. Damage to Mitochondrial DNA and aging.</b></li> <li><b>viii. Evolution of Mitochondrial DNA</b></li> <li><b>ix. mt DNA analysis for study of evolutionary relationships</b></li> </ul>	<p><b>01</b></p>

<p><b>B. cp DNA</b></p> <ul style="list-style-type: none"><li><b>i. Gene structure and organization</b></li><li><b>ii. General features of replication, transcription and translation of cpDNA</b></li><li><b>iii. Comparison of nuclear, eukaryotic, eubacterial mitochondrial and chloroplast DNA</b></li><li><b>iv. Examples of extra nuclear inheritance-</b></li><li><b>v. Leaf Variegation,</b></li><li><b>vi. Poky mutant of Neurospora,</b></li><li><b>vii. Yeast petite mutant,</b></li><li><b>viii. Human genetic diseases</b></li><li><b>ix. Maps of mt DNA and cp DNA</b></li></ul> <p><b>3.2 Chromosomal Rearrangements and effects on gene expression [5L]</b></p> <ul style="list-style-type: none"><li><b>A. Amplification and deletion of genes</b></li><li><b>B. Inversions that alter gene expression</b></li><li><b>C. Transpositions that alter gene</b><ul style="list-style-type: none"><li><b>i. Expression antigenic variation in Trypanosomes</b></li><li><b>ii. Mating type switching in yeast</b></li><li><b>iii. Phase variation in Salmonella</b></li></ul></li></ul>	
<p><b>Unit IV: Molecular tools for genetics, Population genetics (15L)</b></p>	

**4.1 Molecular tools for genetics [9L]**

- 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, human gene therapy)**
- C. Labeled tracers (autoradiography, phosphorimaging, liquid scintillation counting, non-radioactive tracers)**
- D. Nucleic acid hybridization (Southern blots, DNA fingerprinting & DNA typing with their forensic applications, Northern blots, in situ hybridization), DNA sequencing (Sanger's chain termination method, Maxam Gilbert's sequencing), Restriction mapping, Site directed mutagenesis**
- 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 footprinting, knockouts)**

**4.2 Population genetics [6L]**

- 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 allelic 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**

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<p><b>I. Testing for H-W proportions and problems</b></p> <p><b>J. Genetic ill effects of in-breeding</b></p> <p><b>K. Changes in the genetic structure of populations:</b></p> <ul style="list-style-type: none"><li><b>i. Mutation,</b></li><li><b>ii. Migration and gene flow,</b></li><li><b>iii. Genetic drift,</b></li><li><b>iv. Natural selection</b></li><li><b>v. Simple problems based on the natural forces</b></li></ul> <p><b>L. Measuring genetic variation :</b></p> <ul style="list-style-type: none"><li><b>i. RFLP, DNA sequencing</b></li><li><b>ii. Protein electrophoresis</b></li></ul>	
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**PRACTICALS : PSC1MIPR-2 (60 Contact Hrs)**

**List of practicals for Semester I**

- 1.  $\beta$  galactosidase assay**
- 2. UV mutagenesis**
- 3. Acridine orange mutagenesis**
- 4. Isolation of mutants by Replica plate technique**
- 5. Penicillin enrichment technique**
- 6. Ames test**
- 7. Southern hybridization technique [Demonstration]**
- 8. Northern Blotting technique [Demonstration]**
- 9. Restriction mapping**
- 10. Design of primer & PCR**
- 11. Protein electrophoresis**
- 12. Problems on population genetics**

**References:**

**Unit I –**

**Genetics: A Conceptual Approach, 3<sup>rd</sup> Edition by Benjamin Pierce [pg 353-362, 373-380, 386-387, 407- 417, 427-428, 445-447 , - 454-46**

**Unit II -**

**i. Gene X – Lewin [pg. 409-424]**

**ii. Molecular biology of the gene Vth edi. Watson [pg 259-292]**

**iii. Snustad**

**iv. Gene IX- Lewin.[pg. 256-293, 300-325, 331, 609-667]**

**Unit III**

**Unit III –**

**i. Genetics: A Conceptual Approach, 3<sup>rd</sup> Edition by Benjamin Pierce [pg. 579, 584-588, 593-595]**

**ii. iGenetics- Russel [pg. 681-704, 216,217, 169,170]**

**iii. Gene X – Lewin [pg. 488-491]**

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**Unit IV**

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**i. Molecular Biology by R. F. Weaver (chapter 5) 96-133**

**I**

**vii. Snustad [pg. 548-559]**

**- iii. Pierce [Chapter 25]**

**iv. Russel [Chapter 22] v.Klug [pg 639-650]**

**LIST OF REFERENCES FOR MICROBIAL  
GENETICS.**

1. Watson, Baker, Bell, Gann, Levine, Losick, "**Molecular Biology of the Gene**", Fifth Edition, Pearson Education (LPE)
2. Trun, Trempy, "**Fundamental Bacterial Genetics**", Blackwell Publishing
3. Russell, P.J., "**iGenetics- A Molecular Approach**", Third Edition, Pearson International Edition
4. Snustad & Simmons, "**Principals of Genetics**", Third Edition, John Wiley & Sons Inc
5. Watson, Gilman, Witkowski, Zoller, "**Recombinant DNA**", Second Edition, Scientific American Books
6. Klug & Cummings, "**Concepts of Genetics**", Seventh Edition, Pearson Education (LPE)
7. Pierce, B.A., "**Genetics- A Conceptual Approach**", Second Edition, W. H. Freeman & Co
8. Lewin, B., "**Genes-IX**", Jones and Bartlett Publishers

PSC1MI-3 Microbial Biochemistry

THEORY: SEMESTER –I

Course Code	Unit	Topic Headings	Credits	L/ Sem
PSC1MI-3 Microbial Biochemistry	I	<b>AQUEOUS SOLUTIONS AND ACID BASE CHEMISTRY</b>  1.1. Various units of expressing and inter-converting concentration of solutions: molarity, moles, normality, osmolarity, molality, mole fraction 1.2. Bronsted Concept of conjugate acid –conjugate base pairs, ionization of solutions, pH, titration curves, buffers: preparation, action and their use in Biology 1.3 Henderson-Hasselbalch equation , buffer capacity, polyprotic acids, amphoteric salts, ionic strengths  (problem solving under all heads)	4	15
	II	<b>BIOORGANIC MOLECULES</b> 2.1. Amino acids: Classification and stereochemistry, biochemical information from amino acid sequence, derivative, ionization 2.2. Structure and function of i. Proteins: Structure of peptide bond, stability of formation of peptide bond, Ramchandran plot, protein structure, factors determining secondary , tertiary structures: amino acid sequence, thermodynamics of folding, role of disulfide bonds, dynamics of globular protein folding, chaperonins and prions motifs and domains, protein families, protein stability prediction of secondary and tertiary structure, protein-protein interactions, ii. Glycobiology: Carbohydrates, stability of glycosidic bond, glycoconjugates, proteoglycans, glycoproteins, glycolipids, homopolysaccharide folding, functions of oligosaccharides, iii.: Lipids: Lipid classification, structure of lipids in membranes- glycerolipids, ether lipids, galactolipids, sulfolipids, lipids in archaeobacteria, sphingolipids, terpenes, isoprenoids, Functions of lipids- signals, cofactors, pigments		05
				05
			05	
	III	<b>METABOLISM OF ONE AND TWO CARBON COMPOUNDS</b> 3.1. Metabolism of one carbon compounds: i. methylotrophs: Oxidation of methane, methanol, methylamines and carbon assimilation in methylotrophic bacteria and yeasts ii. Methanogens: Methanogenesis from H <sub>2</sub> , CO <sub>2</sub> , CH <sub>3</sub> OH, HCOOH, methylamines, energy coupling and biosynthesis in methanogenic bacteria	15	03
		02		
	02			

	<p><b>iii. Acetogens: autotrophic pathway of acetate synthesis and CO<sub>2</sub> fixation,</b></p> <p><b>iv. Carboxidotrophs: Biochemistry of chemolithoautotrophic metabolism</b></p> <p><b>v. Cynogens and cynotrophs: cynogenesis and cynide degradation</b></p> <p><b>3.2. Metabolism of two- carbon compounds</b></p> <p><b>i. Acetate-TCA and Glyoxylate cycle, modified citric acid cycle, carbon monoxide dehydrogenase pathway and disproportionation to methane</b></p> <p><b>Ethanol- acetic acid bacteria</b></p> <p><b>iii. Glyoxylate and glycollate- dicarboxylic acid cycle, glycerate pathway, beta hydroxyaspartate pathway</b></p> <p><b>Oxalate- as carbon and energy source</b></p>	<p><b>02</b></p> <p><b>02</b></p> <p><b>01</b></p> <p><b>01</b></p> <p><b>01</b></p> <p><b>01</b></p>
<b>IV</b>	<p><b>TRANSFER OF BIOMOLECULES</b></p> <p><b>4.1. Protein transport: extracellular protein secretion, drug export system</b></p> <p><b>4.2. Biological membranes and transport</b></p> <p><b>4.3. Folding of periplasmic proteins, translocation of folded proteins,</b></p>	<p><b>15</b></p> <p><b>05</b></p> <p><b>05</b></p> <p><b>05</b></p>

PRACTICAL-(PSMBP-103): SEMESTER –I

Course Code	Topic Headings	Credits	L/ Week
<b>PSC1MIPR-3 MICROBIAL BIOCHEMISTRY ( 60 CONTACT HOURS)</b>	<b>AQUEOUS SOLUTIONS AND ACID BASE CHEMISTRY</b> 1. Preparation of buffers 2. Determination of pK and PI value for an amino acid <b>BIOORGANIC MOLECULES</b> 3. Extraction of total lipids 4. Isolation of cholesterol and lecithin from egg yolk 5. Identification of fatty acids and other lipids by TLC 6. Determination of degree of unsaturation of fats and oils 7. Isolation of lactose from bovine milk 8. Estimation of total sugars by phenol-sulphuric acid method 9. Isolation of glutamic acid from gluten 10. Determination of molar absorption coefficient ( $\epsilon$ ) of l-tyrosine 11. Determination of the isoelectric point of the given protein 12. Estimation of polyphenols/ tannins by Folin- Denis method <b>METABOLISM OF ONE AND TWO CARBON COMPOUNDS</b> 13. Enrichment, isolation and identification of <i>Methylobacterium</i> <b>TRANSFER OF BIOMOLECULES</b> 14. Diffusion studies of molecules across sheep RBCs 15. Preparation of liposomes	2	04

REFERENCES:

Theory:

Unit I: Biochemical calculations, Segel I.R., John Wiley and Sons, 1995

Unit II: Biochemistry 3rd edition, Mathew, Van Holde and Ahern, Pearson Education Principles of Biochemistry, 4th edition, Zubay, G., Wm.C. Brown Publishers, 1998

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

Unit III: Microbial Biochemistry by GN Cohen-2011, Springer

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

Bacterial metabolism by Gottschalk, Springer-Verlag, 1985

Unit IV: Biochemistry, 4<sup>th</sup> edition, Voet D. and Voet J.G., John Wiley and Sons

Inc., 1995 Practical:

- a. Laboratory manual in biochemistry by Jayaraman J. , New Age International Publishers
- b. An introduction to practical biochemistry 3<sup>rd</sup> edition, David T Plummer, Tata McGraw Hill edition 1998
- c. Experimental biochemistry –A student companion, Rao Beedu, S. Deshpande, IK international Pvt. Ltd.
- d. Laboratory manual in biochemistry, Immunology and Biotechnology, Nigam A and Ayyagiri A. Tata McGraw Hill edition
- e. Source of Experiments for teaching Microbiology, Primrose and Wardlaw
- f. Microbial Physiology and Biochemistry Laboratory manual: A quantitative approach, David White
- g. Principles and techniques of practical biochemistry, 4<sup>th</sup> edition, Wilson K. and Walker J.(Ed.) Cambridge University Press, 1994

**SEMESTER I**

**Course Code: PSC1MI4**

Course Code	Unit	Topic Headings	Credits	L / Week
PSC1MI-4 Medical Microbiology & Immunology	I	<p><b>Advances in medical Microbiology : (15 L)</b></p> <p><b>1.1 Emerging Diseases :-</b></p> <p><b>Detailed Study of following infections including Etiology, Transmission, Pathogenesis, Clinical Manifestations, Lab diagnosis, Prophylaxis, and Treatment:--</b></p> <p><b>Ebola Virus, Zika Virus, MOTT (mycobacteria other than TB) Legionellosis, Chicken gueniew, Cholera caused by V.cholerae 0139, Conditions caused by Helicobacter pylori, SARS.</b></p>	4	01

	<b>II</b>	<p style="text-align: center;"><b>Epidemiology of infectious diseases : (15 L)</b></p> <p><b>2.1 Historical aspects-definition</b></p> <p><b>2.2 Descriptive Epidemiology-aims and uses</b></p> <p><b>2.3 Host parasite interactions in the cause of diseases</b></p> <p><b>2.4 Epidemiological principals in prevention and control of Diseases</b></p> <p><b>2.5 Measures of risks : frequency measures, morbidity frequency measures, mortality frequency measures natality (birth) measures, measures of association, measures of public health impact.</b></p> <p><b>2.6 Public health surveillance: purpose and characteristics , identifying health problems for surveillance, collecting data for surveillance, analyzing and interpreting data, disseminating data and interpretation, evaluating and improving surveillance.</b></p>		<b>01</b>
	<b>III</b>	<p style="text-align: center;"><b>Immune system and health part I; (15 L)</b></p> <p><b>3.1 Immune response to infectious diseases:--</b></p> <p><b>a) Immune response to Prions,</b></p> <p><b>b) Immune response to viral infections- HIV/AIDS-HIV and the immune system-Influenza-AvianH5N1.</b></p> <p><b>c) Immune response to Bacterial diseases- Difference in the Immune response to extracellular and intracellular bacteria : Diphtheria, Tuberculosis</b></p> <p><b>d) Microbial ways of evading immune system.</b></p>		<b>01</b>

	<p><b>IV</b></p>	<p><b>Recent advances in immunology: Immuno biology (15 L)</b></p> <p><b>4.1 Recent advances in Innate immunity</b> including receptors involved and signaling system. Physiological &amp; immunological barriers.</p> <p><b>4.2</b> Lymphocytes, Maturation of Lymphocytic Cells</p> <p><b>4.3 The innate immune response:</b> Inflammation, Acute Phase Reaction</p> <p><b>4.4 Molecular basis of diversity of immunoglobulin molecules.</b></p> <p><b>4.5 Multigene organization of Ig genes.</b></p> <p><b>4.6 Variable-Region Gene Rearrangements.</b></p> <p><b>4.7 Mechanim of Variable-Region DNA Rearrangements.</b></p> <p><b>4.8 Generation of antibody diversity.</b></p> <p><b>4.9 Manipulations of the immune response.</b></p>		<p>01</p>
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**SEMESTER I PRACTICALS (PSC1MIPR-4)**

1. Problem solving exercises in medical microbiology based on diseases caused by- HIV, MOTT, Chickengunia, Helicobacter, Vibrio cholerae 0139.
2. Diagnosis for HIV CD4 lymphocyte count for AIDS
3. ELISA for AIDS,
4. Diagnosis for MOTT
5. Acid fast staining for MOTT
6. Mono - Spot Test for diagnosis of Chickengunia (Demonstration expt.)
7. Diagnosis for V.c.0139 Cholera red test, String test, Oxidase test, Biochemical tests, & isolation on TCBS medium for identification of Vibrio cholerae 0139. serological diagnosis for V.c.0139 using specific monotypic antisera
8. Diagnosis for Helicobacter pylori HPSA (Helicobacter pylori ) detection from stool sample. (Demonstration expt.) (kit method)
9. Study of virulence factors-Phagocytosis & Phagocytic index
10. Collection of human blood & separation of mononuclear cells by ficoll hypaque density gradient centrifugation,
11. Counting of viable cells by trypan blue

For internal assessment:

- a. 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 NGO,s ”SEHAT”.
- b. Collection of data, criteria, methodology etc. Assignment to be submitted.

**References:-**

Unit I

1. Clinics in laboratory medicine, Emerging Infections and their causative agents. September 2004 vol. 24 no. 3.
2. Textbook of Microbiology 8<sup>th</sup> edition 2009-Ananthnarayan & Paniker-University press

Unit II

1. Principles of epidemiology in public health practices  
3<sup>rd</sup> edition ([www.cdc.gov/training/products/ss1000](http://www.cdc.gov/training/products/ss1000))
2. Basic lab methods in medical bacteriology, WHO Geneva.
3. Medical laboratory technology by Godkar.
4. Handbook of Epidemiology- W. Ahrens, I. Pigeot Springer- Verlag Berlin Herdelberg (2005).
5. Epidemiology for Public Health Practice- Robert H Friis & Thomas A. Sellers 3<sup>rd</sup> edition- Jones & Bartlett publishers.
6. Textbook of preventive and Community medicine- Park & Park.
7. Infectious disease surveillance by Nikuchia Nikanatha  
Blackwell Publishing 2005.

Unit III

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

Unit IV

1. Immunology – Essential and Fundamental, Sulabha Pathak and Urmi Palan.  
3<sup>rd</sup> edition Capital publishing company.

2. Immunology- Kuby 6<sup>th</sup> 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 6<sup>th</sup> ed.-

Janeway.Travers.GS. References for Practicals:

1. Medical laboratory technology- by Godkar.
2. Immunology-Essential & Fundamental-Sulbha Phatak & Urmi Palan-3rd edition Capital Publishing Company.
- 3 Clinical immunology – Principle & Practice 3rd ed. 2008 (Part -11 –clinical diagnostic immunology)
4. Bailey & Scott’s – diagnostic microbiology 11th edition – Betty Forbes.
5. Koneman’s Color Atlas & Text book of Diagnostic Microbiology 6th ed.

Semester II Detail Syllabus

PSC2MI-1

Course Code	Title	Credits
PSC2MI-1	Virology (60L)	04
	<p><b>Unit I: (15L)</b></p> <p><b>VIROLOGY (Animal Viruses)</b></p> <p><b>1.1 Animal Viruses : Influenza viruses : Classification, Clinical features, replication, genetic variation, Treatment and Surveillance (4L)</b></p> <p><b>1.2 Rabies virus, epidemiology, Pathogenesis, Immunity, Management of human rabies, Viral life cycle, genetic variation. (3L)</b></p> <p><b>1.3 Pox virus ; Clinical features, Structure of virus, replication, Vaccinia, orthopox virus, variola virus. (4L)</b></p> <p><b>1.4 Herpes Virus : Clinical signs and symptoms, varicella Zoster virus, Epstein-Barr virus, Cytomegalovirus, Life cycle, laboratory diagnosis, treatment (4L)</b></p>	01
	<p><b>Unit II: (15L)</b></p> <p><b>VIROLOGY IN RELATION TO HUMAN HEALTH</b></p> <p><b>2.1) Human Immunodeficiency Virus : transmission, epidemiology, life cycle, prevention, Diagnosis.(4L)</b></p> <p><b>2.2) Hepatitis Virus : Clinical features, epidemiology, Laboratory diagnosis, life cycle, Genetic diversity, prevention (3L)</b></p>	01

<p>2.3)New reemerging viruses, Evolution and adaptation, ecological factors, climate variability, human factors- social behavior, exposure to zoonotic diseases, human movement (4L)</p> <p>2.4)Prions and Viroids, - CJD, BSE, Viruses and Cancer – retrovirus, DNA tumor virus, adeno virus, HCC (5L)</p>	
<p><b>Unit III:</b> (15L)</p> <p style="text-align: center;"><b>VIROLOGY(Bacterial Viruses)</b></p> <p><b>3.1 Bacteriophages : General properties of phages, properties of phage infected Bacterial cultures, Specificity of Phage Infection (03)</b></p> <p><b>3.2 E. coli Phage T4 : Properties of T4 DNA, Genetic organization, the T4 growth cycle, Replication of T4 DNA (03)</b></p> <p><b>3.3 E.coli Phage T7 and Lambda : Organization of the T7 genes, Growth Cycle, Regulation of transcription of T7 phage.(04)</b></p> <p><b>3.4 E.coli Phage (phi) X174, Filamentous DNA phages, Single stranded RNA phages, Lysogenic cycle.(05)</b></p>	<p><b>01</b></p>
<p><b>Unit IV:</b> (15L)</p> <p style="text-align: center;"><b>VIROLOGY(Plant Viruses)</b></p> <p><b>4.1 Plant viruses : Morphology, Transmission of plant viruses, symptoms of plant diseases caused by viruses.(4L)</b></p> <p><b>4.2 Plant virus life cycles, Plant satellite viruses and satellite Nucleic acids</b></p> <p><b>4.3 TMV, Citrus Tristeza Virus (CTV): Viral structure, Genome, Host range, Transmission, Symptom and Control. (6L)</b></p> <p><b>Diagnosis of viral infections in plants(2L)</b></p>	<p><b>01</b></p>

**PRACTICALS: PSC2MIPR-1**

**SEMESTER II (60 Contact Hrs.)**

- 1) Egg inoculation and cultivating animal virus in embryonated egg. Demonstration (04)
- 2) Cultivation of macrophage cell lines and study of cell viability (06)
- 3) Study of Mitosis. (06)
- 4) Study of Meiosis (06)
- 5) Estimation of NO (Nitric Oxide) produced by Macrophages. (08)
- 6) Study of Phagocytosis using bacterial culture / yeast cells (04)
- 7) Study of Cell membrane integrity using uptake of neutral red. (04)
- 8) Writing Research Paper –w.r.t. Techniques used to study cell cycle. (06)
- 9) Review on Cell – Cell communication. (06)
- 10) Assignment on Animal viruses – Epidemiology, Transmission (06)
- 11) Presentation of Assignment – Cell Biology (04)

**REFERENCES :**

- 1) General Virology – Luria
- 2) Introduction to Plant Virology – BOS, I. Longman, London, NY.
- 3) Animal Virology – Fenner and White. Academic Press. NY
- 4) Chemistry of Viruses – Knight C. Springer Verlag. NY
- 5) Virology – Delbecco and Giasberg. Harper and Ravi Pub. NY.
- 6) Bacterial and Bacteriophage Genetics – Edward Birge
- 7) 7)Microbial and Plant Protoplasts – Perberely
- 8) Principles of Virology –Flint, Enquist, Racaniello and Skalka, Vol I & II. ASM,
- 9) Understanding Viruses – Teri Shors. Jones and Bartlett pub.

Course code: PSC2MI-2 (Microbial Genetics)

Semester II

Course Code	Title	Credits
PSC2MI-2	Microbial Genetics (60L)	04
<p>Unit I Viral genetics, gene transfer [15L]</p> <p>1.1Viral genetics [5L]</p> <p>A. Mapping the Bacteriophage genome.</p> <p>i. Phage phenotypes</p> <p>ii. Genetic recombination in phages</p> <p>iii. Genetic fine structure mapping</p> <p>iv. Deletion mapping</p> <p>B. Genes within genes : Bacteriophage <math>\Phi</math> X174</p> <p>C. Constructing phage vectors- phage display vectors, suicide vectors, combining phage vectors and transposons</p> <p>1.2 Gene Transfer [10L]</p> <p>A. Drug resistance and gene transfer in bacteria.</p> <p>B. Genetic exchange in Bacteria – An overview</p> <p>C. Mutant phenotypes in bacteria</p> <p>D. Basic test for transformation, conjugation and transduction</p> <p>E. Transformation:</p> <p>i. The transforming principle</p> <p>ii. Natural competency</p> <p>iii. Process of natural transformation- <i>Bacillus subtilis</i> (in detail)</p> <p>iv. Overview of transformation in <i>Streptococcus pneumoniae</i> &amp; <i>Haemophilus influenzae</i></p> <p>v. Artificial transformation</p>		01

<p>vi. Transformation and gene mapping</p> <p><b>F. Conjugation:</b></p> <p>i. Discovery of conjugation</p> <p>ii. F factors and R factors</p> <p>iii. The conjugation machinery and transfer of DNA</p> <p>iv. F<sup>+</sup> X F<sup>+</sup> mating</p> <p>v. Hfr formation and conjugation</p> <p>vi. Formation of F primes and transfer from one cell to another</p> <p>vii. Genetic uses of F'</p> <p>viii. Gene mapping using Hfr crosses and 50% rule.</p> <p>ix. Mapping closely linked genes</p> <p>x. Mobilization of nonconjugable plasmids by</p> <p>xi. Conjugation from prokaryotes to eukaryotes</p> <p><b>G. Transduction:</b></p> <p>i. Discovery</p> <p>ii. Generalized transduction</p> <p>iii. P1 as model of generalized transduction</p> <p>iv. Specialized transduction- λ phage as model system</p> <p>v. LFT &amp; HFT lysate Making merodiploids with specialized transducing phage Moving mutations from plasmids to specialized transducing phage to chromosome</p>	
<p><b>Unit II: Transposable genetic elements, genetic basis of cancer(15L)</b></p> <p><b>2.1 Transposable genetic elements [6L]</b></p> <p><b>A. Transposable Elements in Prokaryotes : An Overview</b></p> <p><b>The medical Significance of Bacterial Transposons</b></p> <p><b>B. Transposable Elements in Eukaryotes</b></p> <p><b>Ac and Ds Elements in Maize</b></p> <p><b>P Elements and Hybrid Dysgenesis in Drosophila</b></p> <p><b>Mariner, an Ancient and Widespread Transposon</b></p> <p><b>C. Retrotransposons</b></p> <p><b>Retroviruslike Elements</b></p> <p><b>Retroposons</b></p> <p><b>D. The Genetic and Evolutionary Significance of Transposable Elements</b></p>	<p><b>01</b></p>

<p><b>Transposons and Genome Organization Transposons and Mutation</b></p> <p><b>Rearrangement of Immunoglobulin Genes</b></p> <p><b>Evolutionary Issues Concerning Transposable Elements</b></p> <p><b>2.2 Genetic basis of cancer [9L]</b></p> <p><b>A. A Common Killer</b></p> <p><b>B. Cancer: A Genetics Disease</b></p> <p><b>The Many Forms of Cancer</b></p> <p><b>Cancer and the Cell Cycle</b></p> <p><b>A Genetics Basis for Cancer</b></p> <p><b>C. Oncogenes</b></p> <p><b>Tumor-Inducing Retroviruses and Viral Oncogenes</b></p> <p><b>Cellular Homologs of Viral Oncogenes: The Proto-Oncogenes</b></p> <p><b>Mutant Cellular Oncogenes and Cancer</b></p> <p><b>Chromosome Rearrangement and Cancer</b></p> <p><b>D. Tumor Suppressor Genes</b></p> <p><b>Inherited Cancers and Knudson’s Two-Hit Hypothesis Cellular</b></p> <p><b>Roles of Tumor Suppressor Proteins</b></p> <p><b>E. Genetic Pathways to Cancer</b></p>	
<p><b>Unit III: Developmental genetics (15L)</b></p> <p><b>3.1 Developmental genetics [5L]</b></p> <p><b>A. Cloning Experiments</b></p> <p><b>B. The Genetics of Pattern Formation in Drosophila</b></p> <p><b>C. Homeobox Genes in other Organisms</b></p> <p><b>D. The Genetics of Flower Development in Arabidopsis</b></p> <p><b>E. Programmed Cell Death in Development</b></p> <p><b>F. Evo-Devo: The Study of Evolution and Development</b></p> <p><b>3.2 The genetic control of animal development [10L]</b></p> <p><b>A. Stem Cell Therapy: A Brave New World?</b></p> <p><b>B. The Process of Development in Animals</b></p> <p><b>i. Oogenesis and fertilization</b></p> <p><b>ii. The Embryonic Cleavage Divisions and Blastula Formation</b></p>	<p><b>01</b></p>

<ul style="list-style-type: none"> <li>iii. <b>Gastrulation and Morphogenesis</b></li> <li><b>C. Genetic Analysis of Development in Model Organisms</b> <ul style="list-style-type: none"> <li>i. <b>Drosophila as a Model Organism</b></li> <li>ii. <b>Caenorhabditis as a model organism</b></li> </ul> </li> <li><b>D. Genetic Analysis of Development Pathways</b> <ul style="list-style-type: none"> <li>i. <b>Sex Determination in Drosophila</b></li> <li>ii. <b>Sex Determination in Caenorhabditis</b></li> </ul> </li> <li><b>E. Molecular Analysis of Genes Involved in Development</b></li> <li><b>F. Maternal Gene Activity in Development</b> <ul style="list-style-type: none"> <li>i. <b>Maternal-Effect Genes</b></li> <li>ii. <b>Determination of the Dorsal-Ventral and Anterior-Posterior Axes in Drosophila Embryos</b></li> </ul> </li> <li><b>G. Zygotic Gene Activity in Development</b> <ul style="list-style-type: none"> <li>i. <b>Body Segmentation</b></li> <li>ii. <b>Specification of Cell Types</b></li> <li>iii. <b>Organ Formation</b></li> </ul> </li> </ul>	
<p><b>Unit IV: Applications and ethics of genetic technology [15L]</b></p> <p><b>4.1 Mapping Human Genes at the Molecular Level</b></p> <p><b>RFLPs as Genetic Markers</b></p> <p><b>Linkage Analysis Using RFLPs</b></p> <p><b>Positional Cloning: The Gene for Neurofibromatosis</b></p> <p><b>The Candidate Gene Approach: The Gene for Marfan Syndrome</b></p> <p><b>Fluorescent in Situ Hybridization (FISH) Gene Mapping</b></p> <p><b>4.2 Genetic Disorders: Diagnosis and Screening</b></p> <p><b>Prenatal Genotyping for Mutations in the <math>\beta</math>- Globin Gene</b></p> <p><b>Prenatal Diagnosis of sickle-Cell Anemia</b></p> <p><b>Single Nucleotide Polymorphisms and Genetic Screening</b></p> <p><b>DNA Microarrays and Genetic Screening</b></p> <p><b>Genetic Testing and Ethical Dilemmas</b></p> <p><b>4.3 Treating Disorders with Gene Therapy</b></p> <p><b>Gene Therapy for Severe Combined Immunodeficiency (SCRID)</b></p> <p><b>Problems and Failures in Gene Therapy</b></p>	<p><b>01</b></p>

<p><b>The Future of Gene Therapy: New Vectors and Target-Cell Strategies Ethical Issues and Gene Therapy</b></p> <p><b>4.4 DNA Fingerprints</b> <b>Minisatellites (VNTRs) and Microsatellites (STRs) Forensic Applications of DNA Fingerprints</b></p> <p><b>4.5 Genome Projects Use Recombinant DNA technology</b> <b>The Human Genome Project: An overview</b> <b>The Ethical, Legal, and Social Implications (ELSI) Program</b> <b>After the Genome Projects</b></p> <p><b>4.6 Biotechnology is an Outgrowth of Recombinant DNA Technology</b> <b>Insulin Production by Bacteria</b> <b>Transgenic Animal Hosts and Pharmaceutical Products</b> <b>Transgenic Crop Plants and Herbicide Resistance</b></p> <p><b>4.7 Marshalling recombinant DNA technology to fight AIDS</b></p>	
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**SEMESTER II**

**PRACTICALS : PSC2MIPR-2 (60 Contact Hrs)**

List of practicals for semester II

- 1) Transformation
- 2) Conjugation, zygotic induction
- 3) Transduction
- 4) Identification of phage nucleic acid
- 5) Curing of plasmids
- 6) Study of transposable elements
- 7) Isolation of host range mutants
- 8) Problems on gene transfer mechanisms
- 9) Problems on viral genetics
- 10) Cancer genetics- visit to ACTREC

References:

Unit I:

- i. **Principles of Genetics, Third edition by D. Peter Snustad & Michael J. Simmons [pg 396 – pg 414]**
- ii. **Fundamental Bacterial Genetics by Nancy Trun and Janine Trempy – chapters 8, 10 and 11.**
- iii. **Snustad and Simmons 3<sup>rd</sup> edition [pg 418 –435]**

Unit II:

- i. **Principles of Genetics, Third edition by D. Peter Snustad & Michael J. Simmons [pg 440-458, 695-704]**

Unit III:

- i. **Genetics, Second edition by Benjamin A. Pierce [pg. 608-619]**
- ii. **Principles of Genetics, Third Edition by D. Peter Snustad & Michael J. Simmons [ 629- 648]**

Unit IV:

- i. **Concept of Genetics, Seventh Edition by William S. Klug & Michael R. Cummings [pg 524-540]**
- ii. **Recombinant DNA by J.D. Watson (2<sup>nd</sup> edition) [pg 486-504]**

**ADDITIONAL LIST OF REFERENCES FOR MICROBIAL GENETICS.**

1. **Watson, Baker, Bell, Gann, Levine, Losick, “Molecular Biology of the Gene”, Fifth Edition, Pearson Education (LPE)**
2. **Trun, Trempy, “Fundamental Bacterial Genetics”, Blackwell Publishing**
3. **Russell, P.J., “iGenetics- A Molecular Approach”, Third Edition, Pearson International Edition**
4. **Snustad & Simmons, “Principals of Genetics”, Third Edition, John Wiley & Sons Inc**
5. **Watson, Gilman, Witkowski, Zoller, “Recombinant DNA”, Second Edition, Scientific American Books**
6. **Klug & Cummings, “Concepts of Genetics”, Seventh Edition, Pearson Education (LPE)**
7. **Pierce, B.A., “Genetics- A Conceptual Approach”, Second Edition, W. H. Freeman & Co**
8. **Lewin, B., “Genes-IX”, Jones and Bartlett Publishers**

PSC2MI-3 Microbial Biochemistry

THEORY: SEMESTER –II

Course Code	Unit	Topic Headings	Credits	L/ Sem
PSC2MI-3 Microbial Biochemistry	I	<p><b>ANALYTICAL BIOCHEMISTRY</b></p> <p>1.1. Determination of molecular weights, purity, length and volume of organic compounds</p> <p>1.2. Extraction, purification, application and analysis of proteins, carbohydrates and lipids.</p> <p>i. General methods of extraction: salting out, use of organic solvents</p> <p>ii. purification: chromatographic techniques</p> <p>iii. mass determination: ultracentrifuge, GC-MS</p> <p>iv. structure determination: X-ray diffraction,</p> <p>v. location: Confocal spectroscopy</p> <p>1.3. Methods of analysis:</p> <p>i. Proteins,</p> <p>ii. carbohydrates</p> <p>iii. lipids</p> <p>iv. other organic compounds (problem solving under all heads.)</p>	4	15
		02 06		
	II	<p><b>Enzymeology</b></p> <p>2.1. Enzyme kinetics: Discovery of enzymes, enzyme terminology, basic aspects of chemical kinetics, kinetics of enzyme catalyzed reactions, enzyme inhibition (reversible and irreversible), specific examples – effect of pH on enzyme activity (Fumarase), Enzyme action by X-ray crystallography, nerve gas and its significance, HIV enzyme inhibitors and drug design (Problems solving)</p> <p>2.2. Enzyme regulation: Phosphofructokinase as allosteric enzyme, general properties of allosteric enzymes, two themes of allosteric regulations, regulation by covalent modification, regulation by multi-enzyme complexes and multifunctional enzymes, specific example- the blood coagulation cascade (problem solving)</p> <p>2.3. Mechanisms of enzyme catalysis: five themes that occur in discussing enzymatic reactions, detailed mechanisms of enzyme catalysis for example- serine proteases, ribonucleases, triose phosphate isomerase, lysozyme, lactate and alcohol dehydrogenases, catalytic antibodies (Problem solving).</p>		15 05  05
	III	<p><b>SIGNALLING AND STRESS</b></p> <p>3.1. Introduction to two-component signaling systems:</p> <p>i. Response by facultative anaerobes to anaerobiosis, nitrate and nitrite, nitrogen supply, inorganic phosphate supply</p> <p>ii. 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,</p>		15 05

	response to carbon sources		
	iii. Bacterial response to environmental stress- heat-shock response, repairing damaged DNA, the SOS response, oxidative stress,		05
	3.2. Synthesis of virulence factors in response to temperature, pH, nutrient, osmolarity and quorum sensors, chemotaxis, photoresponses, aerotaxis,		05
	3.3. Bacterial development and quorum sensing: Myxobacteria, Caulobacter, bioluminescence, systems similar to LuxR/LuxI in nonluminescent bacteria, biofilms.		
IV	<b>MICROBIAL DEGRADTION</b>		
	4.1. Degradation of aromatic and alicyclic compounds- important organisms, use of mixed cultures and manipulation of degradative genes, common pathways of aromatic degradation, aerobic and anaerobic degradation of aromatic compounds, aromatic and heterocyclic compounds with economical and ecotoxicological significance(phenolic pesticides, pthallic acid esters, lignosplphonates, surfactants, dyes and aromatics released during combustion.)		06
	4.2. Biotransformation of polycyclic aromatic hydrocarbons( PAHs)- Naphthalene, phenanthralene, anthracene, alicyclic and higher aliphatic hydrocarbons, halogenated aliphatics, branched chain alkanes and alkenes		03
	4.3. Biochemical mechanisms of pesticide detoxification		

Course Code : PSC2MIPR3

Course Name: Microbial Biochemistry

L/Weeks : 04

Total contact hrs : 60

Credits : 02

<b>Topic Headings</b>
<b>ANALYTICAL BIOCHEMISTRY</b>
1. Differential extraction with buffers,
2. purification strategy
3. Purification and concentration by precipitation- by decrease of pH, decrease in ionic strength, salting out, organic solvents, organic polymers, denaturation
4. Aqueous- two phase partitioning
<b>ENZYMOMOLOGY</b>
5. purification of an extracellular enzyme( $\beta$ -amylase) by salting out and dialysis
6. Enzyme kinetics-effect of enzyme concentration, substrate concentration, pH , temperature and inhibitors on enzyme activity,
7. Demonstration of proteolytic activity
8. Determination of glucose isomerase present intracellularly in <i>Bacillus sp.</i>

<b>SIGNALLING AND STRESS</b>
<b>9. Adaptation of E. coli to anaerobiosis</b>
<b>10. Chemotaxis of Pseudomonas</b>
<b>11. Effect of temperature and water activity on swarming of Proteus</b>
<b>12. Different bacteriolytic response associated with addition of lysozyme and salt..</b>
<b>MICROBIAL DEGRADTION</b>
<b>13. Microbial degradation of polycyclic aromatic hydrocarbons(PAHs)- enrichment, isolation and screening of bacteria</b>
<b>14. PAH degradation studies</b>
<b>15. Plasmid curing and determination of chemotaxis by drop assay method</b>

**REFERENCES:**

**Theory:**

**Unit I: Biochemistry 3rd edition, Mathew, Van Holde and Ahern , Pearson Education Principles of Biochemistry, 4th edition, Zubey**

**Principles of Biochemistry, Horton and Moran, Scrimgeour Pears Rawn**

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

**Unit II: Principles of Biochemistry, Lehninger A.L., Cox and Nelson, CBS publishers and Distributors Pvt. Ltd. 1994**

**Biochemistry by Conn and Stumph**

**Unit III: The physiology and biochemistry of prokaryotes , White D., Oxford University Press, 2000**

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

**Practical: PSC2MIPR-3**

**a. Laboratory manual in biochemistry by Jayaraman J. , New Age International Publishers**

**b. An introduction to practical biochemistry 3<sup>rd</sup> edition, David T Plummer, Tata McGraw Hill edition 1998**

**c. Experimental biochemistry –A student companion, Rao Beedu, S. Deshpande, IK international Pvt. Ltd.**

**d. Laboratory manual in biochemistry, Immunology and Biotechnology, Nigam A and Ayyagiri A. Tata McGraw Hill edition**

**e. Source of Experiments for teaching Microbiology, Primrose and Wardlaw**

**Microbial Physiology and Biochemistry Laboratory manual: A quantitative approach, David White**

**f. Principles and techniques of practical biochemistry, 4<sup>th</sup> edition, Wilson K. and Walker J.(Ed.) Cambridge University**

Course Code PSC2MI-4	Unit	Topic Headings	Credits	L / Week
PSC2MI-4 Medical Microbiology & Immunology	I	<p><b><u>Advances in medical Microbiology :</u> (15 L)</b></p> <p><b>1.1 Emerging Diseases :-</b> Detailed Study of following infections including Etiology, Transmission, Pathogenesis, Clinical Manifestations, Lab. diagnosis, Prophylaxis, and Treatment.</p> <p>Dengue, Listeriosis, VRE (Vancomycin Resistant enterococci)Leptospirosis, Hepatitis non A , Swine flu, conditions caused by Campylobacter , and prions</p>	4	01
	II	<p><b><u>Clinical Research:</u> (15 L)</b></p> <p><b>2.1 Introduction to Clinical Research.</b></p> <p>a. Good Clinical practice Guidelines b. Ethical aspects of Clinical Research c. Regulatory Requirements in clinical research d. Clinical Research Methodologies and Management e. Clinical Data Management and Statistics in Clinical Research.</p> <p><b>2.2 <u>Modern Diagnostic Methods:</u></b></p> <p>a) -Advances in Molecular and Immunological Techniques. b) -Microarrays. c) -Advances in Fluorescence Technology and (FISH)</p>		01
	III	<p><b><u>Immune system and Health : Part –II</u> (15 L)</b></p>		01
		<p><b>3.1 Recent advances in immune tolerance</b></p> <p>a) -Central Tolerance b) -Peripheral Tolerance c) -Tolerance Induction d) -T-cell Tolerance</p>		

	<p>e) -B-cell Tolerance  f) -Incomplete Tolerance  g) -Duration of Tolerance</p> <p><b>3.2 Recent advances in autoimmunity</b></p> <p>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</p> <p><b>3.3 Transplantation &amp; Transfusion Immunology</b></p> <p>a) -Antigens Involved in Graft Rejection  b) -Allorecognition  c) -Graft Rejection-Role of APC's &amp; Effector Cells  d) -Graft v/s Host Diseases  e) -Immuno Suppressive Therapies  f) -Blood Transfusion:--  i. ABO &amp; Rh Blood Groups  ii. Potential Transfusion Hazards  iii. Transfusion</p> <p><b>Alternatives</b></p> <p><b>3.4 Cancer immunology.</b></p> <p>a) -Cancer:Origin &amp; Terminology  b) -Malignant Transformation of Cells  c) -Oncogenes &amp; Cancer Induction  d) -Tumors of the Immune System  e) -Tumor Antigens  f) -Tumor Evasion of the Immune System</p>		
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	g) -Cancer Immuno Therapy		
IV	<p><b>Challenges in immune system (15 L) 4.1 Recent advances in vaccines</b></p> <p>a) -Challenges faced</p> <p>b) -HIV</p> <p>c) -Measles</p> <p>d) -T.B.</p> <p><b>4.2 Immunodeficiency diseases</b></p> <p>a) -Primary Immunodeficiency</p> <p>b) -Defects in the Compliment System</p> <p>c) -Treatment Approaches for Immunodeficiency</p> <p>d) -Animal Models of Primary Immunodeficiency</p> <p>e) -Secondary Immunodeficiency &amp; AIDS</p> <p><b>4.3 Adversarial strategies to overcome immune response</b></p> <p>a) -microbial strategies in relation to the immune response</p> <p>b) -Inflammation Revisited</p> <p>c) -Protective Response Against Bacteria</p> <p>d) -The Habitat of Intracellular Bacteria</p> <p>e) -Immunity to Fungi</p> <p>f) -Immunity to Parasitic Infection</p>		01

**SEMESTER II PRACTICALS (PSC2MIPR-4)**

Problem solving exercises in medical microbiology with appropriate tests for the diagnosis of diseases :

- 1. Rapid identification for Dengue virus(IgM &IgG)kit method “TULIP” immunochromatography (Demonstration Experiment )**
- 2. Diagnosis for VRE: Isolation using Bile Esculin agar, PYR test.**
- 3. Diagnosis for VRE: AST.**
- 4. Diagnosis for VRE: MIC using High Comb MIC Test.**
- 5. Diagnosis for Leptospirosis: Spirochaete staining.**
- 6. Diagnosis for Hepatitis Non- A:ELISA.**
- 7. Diagnosis for Swine flu-H1N1:Heamagglutination & Heamagglutination inhibition test.**
- 8. Immunoelectrophoresis of proteins – Human serum**
- 9. Determination of ABO & Rh – Antibody titre Major & Minor cross matching of blood.**
- 10. SRID: For detection of immune deficiency and Complement deficiency.**
- 11. Students will have to submit an assignment on clinical trials**

**References:**

Unit I

- 1. Clinics in laboratory medicine, Emerging Infections and their causative agents. September 2004 vol. 24 no. 3.**
- 2. Textbook of Microbiology 8<sup>th</sup> edition 2009-Ananthnarayan & Paniker-University press**
- 3. (Some more References to be cited.)**

Unit II

- 1. Textbook of clinical trials- editors David Machim, Simson Day & Sylvan Green-John Wiley & Sons.**
- 2. Management of Data in Clinical Trials- Eleanor McFadden M.A. - John Wiley & Sons.**
- 3. Clinical Trials- Issues and Approaches- Edited by Stanley H. Shapiro, Thomas A. Louis- Marcel Dekker Inc. New York.**

b.

- 1. Immunology- Kuby 6<sup>th</sup> edition W. H. Freeman and company- New York.**
- 2. The Elements of immunology- Fahim Halim Khan- Pearson Education.**
- 3. Immunology an introduction- 4<sup>th</sup> edition- Ian R. Tizard-Thomson.**
- 4. Roitt’s Essential Immunology 12<sup>th</sup> edition- Wiley- Blackwell.**
- 5. Koneman’s color Atlas & Textbook of Diagnostic Microbiology 6<sup>th</sup> edition-Lippincott Williams & Wilkins**

Unit III

a.

1. Immunology- Kuby 6<sup>th</sup> edition W. H. Freeman and company- New York.
2. Immunology-Essential & Fundamental edited by Sulbha Pathak & Urmi Palan-3<sup>rd</sup> edition- Central Publishing Company.
3. Immunology an introduction- 4<sup>th</sup> edition- Ian R. Tizard-Thomson.

b.

1. Immunology- Kuby 6<sup>th</sup> edition W. H. Freeman and company- New York.
2. Immunology-Essential & Fundamental edited by Sulbha Pathak & Urmi Palan-3<sup>rd</sup> edition- Central Publishing Company.
3. Immunology an introduction- 4<sup>th</sup> edition- Ian R. Tizard-Thomson.
4. Roitt's Essential Immunology 12<sup>th</sup> edition- Wiley- Blackwell.
5. The Elements of immunology- Fahim Halim Khan- Pearson Education.
6. Immuno Biology-the immune system in health & disease-6<sup>th</sup> edition-Janeway, Travers-GS.

c.

1. Immunology- Kuby 6<sup>th</sup> edition W. H. Freeman and company- New York.
2. The Elements of immunology- Fahim Halim Khan- Pearson Education.
3. Immunology-Essential & Fundamental edited by Sulbha Pathak & Urmi Palan-3<sup>rd</sup> edition- Central Publishing Company.

d.

1. Immunology- Kuby 6<sup>th</sup> edition W. H. Freeman and company- New York.
2. Immunology-Essential & Fundamental edited by Sulbha Pathak & Urmi Palan-3<sup>rd</sup> edition- Central Publishing Company.
3. Immunology an introduction- 4<sup>th</sup> edition- Ian R. Tizard-Thomson.
4. Roitt's Essential Immunology 12<sup>th</sup> edition- Wiley- Blackwell.
5. The Elements of immunology- Fahim Halim Khan- Pearson Education

Unit IV

a

1. Current Published papers on recent advances in relevant vaccines to be referred.

b.

1. Immunology- Kuby 6<sup>th</sup> edition W. H. Freeman and company- New York.
2. Roitt's Essential Immunology 12<sup>th</sup> edition- Wiley- Blackwell.

c.

1. Roitt's Essential Immunology 12<sup>th</sup> edition- Wiley- Blackwell.
2. The Pathogenesis of Infectious Disease- Cedric A . Mims.ELBS.

**References for Practicals:**

1. **Medical laboratory technology-** by Godkar.
2. **Immunology-Essential & Fundamental-Sulbha Phatak & Urmi Palan-3rd edition Capital Publishing Company.**
3. Clinical immunology – Principle & Practice 3rd ed. 2008 (Part -11 –clinical diagnostic immunology)
4. **Bailey & Scott’s – diagnostic microbiology 11th edition – Betty Forbes.**
5. **Koneman’s Color Atlas & Text book of Diagnostic Microbiology 6th ed.**

**REFERENCES: USC1MI-1 & USC1MI-2**

1. Prescott ,Hurley.Klein-Microbiology, 7<sup>th</sup> edition, International edition McGraw Hill.
2. Kathleen Park Talaro& Arthur Talaro - Foundations in Microbiology International edition 2002,| McGraw Hill.
3. Michael T.Madigan & J.M.Martin,Brock ,Biology of Microorganisms 12<sup>th</sup> Ed. International edition 2006, Pearson Prentice Hall.
4. A.J.Salle,Fundamental Principles of Bacteriology.
5. Stanier.Ingraham et al ,General Microbiology 4th & 5th Ed. 1987, Macmillan Education Ltd
6. Microbiology TMH 5th Edition by Michael J.Pelczar Jr., E.C.S. Chan ,Noel R. Krieg
7. BIS:12035.1986: Code of Safety in Microbiological Laboratories
8. Outlines of Biochemistry 5/E, Conn P. Stumpf, G. Bruening and R. Doi. John Wiley & Sons. New York 1995
9. Lehninger. Principles of Biochemistry. 4th Edition. D. Nelson and M. Cox. W.H. Freeman and Company. New York 2005
10. Microbiology An Introduction. 6th Edition. Tortora, Funke and Case. Adisson Wesley Longman Inc. 1998.

**REFERENCES: USC2MI-1 & USC2MI-2**

1. Microbiology TMH 5th Edition by Michael J.Pelczar Jr., E.C.S. Chan ,Noel R. Krieg
2. A.J.Salle, Fundamental Principles of Bacteriology,McGraw Hill Book Company Inc.1984
3. Cruikshank, Medical Microbiology , Vol -II
4. Prescott ,Hurley.Klein-Microbiology, 5th & 6th edition, International edition 2002 & 2006, McGraw Hill.
5. Michael T.Madigan & J.M.Martin,Brock ,Biology of Microorganisms 11th Ed. International edition ,2006, Pearson Prentice Hall.
6. Ananthanarayan And Paniker, Textbook Of Microbiology,10<sup>th</sup> edition ,2013,University Press Hyderabad.

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## **PRACTICAL BOOK/JOURNAL**

### **Semester I:**

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

**In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head/ Co-ordinator / Incharge of the department ; failing which the student will not be allowed to appear for the practical examination.**

### **Semester II:**

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

**In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head/ Co-ordinator / Incharge of the department ; failing which the student will not be allowed to appear for the practical examination.**

**Overall Examination and Marks Distribution Pattern**

**Semester I**

<b>Course</b>	<b>USC1MI-1</b>	<b>USC1MI-2</b>	<b>Grand Total</b>
<b>Theory</b>	<b>100 02 Credits</b>	<b>100 02 Credits</b>	<b>200 04 Credits</b>
<b>Practicals</b>	<b>50 02 Credits</b>	<b>50 02 Credits</b>	<b>100 04 Credits</b>
<b>Total Marks</b>	<b>150</b>	<b>150</b>	<b>300</b>
<b>Total Credits</b>	<b>04 Credits</b>	<b>04 Credits</b>	<b>08 Credits</b>

**Semester II**

<b>Course</b>	<b>USC2MI-1</b>	<b>USC2MI-2</b>	<b>Grand Total</b>
<b>Theory</b>	<b>100 02 Credits</b>	<b>100 02 Credits</b>	<b>200 04 Credits</b>
<b>Practicals</b>	<b>50 02 Credits</b>	<b>50 02 Credits</b>	<b>100 04 Credits</b>
<b>Total Marks</b>	<b>150</b>	<b>150</b>	<b>300</b>
<b>Total Credits</b>	<b>04 Credits</b>	<b>04 Credits</b>	<b>08 Credits</b>



Janardan Bhagat Shikshan Prasarak Sanstha's

**CHANGU KANA THAKUR  
ARTS, COMMERCE & SCIENCE COLLEGE, NEW PANVEL  
(AUTONOMOUS)**

Re-accredited 'A<sup>+</sup>' Grade by NAAC

'College with Potential for Excellence' Status Awarded by UGC

'Best College Award' by University of Mumbai

Program: M. Sc.

Revised Syllabus of M.Sc. (Part II) Microbiology

Choice Based Credit, Grading and Semester System

w.e.f. Academic Year 2020-21

## **PREAMBLE OF THE SYLLABUS**

With the introduction of Academic autonomy by the esteemed Changu Kana Thakur Arts, Commerce and Science College, New Panvel from the academic year 2019-2020, the existing syllabus of M.Sc. Microbiology is restructured according to the CBCS pattern for its implementation from 2019-2020. This syllabus is prepared to make students more knowledge oriented in Microbiology subject. The new and updated syllabus is based on interdisciplinary approach with vigour and depth. The contents have been drawn to accommodate the widening horizons of the Microbiology discipline. It reflects the changing needs of the students, pertaining to the fields of Bio-Chemistry, Molecular Biology, Bio-Statistics and Research methodology, Environment protection, emerging techniques and pharmaceutical microbiology. The well-organized curricula including basic as well as advanced concepts in the Microbiology shall inspire the students for pursuing higher studies in Microbiology and for becoming an entrepreneur and also enable students to get employed in the Microbiology subject based industries.

### **OBJECTIVES TO BE ACHIEVED:-**

- To enrich students' knowledge and train them in the microbial sciences.
- To introduce the concepts of application and research in Microbiology.
- To inculcate sense of scientific responsibilities and social and environment awareness.
- To enhance the employability of learners.
- To help students build-up a progressive and successful career.

**M.Sc. Microbiology Syllabus (General outline)**  
**Revised for Choice Based Credit System**  
**To be implemented from the Academic year 2020-21**

<b>SEMESTER III</b>		
<b>Course Code</b>	<b>Title</b>	<b>Credits</b>
<b>PSC3 Mi 1 Theory</b>	<b>Tools and Techniques : Research Methodology</b>	<b>04 Credits (60 L)</b>
<b>Unit-I</b>	Research Fundamentals and Terminology	15 L
<b>Unit-II</b>	Defining Research Problem and Data Collection	15 L
<b>Unit-III</b>	Sampling and Sampling Distributions	15 L
<b>Unit-IV</b>	Data Analysis and Report Writing	15 L
<b>PSC3 Mi 2 Theory</b>	<b>Food Microbiology</b>	<b>04 Credits (60 L)</b>
<b>Unit-I</b>	Microbes in Food	15 L
<b>Unit-II</b>	Uses of Microbes in Food	15 L
<b>Unit-III</b>	Control of Microbes in Food	15 L
<b>Unit-IV</b>	Microbial Detection and Food Safety	15 L
<b>PSC3 Mi 3</b>	<b>Advances In Microbial Technology</b>	<b>04 Credits (60 L)</b>
<b>Unit-I</b>	Agricultural Microbiology	15 L
<b>Unit-II</b>	Animal Biotechnology	15 L
<b>Unit-III</b>	Nano Biotechnology	15 L
<b>Unit-IV</b>	Medical Biotechnology	15 L
<b>PSC3 Mi 4</b>	<b>Applied and Environmental Microbiology</b>	<b>04 Credits (60 L)</b>
<b>Unit-I</b>	Microbial Diversity	15 L
<b>Unit-II</b>	Techniques in Microbial Ecology	15 L
<b>Unit-III</b>	Soil, Marine and Agricultural Microbiology	15 L
<b>Unit-IV</b>	Advanced Food and Water Microbiology	15 L
<b>PSC3 Mi P</b>	<b>PRACTICALS</b>	<b>02 Credits (60 L)</b>
<b>SECTION-1</b>	Literature Survey and Research Project Proposal	15 L
<b>SECTION-2</b>	Food Microbiology	15 L
<b>SECTION-3</b>	Advances in Biotechnology	15 L
<b>SECTION-4</b>	Applied and Environmental Microbiology	15 L <sup>3</sup>

<b>SEMESTER IV</b>		
<b>Course Code</b>	<b>Title</b>	<b>Credits</b>
<b>PSC4 Mi 1 Theory</b>	<b>Tools and Techniques: Biomolecular Analysis</b>	<b>04 Credits (60 L)</b>
<b>Unit-I</b>	Spectroscopic Techniques	15 L
<b>Unit-II</b>	Chromatographic Techniques	15 L
<b>Unit-III</b>	Molecular Biology Techniques	15 L
<b>Unit-IV</b>	Nanotechnology Techniques	15 L
<b>PSC4 Mi 2 Theory</b>	<b>Pharmaceutical Microbiology</b>	<b>04 Credits (60 L)</b>
<b>Unit-I</b>	Principles and Applications of GMP in Pharmaceuticals and Cosmetics	15 L
<b>Unit-II</b>	Quality Management and Regulatory Aspects	15 L
<b>Unit-III</b>	Analytical Aspects for Pharmaceutical and Cosmetic Products	15 L
<b>Unit-IV</b>	Drug Discovery	15 L
<b>PSC4 Mi 3</b>	<b>Advances in Biotechnology</b>	<b>04 Credits (60 L)</b>
<b>Unit-I</b>	Pharmaceutical Biotechnology	15 L
<b>Unit-II</b>	IPR and Ethics in Biotechnology	15 L
<b>Unit-III</b>	Marine Biotechnology	15 L
<b>Unit-IV</b>	Advances in Molecular Biotechnology	15 L
<b>PSC4 Mi 4</b>	<b>Applied and Environmental Monitoring &amp; Management</b>	<b>04 Credits (60 L)</b>
<b>Unit-I</b>	Bioremediation, Biodegradation & Waste disposal	15 L
<b>Unit-II</b>	Biofilm Management	15 L
<b>Unit-III</b>	Environmental Pollution & Monitoring	15 L
<b>Unit-IV</b>	Environmental & Natural Resources Management and Safety Standards	15 L
<b>PSC4 Mi P</b>	<b>PRACTICALS</b>	<b>02 Credits (60 L)</b>
<b>SECTION-1</b>	Dissertation based on Research Project and Poster Presentation.	15 L
<b>SECTION-2</b>	Pharmaceutical Microbiology	15 L
<b>SECTION-3</b>	Advances in Biotechnology	15 L
<b>SECTION-4</b>	Applied and Environmental Monitoring & Management	15 L

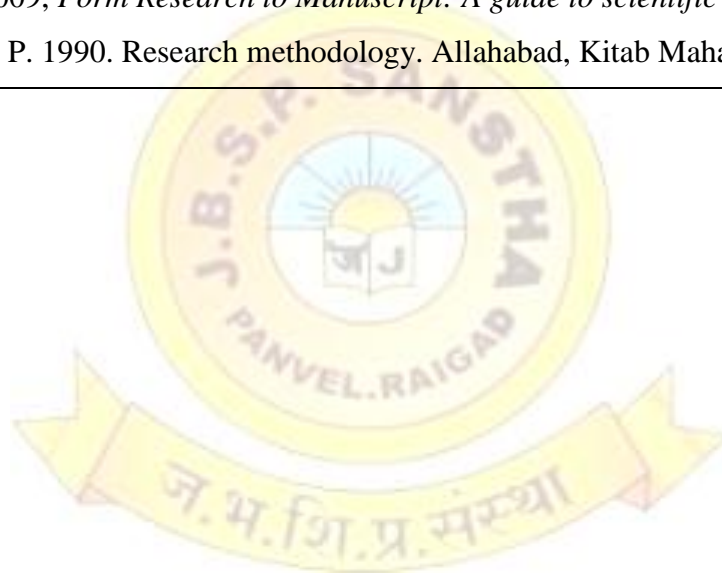
## M. Sc. II Microbiology Syllabus Revision Academic Year 2020-2021

### Semester III

Paper/Unit	Title	Lecture/ Week	Total lectures
<b>PSc3Mi 1</b>	<b>Tools and Techniques : Research Methodology</b>	<b>1</b>	<b>(60)</b>
<b>Unit I</b>	<b>Research Fundamentals and Terminology</b>		<b>(15)</b>
	1.1 Meaning and Objective of research, features of a good research study, scientific method		(05L)
	1.2 Study designs and variations: basic, applied, historical, exploratory, experimental, ex-post-facto, case study, diagnostic research, crossover design, case control design, cohort study design, multifactorial design		(10L)
<b>Unit II</b>	<b>Defining Research problem and data Collection</b>		<b>(15L)</b>
	2.1 Hypothesis, theory and scientific law: development, structure, conditions, sources, formulation, explanation of hypothesis; structure, identification, elements, classification, functions of theory; scientific laws and principles		(05L)
	2.2 Methods and techniques of data collection: types of data, methods of primary data collection( observation/ experimentation/ questionnaire/ interviewing/ case/ pilot study , methods), methods of secondary data collection( internal/ external), schedule method		<b>(10L)</b>
<b>Unit III</b>	<b>Sampling and sampling distributions (15L)</b>		
	3.1 Sampling frame, importance of probability sampling, simple random sampling, systematic sampling, stratified random sampling, cluster sampling, problems due to unintended sampling, ecological and statistical population in the laboratory		05L
	3.2 Variables: nominal, ordinal, discontinuous, continuous, derived		05
	3.3 Dispersion, Correlation, regression, test of statistical significance		05
<b>Unit IV</b>	<b>Data analysis and report writing</b>		<b>(15L)</b>
	4.1 Experimental data collection and data processing: Processing operations, problems in processing, elements of analysis in data processing, software for data processing,		05L
	4.2 Report writing and presentation: types of research reports, guidelines for writing a report, report format, appendices, Miscellaneous information, poster and oral presentations		06L
	<b>Analysis of Variance</b>		<b>04</b>

**References: PSMB301 (Semester III)**

1. Kothari, C.R.,1985, *Research Methodology- Methods and Techniques*, New Delhi, Wiley Eastern Limited.
2. Das, S.K. , 1986, *An Introduction to Research*, Kolkata, Mukherjee and Company Pvt. Ltd.
3. Misra R.P., 1989, *Research Methodology: A Handbook*, New Delhi, Concept Publishing Company
4. Kumar, R., 2005, *Research Methodology-A Step-by-Step Guide for for beginners*,(2nd.ed.),Singapore, Pearson Education.
5. Bhattachraya, D.K., 2006, *Research Methodology*,(2nd.ed.),New Delhi, Excel Books.
6. Panneerselvam R.,2012, *Research Methodology*, New Delhi, PHI Learning Pvt. Ltd.
7. Khan, Irfan Ali, 2008, *Fundamentals of Biostatistics*, Ukaaz Publications
8. Rosner B.A., 2011, *Fundamentals of Biostatistics*, Cengage Learning
9. Katz J.M., 2009, *Form Research to Manuscript: A guide to scientific writing*, USA, Springer Science
10. Saravanavel, P. 1990. *Research methodology*. Allahabad, Kitab Mahal



Paper/Unit	Title	Lecture /Week	Total lectures
<b>PSc3Mi 2</b>	<b>Food Microbiology</b>	<b>1</b>	<b>(60)</b>
<b>Unit I</b>	<b>Microbes in foods</b>		<b>(15)</b>
	1.1 Importance of microbes in food 1.2 Sources of microbes in food 1.3 Normal microbiological quality of food 1.4 Factors influencing microbial growth in food		
<b>Unit II</b>	<b>Uses of microbes in food</b>		<b>(15L)</b>
	2.1 Microbial stress response in food		<b>03</b>
	2.2 Starter cultures		<b>02</b>
	2.3 Microbiology of fermented foods General method of production 2.3.a. Cheese – Swiss and Blue cheese 2.3.b.Fermented meat product – Sausage 2.3.c.Fermented vegetable products – Pickles, soy product , Sauerkraut 2.3.d.Bread and Idli		<b>10L</b>
<b>Unit III</b>	<b>Control of microbes in food</b>		<b>(15L)</b>
	3.1 Control of access		<b>01</b>
	3.2 Control by physical removal, heat, low temperature, reduced aw, low pH and organic acids, modified atmosphere, antimicrobial preservatives, irradiation		<b>10</b>
	3.3 Novel emerging techniques of food preservation		<b>03</b>
	3.4 Control by combination of methods ( Hurdle concept)		<b>01</b>
<b>Unit IV</b>	<b>Microbial Detection and Food Safety</b>		<b>(15L)</b>
	4.1 Conventional Methods. 4.1.a. Methods used, Sampling for microbial analysis 4.1.b.Quantitative microbial enumeration in food 4.1.c.Qualitative methods of microbial detection 4.1.d.Bacterial Toxins 4.1.e.Rapid methods 4.1.f.Biosensors		<b>07</b>
	4.2 Controlling the Microbiological Quality of food. 4.2.a. Quality and Criteria 4.2.b.Sampling Schemes 4.2.c.QC using microbiological control 4.2.d.Control at source 4.2.e.Codes of GMP 4.2.f.HACCP 4.2.g.Laboratory Accreditation		<b>08</b>

**References: PSc3Mi 2****References: Unit 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.

**References: Unit II**

1. Bibek Ray and Arun Bhunia ( 2008) Fundamental Food Microbiology 4th Ed. CRC Press.
2. Gerald Reed ( 2004 ) Prescott and Dunn's Industrial Microbiology 4th Ed. CBS Publishers.
3. J Maud Kordylas ( 1991 ) Processing and Preservation of tropical and subtropical foods. ELBS Macmillan.

**References: Unit III**

1. Bibek Ray and Arun Bhunia ( 2008) Fundamental Food Microbiology 4th Ed. CRC Press.
2. N Shakuntala Manay and Shadaksharaswamy M ( 1985 ) Foods Facts and Principles. New Age International

**References: Unit IV**

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

Paper/Unit	Title	Lecture/Week	Total lectures
PSc3Mi 3	Advances In Microbial Technology	1	(60)
<b>Unit I</b>	<b>Agricultural Microbiology</b>		<b>(15)</b>
	1.1 Plant Tissue Culture for crop improvement--Initiation and maintenance of Callus and Suspension culture, Direct and Indirect Organogenesis, Micropropagation, Artificial seeds, Anther culture and dihaploids, Protoplast isolation culture and fusion, Production of haploids, Somaclonal variations, Germplasm conservation, Somatic hybrids, Cybrids.		
	1.2 Production of secondary metabolites from plant cell cultures, Technology of plant cell culture for production of chemicals, Bioreactor systems and models for mass cultivation of plant cells.		
	1.3 Plant Transformation Technology – Agrobacterium mediated gene transfer, Agrobacterium based vectors, viral vectors, Direct gene transfer methods, chemical methods, electroporation, microinjection, particle bombardment, Molecular breeding, plant selectable markers, Reporter genes, Positive selection, Selectable marker elimination, Transgene silencing, Strategies to avoid transgene silencing.		
	1.4 Plant Genetic Engineering for Productivity and Performance— a) Biotic Stress Tolerance- Herbicide resistance, Glyphosate, Insect Resistance, Bt toxin, Disease Resistance, Virus resistance b) By manipulation of—Photosynthesis, Nitrogen fixation, Nutrient uptake efficiency c) For Quality Improvement-Protein, Lipids, carbohydrates, vitamins and minerals. d) Biosafety concerns of transgenic plants		
	1.5 Plants as bioreactors		
	1.6 Soil Microbes interaction, Biofertilizer, Biopesticide		
<b>Unit II</b>	<b>Animal Biotechnology</b>		<b>(15L)</b>
	2.1 Animal Tissue Culture: Primary culture, Organ culture, Embryo Culture, Established Cell lines		
	2.2 Scale up, Cryopreservation, Culture Collections		
	2.3 Risks and Safety, Bioethics.		
	2.4 Stem Cell Technology, Cloning techniques Applications.		
	2.5 Transgenics and knockouts: Transgenic cattle, Transgenic birds, Transgenic fish		9

	2.6 Applications: Transgenic mice: i) Retroviral method ii) DNA microinjection method iii) Engineered Embryonic Stem cell method		
<b>Unit III</b>	<b>Nanobiotechnology</b>		<b>(15L)</b>
	3.1 Nanoscale systems, nanoparticles, nanowires, thin films and multilayers; Properties of nanomaterials		
	3.2 Synthesis of nanostructures - physical, chemical and biological, microbiological methods - a. Biomolecules as nanostructures. b. Nanoparticulate carrier systems, Micro and Nanofluidics c. Applications: Biosensors, drug and gene delivery systems, chip technologies, nano imaging, Nanomedicine and Cancer diagnostics and treatment.		
<b>Unit IV</b>	<b>Medical Biotechnology</b>		<b>(15L)</b>
	4.1 Genetic Testing of diseases and disorders, Cancer genetics, Immunogenetics; prenatal diagnosis-chorionic villus sampling, amniocentesis, Pre-implantation diagnosis, Genetic counselling.		<b>07</b>
	4.2 Gene therapy-concept, vectors, gene targeting and tissue-specific expression, Antisense Technology		
	4.3 Introduction to pharmacogenomics, Pharmacogenetics and toxicogenomics		
	4.4 Social- genetic discrimination: insurance and employment, human cloning, foeticide, Sex determination		
	4.5 Tissue Engineering, Methods of Synthesis, Biomolecular Engineering		

### References: PSc3Mi 3

#### References: Unit I :PSMB303 (Semester III)

1. Plant Biotechnology: The genetic manipulation of plants,2005,A.Slater ,N.Scott & M.Fowler, Oxford Univ Press, Oxford.
2. Introduction to Plant Biotechnology(3rd Edtn), H.S. Chawla
3. Roberta Smith, Plant Tissue Culture: Techniques and Experiments,2nd Edn, Academic Press,2000
4. H.K.Das(ed),Textbook of Biotechnology,Wiley India,2004
5. J.H.Hammond, P. Mcgarvey, and V.Yusibov(eds), Plant Biotechnolgy, Springer Verlag,Heidelberg,2000
6. B.B.Buchanan, W.Gruissen and R.L.Jones(eds), Biochemistry and Molecular Biology of Plants,American Society of Plant Biology,Rockville,USA,2000.
7. Plant Biotechnology and Agriculture:Prospects for the 21<sup>st</sup> Century, Arie altman ,Paul Michael Hasegawa,
8. Plant Biotechnology and Genetics:Principles, Techniques & Applications, Stewart, C.Neal,June 2008,John Wiley & Sons

#### References: Unit II

1. Animal Cell Culture by Ian Freshney
2. Basic Cell Culture. Ed.J.M.Davis 2<sup>nd</sup>.Ed 2007. Oxford press
3. Animal Cell Culture Sudha Gangal
4. Principles of biotechnology and applications-Glick and Pasternack

#### References: Unit III

1. Nanobiotechnology by David Goodsell. John Wiley
2. Handbook of Nanostructured biomaterials and their applications in nanobiotechnology by Nalwa HS 2005. American scientific publishers
3. Nanobiotechnology by Niemeyer CM & Mirkin CA 2005 .Wiley Interscience

#### References: Unit IV

1. Jogdand S. N., Medical Biotechnology, Himalaya Publishing House, Mumbai, (2008)
2. Judit Pongracz, Mary Keen, Medical Biotechnology, Churchill Livingstone, Elsevier (2009)
3. [Pratibha Nallari](#) & [V. Venugopal Rao](#), Medical Biotechnology, Oxford University Press, India (2010)

Paper/Unit	Title	Lecture /Week	Total lectures
PSc3Mi 4	<b>Applied And Environmental Microbiology (4 Credits)</b>	<b>1</b>	<b>(60)</b>
<b>Unit I</b>	<b>Microbial Diversity</b>		<b>(15)</b>
	1.1 Microbial ecology: concepts, niche, habitat, ecosystem		
	1.2 Introduction to microbial diversity: Types of microorganisms-bacteria, Archaeobacteria, Eucarya interactions between microorganisms , ecological succession		
	1.3 Extremophiles: Habitat, effect of extreme conditions on cellular components membrane structure, nucleic acids and proteins, adaptation mechanism in microorganisms in diverse environments		
	1.4 Study of Thermophiles, Psychrophiles, halophiles, Piezophiles, Acidophiles, Alkaliphiles, Xerophiles, Radiation resistant organisms, Methanogens.		
	1.5 Biotechnological Applications of extreme proteins from the above groups		
	1.6 Geo-microbiology: Biofouling, bio-corrosion, bioleaching.		
<b>Unit II</b>	<b>Techniques in Microbial Ecology</b>		<b>(15L)</b>
	2.1 Environmental sample collection and processing.: Soils and Sediment, Water, Air, Detection of Microorganisms on fomites		
	2.2 Cultural Methods: Cultural methods for isolation & enumeration of Bacteria		
	2.3 Physiological Methods: Measuring microbial activity in pure culture; Carbon respiration, Stable isotope probing, Use of radioisotopes as tracers Adenylate energy charge, Enzyme assays		
	2.4 Functional genomics & proteomics based approach		
	2.5 Immunological methods: Immunoassays		
	2.6 Nucleic acid based methods of analysis: Obtaining Nucleic acids from Environment, Use of Gene probes, PCR,		
	2.7 Recombinant DNA Techniques, RFLP, Denaturing /Temperature gradient, Plasmid analysis, Reporter genes. Rep PCR fingerprinting and microbial diversity		
	2.8 Molecular Techniques to Assess Microbial Community Structure, Function, and Dynamics in the Environment: culturable and unculturable bacterial analysis		
<b>Unit III</b>	<b>Soil, Marine &amp; Agricultural Microbiology</b>		<b>(15L)</b>
	3.1 Soil Microbiology: The litho ecosphere: Soil formation, Properties (physical and chemical) Soil communities. Link to microbial interactions. Soil sampling for surface, subsurface soils .Processing and storage of samples.		
	3.2 Marine microbiology: Marine and estuarine habitats. Characterization and stratification of the oceans Vertical and horizontal zones of marine habitats Marine microbes		12

	characteristics, distribution, composition & activity.		
	3.3 Agricultural microbiology: Factors affecting microbial load of soils. Relationship between plants and microbes rhizosphere, phyllosphere. Beneficial uses of microorganisms for plant growth and development, Interactions with aerial plant structures		
	3.4 Microbial contribution to animal nutrition Special reference to Rumen flora		
	3.5 Biogeochemical cycles for Carbon Nitrogen and Oxygen. Degradation of recalcitrant polymers and xenobiotics eg cellulose, lignin, lignocellulose. Combating Greenhouse effect using microbes. Concept of Carbon credits		
<b>Unit IV</b>	<b>Advanced Food &amp; Water Microbiology</b>		<b>(15L)</b>
	4.1 Sampling, sample processing approaches for analysis of foods implicated in outbreaks with measurement of uncertainty for mycotoxic fungi ,pathogenic bacteria(Enteropathogenic <i>E. coli</i> , <i>Vibrio</i> , <i>Salmonellae</i> ) and viruses (Hepatitis A, Norwalk) in meat/fish products as per BIS/ISO/APHA standards		<b>07</b>
	4.2 Use of biosensors and enzymatic/ thermal techniques for food analysis		
	4.3 Food additives and ingredients: Food additives-definitions, classification and functions, (Preservatives, antioxidants, colors, emulsifiers, sequesterants, natural and microbial flavors )		
	4.4 Toxicological evaluation of food additives		
	4.5 Applications of fibres from food sources, microbial fructooligosaccharides		
	4.6 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 nutraceuticals-stability and analytical issues, labelling issues		
	4.7 Drinking water risk assessment & its safety: Bottled water–legislation: a) Types of bottled water. BIS Regulations regarding the production of bottled waters wrt final quality of the product. b) 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 c) Types of water purifiers: Microbiological specifications and methods used certify water purifiers International standards regulating quality of water purifiers		

## References: PSc3Mi 4

### Unit - I Microbial Diversity

1. Brock Biology of microorganisms 12<sup>th</sup> ed Madigan, Martinko, Dunlap, Clara, Pearson Intl Ed
2. R. M. Atlas and R. Bartha - 1998 - Microbial Ecology - Fundamentals and Applications.
3. Addison Wesley Longman, Inc.
4. Microbial Diversity- Current Perspective and Potential Application--Johri and Satyanarayana
5. Methods in Microbiology Vol 35- Extremophiles (2006) Edited by Fred Rainey, Aharon Oren (Academic press)

### UNIT - II Techniques in Microbial Ecology

1. R. M. Atlas and R. Bartha - 1998 - Microbial Ecology - Fundamentals and applications. Addison Wesley Longman, Inc.
2. R. M. Maier, I. L. Pepper and C. P. Gerba 2010, Environmental Microbiology Academic Press
3. Rastogi & Sani, [Microbes and Microbial Technology](#), 2011, pp 29-57, Molecular Techniques to Assess Microbial Community Structure, Function, and Dynamics in the Environment
4. A K Bej and M H Mahbubani, Applications of the polymerase chain reaction in environmental .Microbiology. *Genome Res.* 1992 1: 151-159
5. The Metagenomics of soil by *Rolf Daniel*, 470/June 2005/vol3, [www.nature.com/reviews](http://www.nature.com/reviews)
6. Metagenomics: DNA sequencing of environmental samples, Susannah Green Tringe and Edward M. Rubin, 806/November 2005/Volume 6
7. [www.nature.com/reviews/genetics](http://www.nature.com/reviews/genetics)

### Unit - III : Soil, Marine & Agricultural Microbiology

1. Marine Microbiology: Ecology and Applications. [Colin Munn](#). Garland publishing. ISBN: 0815365179
2. Environmental Microbiology. [Alan H. Varnam](#). Manson Publishing. 2000.
3. Agricultural Microbiology. [G. Rangaswami](#), [D. J. Bagyaraj](#), [D.G. Bagyaraj](#). PHI Learning Pvt. Ltd., 2004
4. Microbes and Microbial Technology: Agricultural and Environmental Applications. [Iqbal Ahmad](#), [Farah Ahmad](#), [John Pichtel](#). Springer, 2011.

### UNIT -IV: Advanced Food & Water Microbiology

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.

### Practicals PSc3Mi 1

<b>PSc3Mi 1</b>	<b>Tools and Techniques: Research Methodology (60L)</b> <b>Unit I :</b> Literature survey (15L) <b>Unit II :</b> Literature survey (15L) <b>Unit III :</b> Writing Research Project Proposal (15L) <b>Unit IV :</b> Writing Research Project Proposal (15L)	02
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### Practicals PSc3Mi 2

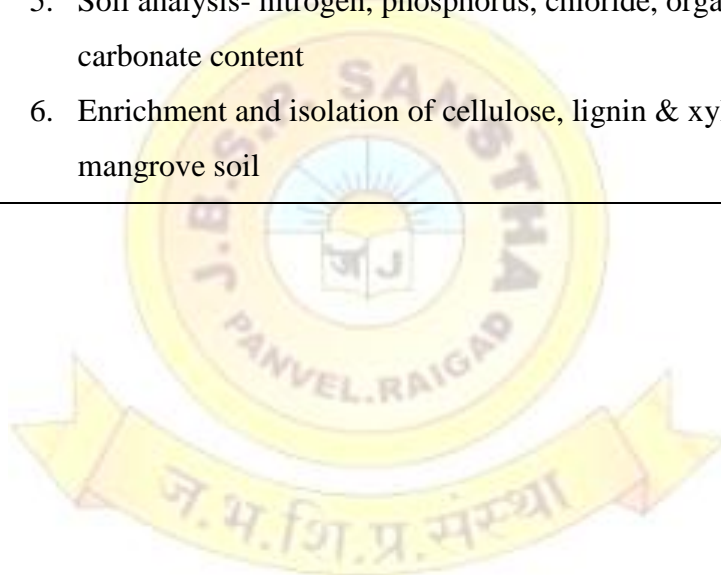
<b>PSc3Mi 2</b>	<b>Food Microbiology (60L)</b> <ol style="list-style-type: none"><li>1. Microbiological study of fermented foods ( Idli batter and sauerkraut )</li><li>2. Microbiological load in carrot and apple juice, salad, mayonese</li><li>3. Quality Assessment and Analysis of food<ol style="list-style-type: none"><li>a. Milk ( Raw, Packed )</li><li>b. Ice-cream</li><li>c. Yoghurt</li></ol></li><li>4. Report to be written in journal on Novel detection methods for food borne pathogens/ toxins</li></ol>	02
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### Practicals PSc3Mi 3

<b>PSc3Mi 3</b>	<b>Advances in Biotechnology</b> <ol style="list-style-type: none"><li>1. Terminology, Laboratory design of Animal tissue culture laboratory</li><li>2. Preparation of complete medium, Sterilization and sterility checking</li><li>3. Chick embryo fibroblast culture, viable staining</li><li>4. Lymphocyte culture, viable staining and heamocytometer count</li><li>5. Preparation of Nanosilver By Wet reduction Method(Chemical),using Neem Extact(plants) &amp; Bacteria(Microbiological)</li><li>6. Characterisation of Nanosilver by UV spectrometry and microscopic methods</li><li>7. Antimicrobial effect of Ionic silver and Nanosilver prepared by above methods</li><li>8. Study of Nanosilver coated Gauze/textiles for antimicrobial effect on different bacteria</li></ol>	02
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### Practicals PSc3Mi 4

<p><b>PSc3Mi 4</b></p>	<ol style="list-style-type: none"> <li>1. Enrichment &amp; isolation of thermophiles from hot springs/compost heaps &amp; extraction of thermophilic enzymes &amp; determination of its specific activity.</li> <li>2. Estimation of anti-oxidants and anti-nutritional factors (tannin/phytic acid) by spectrometric method</li> <li>3. Microbiological analysis of fish samples wrt sample processing for recovery and detection of Enteropathogenic <i>E. coli</i>, <i>Vibrio</i>, <i>Salmonellae</i> as per BIS/ISO/APHA standards and computation of measure of uncertainty</li> <li>4. Assessment of point of use water purifiers (Zero B) for removal of bacteria</li> <li>5. Soil analysis- nitrogen, phosphorus, chloride, organic matter, &amp; calcium carbonate content</li> <li>6. Enrichment and isolation of cellulose, lignin &amp; xylanase degraders from mangrove soil</li> </ol>	<p>02</p>
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**Semester IV**

<b>Paper/Unit</b>	<b>Title</b>	<b>Lecture/Week</b>	<b>Total lectures</b>
<b>PSc4Mi 1</b>	<b>Tools and Techniques : Biomolecular Analysis</b>	<b>1</b>	<b>(60)</b>
<b>Unit I</b>	<b>Unit I Spectroscopic Techniques</b>		<b>(15)</b>
	1.1 UV-visible spectroscopy: Beer- Lambert's Law, Instrumentation, operation, calibration, accuracy and applications		05
	1.2 IR: Principles, Instrumentation, operation, calibration, accuracy and applications		05
	1.3 Atomic Absorption Spectroscopy: Principles, Instrumentation, operation, calibration, accuracy and applications		05
<b>Unit II</b>	<b>Chromatographic Techniques</b>		<b>(15L)</b>
	2.1 Gas Chromatography: Principles, Instrumentation, operation, calibration, accuracy and applications		05
	2.2 High Performance Liquid Chromatography: Principles, Instrumentation, operation, calibration, accuracy and applications		05
	2.3 Supercritical Liquid Chromatography: Properties of SFE/SFC, Instrumentation, operation, advantages and applications		05
<b>Unit III</b>	<b>Molecular Biology Techniques</b>		<b>(15L)</b>
	3.1 Variations/ Modifications of PCR: Hot- Start PCR, Multiplex PCR, Nested PCR, RT-PCR, Broad Range PCR, arbitrarily primed PCR, Quantitative PCR, Real time PCR		05
	3.2 Hybridization array technology: applications of microarrays in microbiology, Microarray platform technologies (oligonucleotide microarrays, cDNA microarrays)		05
	3.3 FISH with other techniques: (confocal laser scanning microscopy, microautoradiography, flow cytometry, immunofluorescence, microsensors, peptide, nucleic acids)		05
<b>Unit IV</b>	<b>Nanotechnology Techniques</b>		<b>(15L)</b>
	4.1 Microscopy: i. Scanning Probe Microscopes - scanning tunnelling microscope (STM), atomic force microscope (AFM), magnetic force microscope (MFM), scanning near field microscope (SNOM) ii. Electron Microscopy: SEM, TEM		10
	4.2 Diffraction Techniques: X-ray diffraction (XRD)		02
	4.3 Photoluminescence Spectroscopy: X-ray and UV photoelectron spectroscopies (XPS)/Auger electron spectroscopy		03 <sup>17</sup>

## References: PSc4Mi 1

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.
4. Viswanathan B. 2010, *NanoMaterials*, New Delhi, Narosa Publishing House.
5. Pattabhi V. and Gantham N. 2002, *Biophysics* ( 2<sup>nd</sup> Ed.) Springer.
6. Narayana P. 2008, *Essentials of Biophysics*, New Age International Pvt Ltd Publishers
7. Sharon, Madhuri and Maheshwar, 2012, *Bio-Nanotechnology: concepts and applications*. New Delhi, Ane books Pvt Ltd.
8. Scott R. P.W. 2012, *Principles and Practice of Chromatography (Chrom-Ed Book Series)* , Reese-Scott Partnership
9. McNair H. M. and Miller J. M., 2009, *Basic Gas Chromatography* , Wiley International
10. Kulkarni Sulabha, 2011, *Nanotechnology: Principles and Practices*, New Delhi, Capital Publishing Company.
11. Chattopadhyay K.K. and Banerjee A.N. , 2012, *Introduction to Nanoscience and Nanotechnology*, New Delhi, PHI Learning Pvt. Ltd.
12. Miller J. M. , 2009, *Chromatography: Concepts and Contrasts*, USA, John Wiley and Sons, Inc.
13. Banwell, C.N. and McCash, E.M., 2012, *Fundamentals of Molecular Spectroscopy*, 4<sup>th</sup> Ed., New Delhi, Tata McGraw Hill Education Pvt. Ltd.
14. Upadhyay, Upadhyay and Nath, 2012, *Biophysical Chemistry: Principles and Techniques*, Mumbai, Himalaya Publishing House
15. Braithwaite A. and Smith F.J., 2001, *Chromatographic Methods*, 5<sup>th</sup> Ed. , London, Kluwer Academic Publishers
16. *Analytical Chemistry by Open Learning Series*, 2008, New York, John Wiley and Sons.
17. Braun R. , *Introduction to Instrumental Analysis*, New York, McGraw Hill Book Company
18. Skoog, Holler and Nieman, *Principles of Instrumental Analysis*, 5<sup>th</sup> Ed. Australia, Thomson Brock/Cole

Paper/Unit	Title	Lecture/ Week	Total lectures
PSc4Mi 2	<b>Pharmaceutical Microbiology</b>	<b>1</b>	<b>(60)</b>
<b>Unit I</b>	<b>Principles and applications of GMP in pharmaceuticals and cosmetics</b>		<b>(15)</b>
	1.1 Principles – Applications and Definitions		
	1.2 The concept of Quality		
	1.3 The regulatory factors		
	1.4 QC, QA and GMP		
	1.5 Quality assurance beyond GMP		
	1.6 ISO		
	1.7 Sanitary practices in cosmetic manufacturing		
<b>Unit II</b>	<b>Quality management and regulatory aspects</b>		<b>(15L)</b>
	2.1 Premises and contamination control, location, design, structure, layout, services and cleaning		
	2.2 Personnel management, training, Hygiene and health		
	2.3 Documentation		
	2.4 Quality control and GCLP		
	2.5 Sterile and other products		
	2.6 Global regulatory and toxicological aspects of cosmetic preservation		
<b>Unit III</b>	<b>Analytical aspects for pharmaceutical and cosmetic Products</b>		<b>(15L)</b>
	3.1 Quality control and GCLP		
	3.2 Sterile and other products.		
	3.3 Validation		
	3.4 Cosmetics microbiology- testing methods and preservation 3.4.a Antimicrobial preservation efficacy and microbial content testing 3.4.b Validation method for cosmetics 3.4.c Preservation strategy 3.4.d Evaluation of antimicrobial mechanism		
<b>Unit IV</b>	<b>Drug Discovery</b>		<b>(15L)</b>
	4.1 Modern Methods of Drug Discovery		
	4.2 Proteomics		
	4.3 Bioinformatics		19

	4.4 High throughput screening technology		
	4.5 Natural products for lead identification		
	4.6 The role of protein 3D structures in the drug discovery process.		

**References: PSc4Mi 2**

**Unit I**

1. Sharp John (2000) Quality in the manufacture of medicines and other healthcare products. Pharmaceutical Press.
2. Iyer S. (2003) Guidelines on cGMP and quality of Pharmaceutical products. D K Publishers Mumbai.
3. Philip A , Taylor and Francis ( 2006 ) Cosmetic Microbiology a practical approach.2<sup>nd</sup> Ed.

**Unit II**

1. Denyer S p, Hodges N A and Gorman S P (2005) Hugo and Russell's Pharmaceutical Microbiology. Blackwell Publishing.
2. Bibek Ray and Arun Bhunia (2008) Fundamental Food Microbiology. 4<sup>th</sup> Ed. CRC Press.
3. Sharp John (2000) Quality in the manufacture of medicines and other healthcare products. Pharmaceutical Press.
4. Bhatia R and Ichhapujani R L (1995) Quality Assurance in Microbiology. CBS publishers and distributors.

**Unit :III**

1. Sharp John (2000) Quality in the manufacture of medicines and other healthcare products. Pharmaceutical Press.
2. Philip A , Taylor and Francis (2006) Cosmetic Microbiology a practical approach.2<sup>nd</sup> Ed.

**Unit IV**

1. Hillisch A and Hilgenfeld R (2009) Modern Methods of drug discovery. Springer International Edition.
2. Kadam s s, Mahadik K R and Bothara K G (2009). Principles of medicinal Chemistry. Vol II Nirali Prakashan Pune.
3. Lemke T L and Williams D A (2008) Foye's Principles of Medicinal Chemistry. 6<sup>th</sup> Ed. Wolter Luwer, Lippincott Williams and Wilkins. N Delhi.



	<p>Regulatory Concerns, Human Misuse</p> <p>2.2.e) Future ‘Bioethical Conflicts’ in Biotechnology. - Changing perception of Nature, Human Genetic Engineering</p> <p>2.2.f) Bioethics vs Business: A Conflict?- IPP, Global Issues of Technology Transfer, Safety vs Costs, Is New Technology Better</p> <p>2.2.g) Resolution of Conflicts- Who can be trusted?, Public Education, Sufficient Regulations</p> <p>2.2.h) Ethical limits of Biotechnology.-Absolute or Relative, Timeless or Transient</p> <p>2.2.i)Criteria to Assess whether Biotech Research is Ethical.</p>		
<b>Unit III</b>	<b>Marine Biotechnology</b>		<b>(15L)</b>
	3.1 Extreme environmental conditions, Marine life forms, Biomimetic materials, new class of pharmaceuticals, industrial products and processes, vaccines, diagnostics and analytical reagents, Environmental research in marine environment, Methods in Marine Microbiology – Detection of microorganisms and microbial activity, Metabolic diversity, Extreme Environment conditions, Marine bacteria, marine archaea, Biofouling and biodeterioration, Degradation of pollutants, Bioremediation, Role of microorganisms in ocean processes, Marine Genomics and Proteomics.		
	3.2 Marine bioprospecting – Isolation of Marine Natural Products		
	3.3 Diversity of marine derived compounds - Alkaloid, Terpenoids and steroides, nucleoside, aminoacids, peptides, depsipeptide, polyketide, Macrolide; Marine Enzymes- protease, lipase, chitinase, glucanase; Marine biominerals; Biomineralized structures; Biocomposites; Biopolymers - polysaccharides, chitin, marine collagens		
	3.4 Bioactive Compounds And Biomaterials From Marine Environment.		
<b>Unit IV</b>	<b>Advances in Molecular Biotechnology</b>		<b>(15L)</b>
	4.1 Chemical synthesis and sequencing of DNA: Phosphoramidite method, Uses of synthesized oligonucleotides, Dideoxynucleotide method for sequencing of DNA, Automated DNA sequencing, Using Phage M13 as a sequencing vector		
	4.2 Manipulation of Gene Expression in Procaryotes: Gene expression from strong and regulatable promoters, Fusion proteins, unidirectional tandem gene arrays, Increasing protein stability, protein folding, DNA integration into host chromosome		
	4.3 Heterologous protein production in eukaryotic cells: Expression systems like Saccharomyces cerevisiae, Pichia pastoris, Baculovirus-Insect cell, mammalian cell		
	4.4 Directed Mutagenesis: Oligonucleotide directed mutagenesis with M13, Oligonucleotide directed mutagenesis with plasmid DNA, PCR amplified oligonucleotide directed mutagenesis, Random mutagenesis with degenerate oligonucleotide primer,		22

	Random mutagenesis with nucleotide analogues, Error-prone PCR, DNA shuffling, Mutant proteins with unusual amino acids		
	4.5 Protein Engineering: Adding disulfide 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		
	4.6 Synthetic Biology: Introduction, types, mechanisms, applications in industry		

### References: PSc4Mi 3

#### Unit I :

1. Gary Walsh, Pharmaceutical Biotechnology – Concepts and Applications (EBook), John Wiley & Sons Ltd. (2007)
2. Jogdand S. N., Biopharmaceuticals, Himalaya Publishing House, Mumbai (2006)
3. K. Sambamurthi, Pharmaceutical Biotechnology, New Age International (2006)
4. Daan J. A. Crommelin, Robert D. Sindelar and Bernd Meibohm Pharmaceutical Biotechnology: Fundamentals and Applications, informa healthcare, (Oct 30, 2007)

#### References: Unit II: 2.1:

1. Biodiversity, Biotechnology & Traditional Knowledge- Understanding Intellectual Property Rights , Aravind Kumar, Govind Das, Narosa
2. A textbook of Biotechnology, R.C.Dubey ,S.Chand.

#### References: Unit II: 2.2:

1. Biotechnology, Second Completely Revised Edition-Volume 12-Legal, Economic and **Ethical** Dimensions. Volume Editor-D.Brauer(A multi- Volume Comprehensive Treatise), H.J.Rehm and G.Reed, A.Puhler ,P Stadler
2. Ethics in Biotechnology-An Executive Guide, Chris MacDonald & Rahul.K. Dhanda
3. [www.BiotechEthics.ca](http://www.BiotechEthics.ca)

#### References:Unit: III :

1. RSK Barners & R.N Huges : Introduction to Marine Ecology, Blackwell
2. David H.Attway & Oskar R.Zabosky: Marine Biotechnology: Volume 1, 2, 3, Plenum Press, (1993).
3. P.J.Scheuer: Marine. Natural Products, Volume 1 & 2 (1978). Volume (1980-81) Academic Press.
4. O.Kinne: Marine Ecology, Vol.V.Ocean Management 3&4, John Wiley & Sons, (1984).
5. Rita Colwell (Ed.): Biotechnology in Marine Sciences, Academic Press, (1981).
6. R.R.Colwell (ed), Biotechnology of Marine Science, (1982).
7. R.R.Colwell et. al (eds) Biotechnology of Marine polysaccharides, (1985).
- David H.Attway & Oskar R.Zabosky: Marine Biotechnology, Volume 1, 2, 3, plenum press (1993).
8. P.J.Scheuer: Marine Natural Products, Volume 1&2 (1978) Volume (1980, 81), Academic Press

#### References: Unit IV

1. Molecular Biotechnology: Principles and Applications of Recombinant DNA Bernard R. Glick, Jack J. Pasternak, 4/e (2010), ASM Press
2. An Introduction to Molecular Biotechnology: Molecular Fundamentals, Methods and Applications in Modern Biotechnology edited by Michael Wink, (2006)Wiley VCH
3. Molecular biotechnology: principles and practices Channarayappa, (2006), Universities Press
4. Synthetic Biology

Paper/ Unit	Title	Lecture/ Week	Total lectures
<b>PSc4Mi 4</b>	<b>Applied and Environmental Monitoring &amp; Management</b>	<b>1</b>	<b>(60)</b>
<b>Unit I</b>	<b>Bioremediation, biodegradation &amp; Waste disposal</b>		<b>(15)</b>
	1.1 Engineering and bioremediation process its needs and limitations		
	1.2 Bioremediation in Soil of BTEX hydrocarbons		
	1.3 Petroleum contamination, Polycyclic aromatic compounds		
	1.4 Nitroaromatic compounds, PCB, Chlorinated Phenols, Chlorinated aliphatic compounds. Molecular technique in Bioremediation		
	1.5 Sewage & Sludge treatment and disposal methods.		
<b>Unit II</b>	<b>Biofilm management</b>		<b>(15L)</b>
	2.1 Structure and properties of biofilms		
	2.2 Formation of biofilm , Regulation of Initial Attachment, Biofilm Formation Proceeds via Multiple Convergent Genetic Pathways, Early Attachment Events, Maturation of the Biofilm , Detachment and Return to the Planktonic Growth Mode		
	2.3 Study of Quorum Sensing: Cell- Cell Communication amongst bacteria, and its similarity with <i>M. xanthus</i> Fruiting Body Development.		
	2.4 Multispecies biofilms: Clinical Relevance		
	2.5 Biofilms in plant-associated habitats: In the Phyllosphere (impact on survival and bacterial interactions, interaction of plants with epiphytic biofilms,), In the Rhizosphere (ubiquity and importance for rhizosphere bacteria, impact of rhizosphere biofilms on plant biology,)		
	2.6 Biofilm eradication: Methods and commonly used biocides such as surfactants, enzymes, triclosan, chlorhexidine, quarternary ammonium compounds		
	2.7 Use of other biofilm management methods such as probiotic organisms and prebiotics to restore disrupted beneficial biofilms to a “normal state”. Correction of environmental conditions for enhanced bioremediation of biofilms (eg dental plaque)		
	2.8 Disadvantages of biofilm management strategies-development of resistant strains-cross resistance induction		
	2.9 Biofilms from different environments, Impact of environment on biofilm development and its composition and implications of each on biofilms in water bodies, biofouling associated microbial biofilms prosthetics associated biofilms, human associated biofilms eg. Gut		
<b>Unit III</b>	<b>Pollution control and monitoring</b>		<b>(15L)</b>
	3.1 Introduction to Pollution, Pollution Control and Monitoring, Natural and anthropogenic pollution. Role of government and public in		<sup>24</sup>

	pollution control		
	3.2 Air pollution: Sources - Organic and inorganic pollutants, particulate matter, photochemical smog, acid rain, ozone depletion, greenhouse effect, global warming, and role of microorganisms in cause and mitigation of global warming, climate change. Control measures of air pollution - dust control equipment, control measures for specific gaseous pollutants Effects of air pollution, assessment & monitoring. (Indoor air pollution, vehicular pollution and control, odour control)		
	3.3 Water pollution: Sources of water and their contamination, types of pollutants, Effects of water pollution on plants, animals and human beings. Indicator microorganisms. Eutrophication – causes, effects and control measures		
	3.4 Wastewater treatment – aerobic and anaerobic. CETP, Water quality criteria and standards for discharge. Assessment & monitoring of water pollution.		
	3.5 Marine pollution: Sources, effects and coastal management		
	3.6 Thermal pollution: Sources, effects and control		
	3.7 Soil Pollution: Chemical composition and classification (hazardous and non-hazardous) of soil, sources of soil pollution, effects on plants, animals and human beings, biomagnification, control measures, assessment and monitoring		
	3.8 Noise pollution: Sources, impact, measurement and indices, control and abatement		
	3.9 Radioactive pollution: Sources, effects, prevention and control measures		
<b>Unit IV</b>	<b>Environmental &amp; natural resources management and safety standards</b>		<b>(15L)</b>
	4.1 Natural resources: Renewable/ non-renewable. Land, water, forest, minerals, energy, food. Associated problems and management practices. Environmental Impact Assessment and Sustainable Development		
	4.2 Solid waste management: Biodegradable waste from kitchen, abattoirs and agricultural fields and their recycling by aerobic composting or biomethanation. Non biodegradable waste like plastics, glass metal scrap and building materials and plastic recycling, metal recycling.		
	4.3 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		
	4.4 Biomedical and electronic waste management, recovery of precious metals from electronic waste resources.		
	4.5 Biohazards: Introduction, levels of biohazards, Risk assessment, proper cleaning procedures		25

	4.6Biosafety: Historical background and introduction, need of biosafety levels, biosafety guidelines for GMOs and LMOs. Role of Institutional biosafety committee. RCGM, GEAC, etc. for GMO applications in food and agriculture. Environmental release of GMOs. Overview of national regulations and relevant international agreements. Ecolabelling, IS 22000, Generally Recognized as Safe (GRAS)		
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<b>References: PSc4Mi 4</b>
<b>UNIT- I: Bioremediation, biodegradation &amp; Waste disposal</b> 1. Principles and Applications by Ronald L 2. Crawford and Don L Crawford 3. Biotechnology: B.D.Singh 4. A textbook of Biotechnology: R.C.Dubey 5. Environmental Biotechnology by Allan Scragg, 2nd Edn
<b>UNIT- II: Biofilm management</b> 1. Davies DG, Parsek MR, Pearson JP, Iglewski BH, Costerton JW, Greenberg EP. 1998. The involvement of cell-to cell signals in the development of a bacterial biofilm. <i>Science</i> 280 (5361):295–98 2. O’Toole GA, Kolter R. 1998. The initiation of biofilm formation in <i>Pseudomonas aeruginosa</i> WCS365 proceeds via multiple, convergent signaling pathways: a genetic analysis. <i>Mol. Microbiol.</i> 28:449–61 3. Morris, C. E. and Monier, J. M. 2003. The ecological significance of biofilm formation by plant-associated bacteria. <i>Annu. Rev. Phytopathol.</i> 41:429–53 4. O’Toole, G., Kaplan, H. B. and Kolter, R., 2000. Biofilm formation as microbial development. <i>Annu. Rev. Microbiol.</i> 2000. 54:49–79 5. Bacterial biofilms: from the Natural environment to infectious diseases. <i>Nature Reviews Microbiology</i> 2, 95-108 (February 2004)
<b>UNIT - III Pollution control and monitoring</b> 1. Environmental microbiology. P. D. Sharma. Alpha Science International 2005 ed. 2. Wastewater engineering: Treatment and reuse. Metcalf and Eddy, Tata McGraw Hill Publishing Co. Ltd. 4th Ed. 3. A textbook of environmental pollution and control. S S. Dara 4. Environmental chemistry A. K. De 5. Environmental pollution control engineering. C. S. Rao. New Age International Publishers. 6. APHA 1998. Standard Methods for the examination of water and wastewater, 20th Ed. 7. Biotechnology of Odour and Air pollution Control. Springer 8. Water and Wastewater analysis Volume 1. Handbook of methods in environmental studies. S. K. Maiti. ABD Publishers 2004 9. Soil analysis Volume 2. Handbook of methods in environmental studies. S. K. Maiti. ABD Publishers 2004 10. Environmental chemistry B. K. Sharma
<b>UNIT - IV Environmental &amp; natural resources management and safety standards</b> 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

### Practicals PSc4Mi 1

<b>PSc4Mi 1</b>	<b>Tools and Techniques: Biomolecular Analysis</b> <b>Unit I :</b> Research project experimental work <b>Unit II:</b> Research project experimental work <b>Unit III:</b> Research project experimental work <b>Unit IV:</b> Research project experimental work	02
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### Practicals PSc4Mi 2

<b>PSc4Mi 2</b>	<b>Pharmaceutical Microbiology</b> <ol style="list-style-type: none"><li>1. Sterility testing and reporting ( as per Pharmacopeia)</li><li>2. Microbial load in cosmetic product</li><li>3. Efficacy testing of preservatives like parabens</li><li>4. Efficacy of preservation and shelf life study.</li><li>5. Preparation of cosmetic product and its preservation study</li><li>6. Report on LAL and other tests for QC</li></ol>	02
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### Practicals PSc4Mi 3

<b>PSc4Mi 3</b>	<b>Advances in Biotechnology</b> <ol style="list-style-type: none"><li>1. Assignments on IPR-Case studies on different patents granted</li><li>2. Report on International Bioethics survey on specific concerned issues</li><li>3. Research Project experimental work</li></ol>	02
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### Practicals PSc4Mi 4

<b>PSc4Mi 4</b>	<b>Applied and Environmental Monitoring &amp; Management</b> <ol style="list-style-type: none"><li>1. Biofilm visualization by staining of a slide immersed in different environments such as soil, water, saliva (to emphasize compositional and structural variations in biofilms from different environment).s</li><li>2. Determination of MIC of disinfectant/antimicrobials with sessile and planktonic bacteria (to show higher resistance of biofilms to antimicrobials as compared to planktonic cells) quantified using crystal violet assay</li><li>3. 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.</li><li>4. Demonstration of Analysis of SO<sub>x</sub>, NO<sub>x</sub> , heavy metal (As/Cr) pollutants using volumetric/ spectrophotometric methods.</li><li>5. 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.</li><li>6. Preparation/ drafting of an EIA report.</li><li>7. Case studies: sustainable agricultural practices, coastal zone management,</li><li>8. MEOR, management of monuments, air pollution episodes, oil spills.</li></ol>	02
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## Modality of Assessment

### I] Theory Examination pattern

#### A. Internal examination 40%

Sr. No.	Internal Examination pattern	Marks
1.	Internal Class Test	20
2.	<ul style="list-style-type: none"> <li>• One seminar based on curriculum to be assessed</li> <li>• by the teacher of the institution teaching P. G. learners</li> <li>• Selection of the topic, Introduction, write up, references &amp; Presentation with the use of ICT</li> </ul>	15
3.	<ul style="list-style-type: none"> <li>• Active participation in routine</li> <li>• Class instructional deliveries</li> <li>• Overall conduct as a responsible learner</li> </ul>	05

#### B. External examination - 60 %

##### Semester End Theory Assessment -

**60 marks**

- i. Duration - These examinations shall be of two and half hours duration.
- ii. Theory question paper pattern :-
  1. There shall be **five** questions each of **12** marks. On each unit there will be one question & fifth one will be based on all the four units.
  2. All questions shall be compulsory with internal choice within the questions. Each question will be of **24** marks with options.
  3. Questions may be sub divided into sub questions **a, b, c & d only, each carrying six marks OR a, b, c, d, e & f only** each carrying **four** marks and the allocation of marks depends on the weightage of the topic.

### II] Practical Examination Pattern

(A) **Internal Examination:- There will not be any internal examination/ evaluation for practicals.**

(B) **External (Semester end practical examination) Per course :-**

Sr. No.	Particulars	Marks
1	Laboratory work	40
2	Journal	05
3	Viva	05

### **Semester III:**

Practical examination will be held at the college at the end of the semester. One external examiner and one internal examiner will be appointed by the Principal/ Chairman, Board of studies in Microbiology of the college. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination. In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head of the Department/ Co-coordinator of the department; failing which the student will not be allowed to appear for the practical examination.

**Research proposal:** Candidates are required to present two copies of duly certified research proposal (Spiral bound) as per the format of University Grants Commission with relevant references (minimum 25) and make the power point presentation of the same for the evaluation by the examiner.

**Assignments:** Candidates are required to present duly certified assignments (Spiral bound) as per the format provided by the institution and make the oral presentation of the same for the evaluation by the examiner.

### **Semester IV:**

Practical examination will be held at the college at the end of the semester. One external examiner and one internal examiner will be appointed by the Principal/ Chairman, Board of studies in Microbiology of the college. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination. In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head of the Department/ Co-coordinator of the department; failing which the student will not be allowed to appear for the practical examination

**Research project work:** Candidates are required to present duly certified dissertation report based on the topic of research along with the laboratory notebook containing raw data and make the poster presentation of the research work for evaluation by the examiner.

**Assignments:** Candidates are required to present duly certified assignments (Spiral bound) as per the format provided by the institution and make the oral presentation of the same for the evaluation by the examiner.

### Semester III

Course	PSc3Mi 1		Total	PSc3Mi 2		Total	PSc3Mi 3		Total	PSc3Mi 4		Total	Grand total
	Internal	External		Internal	External		Internal	External		Internal	External		
Theory	40	60	100	40	60	100	40	60	100	40	60	100	400
Practical	--	50	50		50	50		50	50		50	50	200

Course	PSc4Mi 1		Total	PSc4Mi 2		Total	PSc4Mi 3		Total	PSc4Mi 4		Total	Grand total
	Internal	External		Internal	External		Internal	External		Internal	External		
Theory	40	60	100	40	60	100	40	60	100	40	60	100	400
Practical	--	50	50		50	50		50	50		50	50	200