

Janardan Bhagat Shikshan Prasarak Sanstha's

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



Re-accredited 'A+' 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 Credit System (CBCS)

w.e.f. Academic Year 2022-23

M. Sc. I Microbiology Syllabus

M. Sc. I Microbiology Syllabus Semester I and II

INDEX

SEMESTER I

THEORY

Course Code	Unit	Topic Headings	Credits	Lecture/Topic
PSC1MI-1 Molecular Genetics -1	I	Genetic Exchange among bacteria and Recombination	04	15
	II	Eukaryotic Transposable elements, DNA repair and Genetics of Cancer		15
	III	Regulation of gene expression in prokaryotes		15
	IV	Global regulation of genes in bacteria		15

Course Code	Unit	Topic Headings	Credits	Lecture/Topic
PSC1MI-2 Biochemistry	I	Concepts in chemical reactivity and aqueous solution	04	15
	II	Bioorganic molecules		15
	III	Degradation and transformation of organic molecules		15
	IV	Physiology and metabolism of anaerobic bacteria		15

Course Code	Unit	Topic Headings	Credits	Lecture/Topic
PSC1MI-3 Medical Microbiology and Microbial pathogenesis	I	Mechanisms of Pathogenesis- 1	04	15
	II	Mechanisms of Pathogenesis-2 and Human Microbiome		15
	III	Emerging infectious diseases in India(with emphasis on Etiology, virulence mechanism, diagnosis and prevention) and Epidemiology		15
	IV	Clinical Bacteriology		15

Unit	Topic Headings	Credits	Practical/Week
PSC1MIPR-1	Molecular Genetics -1	04	02
PSC1MIPR-2	Biochemistry	04	02
PSC1MIPR-3	Medical Microbiology and Microbial pathogenesis	04	02

Course Code	Unit	Topic Headings	Credits	Lecture/Topic
PSC2MI-1 Molecular Genetics -2	I	Regulation of Gene Expression in Eukaryotes	04	15
	II	Genetic regulation of the development of Drosophila , organelle DNA & population genetics		15
	III	Molecular tools for genetics		15
	IV	Metagenomics, comparative & functional Genomics, Proteomics		15

Course Code	Unit	Topic Headings	Credits	Lecture/Topic
PSC2MI-2 Applied Biochemistry	I	Enzymology	04	15
	II	Signalling and stress		15
	III	Unusual biomolecules and bioactive compounds		15
	IV	Metabolism of one and two carbon compounds		15

Course Code	Unit	Topic Headings	Credits	Lecture/Topic
PSC2MI-3 Applied Immunology	I	Adversarial strategies during infection	04	15
	II	Immunodeficiency		15
	III	Advances in Allergy and other hypersensitivity		15
	IV	Tumor Immunology & Autoimmune diseases		15

Unit	Topic Headings	Credits	Practical/Week
PSC2MIPR-1	Molecular Genetics -2	04	02
PSC2MIPR-2	Applied Biochemistry	04	02
PSC2MIPR-3	Applied Immunology	04	02



Programme Outcomes - M. Sc. (Microbiology)

Sr. No.	Outcome for M.Sc. Program After completion of M.Sc. program students will acquire	Graduate Attribute
PO1	The ability to identify and describe broadly accepted methodologies of science, and different modes of reasoning.	Disciplinary knowledge
PO2	An ability to demonstrate proficiency in various instrumentation, modern tools, and advanced techniques to meet industrial expectations and research outputs.	Disciplinary knowledge
PO3	Ability to identify problems, formulate, and prove hypotheses by applying theoretical knowledge and skills relevant to the discipline.	Problem-solving
PO4	The ability to articulate thoughts, research ideas, information, scientific outcomes in oral and in written presentation to range of audience.	Communication skills
PO5	A capacity for independent, conceptual, and creative thinking, and critical analysis through the existing methods of enquiry.	Critical thinking
PO6	Acquisition of skills required for cutting edge research, investigations, field study, documentation, networking, and ability to build logical arguments using scholarly evidence.	Research skills
PO7	An ability to portray good interpersonal skills with the ability to work collaboratively as part of a team undertaking a range of different team roles	Teamwork
PO8	The ability to understand ethical responsibilities and impact of scientific solutions in global, societal, and environmental context and contribute to sustainable development	Moral and ethical awareness/ multicultural competence
PO9	An openness to and interest in life-long learning through directed and self-directed study	self-directed learning
PO10	The ability to translate the knowledge and demonstrate the skills required to be employed and successful professional development.	Life-long learning
PO11	The ability to identify and describe broadly accepted methodologies of science, and different modes of reasoning.	Disciplinary knowledge

Programme Specific Outcomes - M. Sc. (Microbiology)

PSOs	
PSO1	The program is aimed at equipping the students with basic knowledge in various branches of Microbiology such as Microbial Genetics, Molecular Biology, Virology, Medical Microbiology, Immunology, Microbial Biochemistry, Environmental Microbiology, Advances in Biotechnology and Industrial (food, pharmaceutical) Microbiology. Additionally, it also makes students aware of interdisciplinary sciences such as Bioinformatics and Bioinstrumentation
PSO2	At the end, student will have employability in food industry, pharmaceutical industry, Agricultural industry and fishery. Students will work as microbiologist in Research, QC, QA and production departments
PSO3	Students will develop basic understanding of the subject and will have developed life skills to solve environmental and hygiene related problems

M. Sc. I Microbiology Semester I Syllabus

Course Code	: PSC1MI-1	Title of the Paper	: Molecular Genetics -1
Credits	: 4	Total No. of Lectures	: 60 (15 Lectures/Unit)

Course Name and No.: 1 Molecular Genetics -1		BTL
After Completion of course, the learner will be able to		
CO1	Explain the importance of DNA recombination and repair	Understand
CO2	Explain the concept of global gene regulation and its importance in bacterial physiology	Understand
CO3	Describe the molecular mechanisms underlying gene regulation in prokaryotes	Remember

Sub unit	Topics	No. of Lectures
Unit I	Genetic Exchange among bacteria and Molecular basis of Homologous Recombination	
1.1	Conjugation 1.1.1 Overview, Classification of self-transmissible plasmids 1.1.2 Mechanism of DNA transfer during Conjugation in Gram negative bacteria 1.1.3 Chromosome transfer by plasmids-Formation of Hfr strains, transfer & mobilization of chromosomal DNA by integrated plasmids, prime factors 1.1.4 Transfer system of gram positive bacteria-Plasmid pheromones	05
1.2	Transformation 1.2.1 Development of Competence in Gram positive bacteria and Gram negative bacteria, competence based on type IV secretion systems. 1.2.2 Regulation of competence in Bacillus subtilis- Competence pheromones. 1.2.3 Role of natural transformation- Nutrition, repair, recombination, Importance of natural transformation for forward and reverse genetics. 1.2.4 Artificially induced competence- Calcium ion induction, transformation by plasmids, transfection by phage DNA, transformation of cells with chromosomal genes, Electroporation.	05
1.3	Homologous recombination at molecular level 1.3.1 Models for Homologues recombination 1.3.2 Homologues recombination protein machines 1.3.3 Homologous recombination in E.coli (Rec BCD pathway) 1.3.4 Homologous recombination in eukaryotes- Mating type switching 1.3.5 Site Specific recombination	05
Unit II	Transposable elements, DNA repair and Genetics of Cancer	
2.1	2.1.1 Transposable genetic elements in eukaryotes: Transposable Ac and Ds Elements in Maize, P Elements and Hybrid Dysgenesis in Drosophila. 2.1.2 Retrovirus and Retro transposons : Retrovirus, Retrovirus like elements, Retroposons 2.1.3 Transposable elements in Humans 2.1.4 The Genetic and Evolutionary Significance of Transposable Elements: Transposons as mutagens, Genetic transformation with transposons,	07

	Transposons and Genome organization, Evolutionary Issues Concerning Transposable Elements	
2.2	DNA repair 2.2.1 Eukaryotic Nucleotide Excision repair 2.2.2 Mismatch repair mechanism in humans 2.2.3 Non-homologous end joining (NHEJ) pathway for repairing double stranded breaks	02
2.3	Genetic Basis of Cancer 2.3.1 Cancer: A Genetic Disease, Forms of Cancer, Cancer and the Cell Cycle 2.3.2 Oncogenes: Tumor-Inducing Retroviruses and Viral Oncogenes, Cellular Proto-Oncogenes, protein products of protooncogenes, Changing cellular protooncogenes into oncogenes, Chromosome Rearrangement and Cancer. 2.3.3 Tumor Suppressor Genes: the Retinoblastoma tumor suppressor gene- RB, P53, Breast cancer tumor suppressor genes, MicroRNAs genes, Mutator genes, Telomere shortening genes 2.3.4. The multistep nature of cancer	06
Unit III	Regulation of gene expression in prokaryotes	
3.1	Operon Systems (Detailed Molecular structure of repressor and operator sites) 3.1.1 The <i>E. coli</i> Lac operon 3.1.2 The <i>E.coli</i> Gal operon 3.1.3 The <i>E. coli</i> ara operon 3.1.4 The <i>E. coli</i> Maltose operon 3.1.5 Trp operon of <i>Bacillus subtilis</i> 3.1.6 Riboswitch regulation	15
Unit IV	Global regulation of genes in bacteria	
4.1	Global regulation systems 4.1.1 Regulation of Nitrogen assimilation 4.1.2 Pathways for nitrogen assimilation, regulation of nitrogen assimilation by the Ntr system 4.1.3 Stress response In Bacteria: Heat shock regulation in <i>E coli</i> 4.1.4 Iron regulation in <i>E coli</i> 4.1.5 Regulation of Sporulation in <i>Bacillus subtilis</i>	01 03 03 02 06
	Self-study: Solve at least five problems on gene transfer and regulation given at the end of the chapter in Lehninger/schaum series/Russell etc	

PRACTICALS BASED ON PSC1MIPR-1

1. Demonstration of Conjugation in *E. coli*
2. Preparation of competent *E. coli* cells
3. Isolation of plasmid DNA from mini-cultures and maxi cultures
4. Transformation of competent cells using plasmid DNA
5. Endospore formation in *Bacillus subtilis*: Requirements for germination and outgrowth of spores, correlation between sporulation and protease activity

6. Response of nutrient stress on the growth and size of *Pseudomonas sp.*
7. Cancer genetics- visit to ACTREC, TIFR, BARC etc

REFERENCES

1. iGenetics- A Molecular Approach, Russell, P.J., 3rd edition, 2010, Pearson International edition
2. Fundamental Bacterial Genetics, Trun Trempy, 1st edition, 2004, Blackwell Publishing
3. Molecular Biology of the Gene, Watson, Baker, Bell, Gann, Levine, Losick, 7th edition, 2007, Pearson Education
4. Genes IX, Lewin, B., 2006, Jones and Bartlett Publishers
5. Genetics: A Conceptual Approach, Benjamin Pierce 4th edition, 2008, W. H. Freeman & Co
6. Principals of Genetics, Snustad & Simmons, 6th edition, 2012, John Wiley & Sons Inc
7. Molecular biology –Genes to proteins 3rd ed. by Burton E. Tropp (Jones & Bartlett publishers)
8. Molecular Genetics of bacteria, 3rd Edition by Larry Snyder and Wendy Champness (ASM press)

Course Code : PSC1MI-2	Title of the Paper :	Biochemistry
Credits : 4	Total No. of Lectures :	60 (15 Lectures/Unit)

Course Name and No.: 2 Biochemistry		BTL
After Completion of course, the learner will be able to		
CO1	Correlate the structure and function of bioorganic molecules to their biological roles.	Apply
CO2	Explain the enzymatic mechanisms involved in the breakdown of complex organic molecules.	Understand
CO3	Analyze the role of anaerobic bacteria in biogeochemical cycles and ecosystem functioning.	Analyze

Sub unit	Topics	No. of Lectures
Unit I	Concepts in chemical reactivity and aqueous solution	
1.1	Aqueous solutions: Concentrations based on weight, volume and degree of saturation. [Only problem solving]	05
1.2	Acids and bases Bronsted concept of conjugate acid-conjugate base, pH, pOH, buffers, titration curves, Hendersen - Hasselbach equation, polyprotic acids, amphoteric salts [problem solving]	06
1.3	Chemical reactivity and forces between molecules	04
Unit II	Bioorganic molecules	
2.1	Protein Chemistry: Peptides and the peptide bond, protein structures, protein types, factors determining structure , dynamics of globular proteins, Chaperonins, prion motifs and domains	07
2.2	Carbohydrates: Derivatives of monosaccharides, glycoconjugates, carbohydrates as informational molecules	04
2.3	Lipids: structural lipids, lipids as signal, cofactors and pigments	02
2.4	Coenzymes, antioxidants and metals	02
2.5	Self-study: Solve at least five problems given at the end of the chapter in Lehninger or any other textbook	
Unit III	Degradation and transformation of organic molecules	
3.1	Biotic reactions, mechanistic aspects Environmental factors affecting biodegradation	03
3.2	Degradation and transformation of aromatic compounds: monocyclic, polycyclic, carboxylates and related compounds, halogenated hydrocarbons	10
3.3	Persistence and biomagnification of xenobiotics	02
3.4	Self-study: identify a product containing aromatic compound and design a flow sheet to degrade or transform it	
Unit IV	Physiology and metabolism of anaerobic bacteria	
4.1	Anaerobes and oxygen, physiology of anaerobes, anaerobes in natural environments, types of anaerobic and microaerophilic bacteria	08
4.2	Techniques in Anaerobic Microbiology	03
4.3	Applications of anaerobes	04

PRACTICALS BASED ON PSC1MIPR-3

1. Preparation of buffers
2. Extraction, isolation, partial purification (if necessary), calculation of percentage yield and performing a confirmatory test for the following:
 - a. Lactose from milk
 - b. Albumins and globulins from egg white
3. Determination of pK values by titration curves
4. Interpretation of Ramchandran plot
5. Analysis/estimation of aromatic compounds like naphthalene
6. Cultivation of anaerobic bacteria using Gaspak method
7. Cultivation of anaerobes- *Clostridium* species using litmus milk, observation of stormy fermentation of milk, use of Robertson's cooked meat medium and anaerobic chamber
8. Anti-oxidant assay by DPPH method

REFERENCES

Unit 1

1. Biochemical calculations, Segel I.R., John Wiley and Sons, 1995
2. Schaum's solved problem series. 3000 solved problems in Chemistry. David E. Goldberg. McGraw Hill International Editions 1997
3. Biochemistry: The chemical reactions of living cells (Vol 1) David E. Metzler Academic Press

Unit 2

1. Biochemistry 3rd edition, Mathew, Van Holde and Ahern, Pearson Education
2. Lehninger-Principles of Biochemistry, Michael M. Cox and David L. Nelson, 5th Edition. W.H. Freeman and Company, New York reprinted 2008
3. Biochemistry, Voet D. and Voet J.G., 4th edition, 1995, John Wiley and Sons Inc

Unit 3

1. Environmental degradation and transformation of organic chemicals- Alasdair H. Neilson and Ann-Safie Allard. CRC press, 2008
2. Biotransformations: Microbial degradation of health-risk compounds edited by Ved Pal Singh. Elsevier 1995.
3. Microbial Ecology: Fundamentals and applications 4th ed. Ronald H. Atlas and Richard Bartha. Reprint 2005. Pearson Education.
4. Environmental Microbiology. Raina M. Maier, Ian L. Pepper, Charles P. Gerba. Academic Press (Elsevier) 2000

Unit 4

1. Anaerobic bacteria K.T.Holland, J.S. Knapp, J.S. Shoemith. Chapman &Hall, New York. 1987.
2. Bacterial Metabolism, Gottschalk, G., 2nd edition, 1985, Springer-Verlag
3. Brock Biology of Microorganisms. Michael Madigan, John M. Martinko. Pearson International edition. 11th edition

Course Name and No.-3 Medical Microbiology and Microbial Pathogenesis		BTL
After Completion of course, the learner will be able to		
CO1	Analyze the molecular mechanisms of virulence factors employed by pathogens to cause disease	Analyze
CO2	Analyze the virulence factors and mechanisms of transmission for selected emerging pathogens	Analyze
CO3	Apply bacteriological techniques for the isolation, identification, and characterization of clinically relevant bacteria	Apply

Sub unit	Topics	No. of Lectures
Unit I	Mechanisms of Pathogenesis-1	
1.1	Overview of bacterial mechanisms of evading/surviving host defense Bacterial persistence within the host a. Surviving phagocytosis eg: <i>Legionella</i> , <i>Salmonella</i> , and <i>Mycobacterium</i> b. Chronic infections eg: Brucellosis and typhoid fever	01 04
1.2	Toxins and secretion systems a. Bacterial toxins and intoxications- eg: Diphtheria and Botulism-its regulation , mode of action b. Secretion Systems specific to Gram Negative Bacteria and Gram-Positive Bacteria	02 03
1.3	Mechanisms of Virulence Regulation: I. Types of Regulation II. Bacterial communication and virulence: a. Quorum Sensing signalling molecules b. Mechanisms of quorum sensing in Gram Negative and Gram positive bacteria	02 03
Unit II	Pathogenesis and Human Microbiome	
2.1	Microbial biofilms a. Structure, properties and formation b. Biofilm-related Infections on Tissue Surfaces c. Biofilms Associated with Medical Devices and Implants	05
2.2	Antibiotic Resistance a. Genetic Basis of antimicrobial resistance b. Mechanistic basis of antimicrobial resistance- modification of antibiotic molecules, decreased penetration and efflux, changes in target sites, Resistance Due to Global Cell Adaptations	04
2.3	The Human Microbiome a. Introduction to the concept of Microbiome, The Human Microbiome Project	06

	b. Gut microbiome- types of organisms, functions, role in health and disease	
	Self-Study: 1. Current developments in the Human Microbiome project 2. Microbiome of any other system or organ other than gut	
Unit III	Emerging infectious diseases in India and Epidemiology	
3.1	Emerging infectious diseases (with emphasis on etiology, virulence mechanism, diagnosis and prevention) a. Pandemic Influenza b. Nipah Virus c. <i>Acinetobacter</i> d. <i>Candida auris</i> e. Hepatitis C f. Rickettsial infections	10
3.2	Epidemiology a. Methods and procedures for epidemiological study of infections. b. Epidemiology of infectious diseases, case studies- food borne diseases, XDR-TB	05
Unit IV	Clinical Bacteriology	
4.1	Laboratory Methods for Antimicrobial susceptibility testing a. Conventional testing methods b. Commercial Testing methods c. Other methods- Time kill curves, Serum killing curves d. Testing antibiotic combinations	04
4.2	Detection of specific types of Antibiotic Resistance a. Methicillin(Oxacillin) resistant and decreased Vancomycin susceptibility in <i>Staphylococci spp.</i> b. Beta lactam resistance and Decreased susceptibility to Vancomycin in Enterococci	04
4.3	Quality Control in Medical Microbiology a. Laboratory design and safe microbiological practice GLP in culture and media preparation b. Sample management and Process control (an overview) c. Quality control of culture media, reagents, equipments, process, personnel, report	07

PRACTICALS BASED ON PSC1MIPR-4

1. Study of few virulence mechanisms in pathogens
2. Study of Quorum Sensing and Quorum sensing inhibitors in *C. violaceium*
3. Microbial Biofilm formation on various surfaces
4. Determination of Minimum Biofilm Inhibition Concentration of an antibiotic

5. Detection of specific types of Antibiotic Resistance.
 - a. MRSA
 - b. VRE
6. Antibiotic susceptibility testing- Conventional micro broth dilution method according to CLSI guideline.
7. Checker Board Assay for detecting synergistic activity of two antibiotics
8. Determination of Quality Assurance of laboratory media, reagents.
9. Problems on Epidemiology

TEXTBOOKS

1. Bacterial Pathogenesis- A Molecular Approach by Brenda Wilson, Abigail Saylers et al, Third ed, ASM Press, 2011
2. Virulence Mechanisms of Bacterial Pathogens, by Indira Kudva, Nancy Cornick et al, Fifth ed, ASM Press, 2016
3. Medical Biofilms-Detection Prevention and Control by Jana Jass, Susanne Surman et al, Wiley, 2003
4. The Human Microbiota and Microbiome ed by Julian Marchesi, Advances in Molecular and Cellular Microbiology 25, CAB International, 2014
5. A brief guide to emerging infectious diseases and zoonoses.WHO
6. Understanding emerging and re-emerging infectious diseases by Suparna Duggal and Jyoti Mantri Himalaya Publishing House
7. Friis, Robert H_Sellers, Thomas A, Epidemiology for Public Health Practice-Jones and Bartlett Learning (2014).pdf.
8. Principles of Epidemiology in Public Health Practice-Third Edition, An Introduction to Applied Epidemiology and Biostatistics –Centers for Disease Control and Prevention (CDC).
9. Handbook of Microbiological Quality Control, Pharmaceutical and Medical DevicesRosamund M Baird. (CRC Press)
10. Introduction to Diagnostic Microbiology for the Laboratory Sciences, Maria DannessaDelost, 2015, Jones and Bartlett Learning
11. Ananthanarayan and Paniker’s Textbook of Microbiology, by Reba Kanungo, 10thedUniversities Press; Tenth edition, 2017
12. Bailey and Scotts Diagnostic Microbiology Forbes, Sahem et al 12thed, Moshby

REFERENCES

1. Micromanagement in the gut: micro environmental factors govern colon mucosal biofilm structure and functionality by Rosemarie De Weirdt and Tom Van de Wiele, Biofilms and Microbiomes (2015) 1, 15026; doi:10.1038/npjbiofilms.2015.26
2. Clinical and Pathophysiological Overview of Acinetobacter Infections: a Century of Challenges, Clin Microbiol Rev 30:409 –447.https://doi.org/10.1128/CMR.00058- 16.Published on 14th Dec, 2016
3. Nett JE (2019) *Candida auris*: An emerging pathogen “incognito”? PLoSPathog 15(4): e1007638. https://doi.org/10.1371/journal.Published: April 8, 2019

4. Spivak ES, Hanson KE. 2018. *Candida auris*: an emerging fungal pathogen. *J Clin Microbiol* 56:e01588-17. <https://doi.org/10.1128/JCM.01588-17>.
5. Ang BSP, Lim TCC, Wang L. 2018. Nipah virus infection. *J Clin Microbiol* 56:e01875-17. <https://doi.org/10.1128/JCM.01875-17>.
6. Abdad MY, Abou Abdallah R, Fournier P-E, Stenos J, Vasoo S. 2018. A concise review of the epidemiology and diagnostics of rickettsiases: *Rickettsia* and *Orientia* spp. *J Clin Microbiol* 56:e01728-17. <https://doi.org/10.1128/JCM.01728-17>.
7. Rickettsial Infections: Indian Perspective Narendra Rathi And Akanksha Rathi, *Indian Pediatrics* Vol 47 February 17, 2010
8. Special Article on Quality Assurance in Microbiology by D.R. Arora- *Indian Journal of Medical Microbiology*, (2004) 22 (2) : 81-86.

**M. Sc. I Microbiology Semester I Syllabus
(Elective Course)**

Course Code : PSC1MI-4 (Elective)

Title of the Paper: Environmental Microbiology and Sustainability

Credits : 2 Total No. of Lectures : 30 (15 Lectures/Unit)

Course Name and No.: Elective 1 - Environmental Microbiology & Sustainability		BTL
CO1	Evaluate the biotechnological potential of extremophiles and their enzymes (extremozymes) for various applications	Evaluate
CO2	Demonstrate a comprehensive understanding of ecological principles and their application to environmental management	Remember
CO3	Analyze the impacts of human activities on ecosystems and natural resources	Analyze

Sub unit	Topics	No. of Lectures
Unit I	Extremophiles	
1.1	Physiology, Biochemistry and Applications of: a. Thermophiles b. Psychrophiles c. Piezophiles d. Radiation resistant organisms	07
1.2	Physiology, Biochemistry and Applications of: a. Acidophiles b. Alkaliphiles c. Halophiles	05
1.3	Geo Microbiology – Bio corrosion and Bioleaching	03
Unit II	Environment & Natural Resource Management & Safety Standards	
2.1	Natural resources: a. Renewable/ non-renewable resources of Land, water, forest, minerals, energy, food b. Associated problems and management practices c. Environmental Impact Assessment and Sustainable Development	02
2.2	Solid waste management: a. Classification of solid waste b. Effects of solid waste pollution c. Key components of solid waste management 1. On site disposal options 2. Offsite disposal options d. Biodegradable waste from kitchen, abattoirs and agricultural fields and their recycling by aerobic composting or bio-methanation e. Non-biodegradable waste like plastics, glass, metal scrap, e waste and building materials, and its recycling	04
2.3	Hazardous waste management: a. Hazardous wastes: definition, levels of biohazards, Risk assessment and handling procedures	05

	<ul style="list-style-type: none"> b. Xenobiotic compounds and its biodegradation c. Management of hazardous waste using biotechnological applications d. Examples: cyanide detoxification, petrochemical industry effluents, phenols, Hazardous waste from paint, pesticides and chemical industries Probable means to reduce these waste through Common Effluent 	
2.4	<p>Biosafety:</p> <ul style="list-style-type: none"> a. Need for biosafety levels b. Biosafety guidelines for GMOs and LMOs c. Role of Institutional bio safety committee. RCGM, GEAC, etc. for GMO applications in food and agriculture d. Environmental release of GMOs e. Overview of national regulations and relevant international agreements f. Ecolabelling, ISO 14001 g. Generally Recognized as Safe (GRAS) 	04
	<p>Self-study topics:</p> <ul style="list-style-type: none"> 1. Methods of extracting total bacterial DNA from a habitat 2. Case study : EIA report of a polluted ecosystem 	

REFERENCES

Unit 1

1. Gerday, C., Glansdorff, N., & American Society for Microbiology. (2007). Physiology and biochemistry of extremophiles. Washington, D.C: ASM Press.
2. Horikoshi, K., Antranikian, G., Bull, A.T., Robb, F.T., Stetter, K.O. (Eds.) (2011), Extremophiles Handbook. Springer
3. Fred A. Rainey and Aharon Oren (2006). Methods in Microbiology - Volume 35, Extremophiles, 1st edi., Academic Press.
4. S.K.Kawatra and K.A. Natarajan, "Mineral Biotechnology- Microbial Aspects of Mineral Beneficiation, Metal Extraction, and Environmental Control", published by SME, Littleton, CO (USA) 2001
5. S.W.Borenstein, Microbiologically influenced corrosion handbook, Woodhead pub. Ltd., Cambridge (1994)
6. Microorganisms In Biofouling and Biocorrosion: <https://nptel.ac.in/courses/113108055/module7/lecture34.pdf>

Unit 2

1. Textbook for Environmental Studies For Undergraduate Courses of all Branches of Higher Education by Erach Bharucha for University Grants Commission
2. Essential environmental studies, S.P.Mishra, S.N.Pandey, Ane books pvt ltd
3. Environmental management, Jadhav H. V., 2002, Vipul Prakashan.
4. Environmental Biotechnology (Industrial Pollution Management) by S N Jogdand, Himalaya publishing house
5. Environment and Ecology, S.P.Mishra, S.N.Pandey, Ane books pvt ltd

6. Technical EIA guidance manual for Common Hazardous Waste Treatment, Storage and Disposal Facilities, Prepared by Ministry of environment and forests, Government of India, 2010: <http://environmentclearance.nic.in/>
7. Guidelines for environmentally sound management of e-waste, ministry of environment & forests central pollution control board, Delhi,2008: [http://www.cpcb.nic.in/latest/e waste pdf](http://www.cpcb.nic.in/latest/e%20waste%20pdf)
8. Evidence-Based Biosafety: a Review of the Principles and Effectiveness of Microbiological Containment Measures, 2008: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2493080/>

Evaluation Pattern

Choice Based Credit System (CBCS)

❖ Revised 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	Any two tools out of these (10 Marks each) 1. Group/ Individual Project 2. Presentation and write up on the selected topics of the subjects (Semester I & II) / Case studies (Semester II). 3. Test on Practical Skills 4. Open Book Test 5. Quiz (Semester I)	20 Marks

Question Paper Pattern

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

❖ Maximum Marks: 20

❖ Duration: 30 Minutes

Particular	Marks
Match the Column / Fill in the Blanks / Multiple Choice Questions/ True/False/Answer in One or Two Lines (Concept based Questions) (1 Marks each)	20 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**

1. There shall be five questions each of 12 marks.
2. All questions shall be compulsory with internal options.
3. Question may be subdivided into sub-questions a, b, c... and the allocation of marks depends on the weightage of the unit.

❖ 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.

Janardan Bhagat Shikshan Prasarak Sanstha's

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



Re-accredited 'A+' 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 Credit System (CBCS)

w.e.f. Academic Year 2023-24

M. Sc. I Microbiology Syllabus

M. Sc. I Microbiology Syllabus Semester I and II

INDEX

SEMESTER I

THEORY

Course Code	Unit	Topic Headings	Credits	Lecture/Topic
PSC1MI-1 Molecular Genetics -1	I	Genetic Exchange among bacteria and Recombination	04	15
	II	Eukaryotic Transposable elements, DNA repair and Genetics of Cancer		15
	III	Regulation of gene expression in prokaryotes		15
	IV	Global regulation of genes in bacteria		15

Course Code	Unit	Topic Headings	Credits	Lecture/Topic
PSC1MI-2 Biochemistry	I	Concepts in chemical reactivity and aqueous solution	04	15
	II	Bioorganic molecules		15
	III	Degradation and transformation of organic molecules		15
	IV	Physiology and metabolism of anaerobic bacteria		15

Course Code	Unit	Topic Headings	Credits	Lecture/Topic
PSC1MI-3 Medical Microbiology and Microbial pathogenesis	I	Mechanisms of Pathogenesis- 1	04	15
	II	Mechanisms of Pathogenesis-2 and Human Microbiome		15
	III	Emerging infectious diseases in India(with emphasis on Etiology, virulence mechanism, diagnosis and prevention) and Epidemiology		15
	IV	Clinical Bacteriology		15

Unit	Topic Headings	Credits	Practical/Week
PSC1MIPR-1	Molecular Genetics -1	04	02
PSC1MIPR-2	Biochemistry	04	02
PSC1MIPR-3	Medical Microbiology and Microbial pathogenesis	04	02

Course Code	Unit	Topic Headings	Credits	Lecture/Topic
PSC2MI-1 Molecular Genetics -2	I	Regulation of Gene Expression in Eukaryotes	04	15
	II	Genetic regulation of the development of Drosophila , organelle DNA & population genetics		15
	III	Molecular tools for genetics		15
	IV	Metagenomics, comparative & functional Genomics, Proteomics		15

Course Code	Unit	Topic Headings	Credits	Lecture/Topic
PSC2MI-2 Applied Biochemistry	I	Enzymology	04	15
	II	Signalling and stress		15
	III	Unusual biomolecules and bioactive compounds		15
	IV	Metabolism of one and two carbon compounds		15

Course Code	Unit	Topic Headings	Credits	Lecture/Topic
PSC2MI-3 Applied Immunology	I	Adversarial strategies during infection	04	15
	II	Immunodeficiency		15
	III	Advances in Allergy and other hypersensitivity		15
	IV	Tumor Immunology & Autoimmune diseases		15

Unit	Topic Headings	Credits	Practical/Week
PSC2MIPR-1	Molecular Genetics -2	04	02
PSC2MIPR-2	Applied Biochemistry	04	02
PSC2MIPR-3	Applied Immunology	04	02



Programme Outcomes - M. Sc. (Microbiology)

Sr. No.	Outcome for M.Sc. Program After completion of M.Sc. program students will acquire	Graduate Attribute
PO1	The ability to identify and describe broadly accepted methodologies of science, and different modes of reasoning.	Disciplinary knowledge
PO2	An ability to demonstrate proficiency in various instrumentation, modern tools, and advanced techniques to meet industrial expectations and research outputs.	Disciplinary knowledge
PO3	Ability to identify problems, formulate, and prove hypotheses by applying theoretical knowledge and skills relevant to the discipline.	Problem-solving
PO4	The ability to articulate thoughts, research ideas, information, scientific outcomes in oral and in written presentation to range of audience.	Communication skills
PO5	A capacity for independent, conceptual, and creative thinking, and critical analysis through the existing methods of enquiry.	Critical thinking
PO6	Acquisition of skills required for cutting edge research, investigations, field study, documentation, networking, and ability to build logical arguments using scholarly evidence.	Research skills
PO7	An ability to portray good interpersonal skills with the ability to work collaboratively as part of a team undertaking a range of different team roles	Teamwork
PO8	The ability to understand ethical responsibilities and impact of scientific solutions in global, societal, and environmental context and contribute to sustainable development	Moral and ethical awareness/ multicultural competence
PO9	An openness to and interest in life-long learning through directed and self-directed study	self-directed learning
PO10	The ability to translate the knowledge and demonstrate the skills required to be employed and successful professional development.	Life-long learning
PO11	The ability to identify and describe broadly accepted methodologies of science, and different modes of reasoning.	Disciplinary knowledge

Programme Specific Outcomes - M. Sc. (Microbiology)

PSOs	
PSO1	The program is aimed at equipping the students with basic knowledge in various branches of Microbiology such as Microbial Genetics, Molecular Biology, Virology, Medical Microbiology, Immunology, Microbial Biochemistry, Environmental Microbiology, Advances in Biotechnology and Industrial (food, pharmaceutical) Microbiology. Additionally, it also makes students aware of interdisciplinary sciences such as Bioinformatics and Bioinstrumentation
PSO2	At the end, student will have employability in food industry, pharmaceutical industry, Agricultural industry and fishery. Students will work as microbiologist in Research, QC, QA and production departments
PSO3	Students will develop basic understanding of the subject and will have developed life skills to solve environmental and hygiene related problems

M. Sc. I Microbiology Semester II Syllabus

Course Name and No.: 1 Molecular Genetics -2		BTL
After Completion of course, the learner will be able to		
CO1	Explain the role of chromatin structure, epigenetic modifications, and transcription factors in gene regulation	Understand
CO2	Apply population genetics principles to understand genetic variation and evolution	Apply
CO3	Explain the principles and applications of various molecular techniques used in genetics research	Understand

Sub unit	Topics	No. of Lectures
Unit I	Regulation of Gene Expression in Eukaryotes	
1.1	Control of Gene Expression in Eukaryotes:	
	1.1.1 Role of regulatory proteins, activators and repressors molecules	05
	1.1.2 The Role of Chromatin in Regulating Gene transcription	02
	1.1.3 Silencing and Genomic Imprinting	02
	1.1.4 RNA Processing Control	02
	1.1.5 RNA Interference	02
	1.1.6 Post transcriptional regulation of gene expression	02
Unit II	Genetic Regulation of the Development Of <i>Drosophila</i> , Organelle DNA & Population Genetics	
2.1	Drosophila developmental	04
	a. Stages	
	b. Embryonic development	
	c. Maternal effect genes	
	d. Segmentation genes	
	e. Homeotic genes	
	Self-study: Drosophila a traditional geneticist's and embryologist 's tool.	04
2.2	2.2.1 Organelle DNA:	02
	a. The genetics of organelle encoded traits	
	b. The endosymbiotic theory	
	2.2.2 Mitochondrial DNA	03
	a. The gene structure and organization of mitochondrial DNA	
	b. Non universal codons in Mitochondrial DNA, replication, transcription and translation of Mitochondrial DNA	
	c. Evolution of Mitochondrial DNA	
	2.2.3 Chloroplast DNA	02
	a. Properties similar to Eubacterial DNA	
	b. Gene structure and organization of chloroplast DNA	
	c. Replication, transcription and translation of chloroplast DNA	

2.3	Population genetics <ol style="list-style-type: none"> 1. Genetic structure of population 2. Hardy-Weinberg Law 3. Genetic variation in space and time 4. Genetic variation in Natural population 5. Forces that change gene frequencies in populations: <ol style="list-style-type: none"> a. Mutation b. Random genetic drift c. Migration d. Natural selection e. Balance between mutation and selection f. Assortative mating g. Inbreeding 6. Summary of the effects of evolutionary forces on the genetic structure of population 7. The role of genetics in conservation Biology 	05
Unit III	Molecular Tools For Genetics	
3.1	Polymerase Chain Reaction- Fundamentals of the PCR, Variations/ Modifications of PCR: Reverse transcriptase PCR, Differential display PCR, Real time Fluorescent PCR, Hot- Start PCR, Multiplex PCR, Nested PCR, Applications	05
3.2	Molecular tools for studying genes and gene activity <ol style="list-style-type: none"> 3.2.1 Molecular separations: Gel electrophoresis, Two-dimensional gel electrophoresis 3.2.2 Labelled tracers: Autoradiography, Liquid scintillation counting Nonradioactive tracers 3.2.3 Using nucleic acid hybridization: Southern blots, DNA fingerprinting and DNA typing, In situ hybridization: Locating genes in chromosomes, Immunoblots 3.2.4. DNA sequencing and physical mapping: The Sanger Chain-Termination Sequencing method, High-throughput Sequencing, Restriction Mapping, Site-directed mutagenesis 3.2.4 Mapping and quantifying transcripts, Northern blots, S1 mapping, Primer extension, Run-off transcription and G-less cassette transcription 3.2.5 Measuring transcription rates in vivo: Reporter gene transcription, Measuring protein accumulation in vivo: Assaying DNA – protein interactions, footprinting methods, Chromatin immune-precipitation (ChIP) 3.2.6 Knockouts: Gene knock out in yeast, Gene knockouts in mouse, Knocking down expressed gene by RNA interference (RNAi) 	10
Unit IV	Metagenomics, Comparative & Functional Genomics, Proteomics	
4.1	Metagenomics <ol style="list-style-type: none"> 4.1.1 Comparative Genomics: finding Genes that make us human, recent changes in the human genome 4.1.2 Characterization of Gene amplification and deletions in Cancer using DNA microarrays (Representational Oligonucleotide Microarray Analysis (ROMA)) 	08

	4.1.3 Functional genomics-DNA Microarray technology, Serial analysis of gene expression (SAGE)	
4.2	Proteomics 4.2.1 Separation and identification of proteins (2D PAGE, MALDI –TOF), Protein profiling (LC-MS) 4.2.2 Protein interaction by Co-immunoprecipitation, protein tagging system, Protein Microarrays, Protein-protein interaction Mapping (Two hybrid assay, TAP tag procedure)	07
	Self-study: Use of MALDI-TOF for identification of microbial cultures	

PRACTICALS BASED ON PSC2MIPR-1

1. Southern hybridization technique [Demonstration]
2. Northern Blotting technique [Demonstration]
3. Western blotting [Demonstration]
4. Restriction digestion of DNA & Restriction mapping
5. Design of primer & its use for polymerization by PCR
6. DNA electrophoresis
7. Protein electrophoresis (PAGE)
8. Problems on population genetics
9. LC-MS protein expression profile , MALDI-TOF, Microarray- Visit to research institute

REFERENCES

1. iGenetics- A Molecular Approach, Russell, P.J., 3rd edition, 2010, Pearson International edition
2. Fundamental Bacterial Genetics, Trun, Trempey, 1st edition, 2004, Blackwell Publishing
3. Molecular Biology of the Gene, Watson, Baker, Bell, Gann, Levine, Losick, 7th edition, 2007, Pearson Education
4. Genes IX, Lewin, B., 2006, Jones and Bartlett Publishers
5. Genetics: A Conceptual Approach, Benjamin Pierce 4th edition, 2008, W. H. Freeman & Co
6. Principles of Genetics, Snustad & Simmons, 6th edition, 2012, John Wiley & Sons Inc
7. Molecular biology –Genes to proteins 3rd ed. by Burton E. Tropp (Jones & Bartlett publishers)
8. Molecular Genetics of bacteria, 3rd Edition by Larry Snyder and Wendy Champness (ASM press)
9. Molecular biology -Understanding the Genetic Revolution by David P. Clark(Elsevier Academic press)
10. Molecular Biotechnology Principles and applications of Recombinant DNA 4th edi Glick, Pasternak, Patten
11. Recombinant DNA J.D. Watson 2nd ed
12. PCR, Clive R. Newton, Alex Graham. (1997); BIOS Scientific Publishers.
13. Molecular Biology by R. F. Weaver 3rd edition, McGraw-Hill international edition

Course Code : PSC2MI-2
Credits : 4

Title of the Paper: Applied Biochemistry
Total No. of Lectures: 60 (15 Lectures/Unit)

Sub unit	Topics	No. of Lectures
Unit I	Enzymes: the catalysts of Cells	
1.1	Information from kinetics, specificity of enzymatic action, mechanisms of catalysis	07
1.2	Inhibition and activation of enzymes	02
1.3	Enzyme isolation and purification	06
	Self-study: Draw Eadie-Hofstee, Hanes-Woolf plot, Dixon plot and Cornish-Bowden plot and interpret	
Unit II	Signaling and stress	
2.1	Introduction to two-component signalling systems	07
2.2	Synthesis of virulence factors in response to temperature, pH, nutrient, osmolarity and quorum sensors, chemotaxis, photoresponses, aerotaxis	04
2.3	Bacterial development and quorum sensing: Myxobacteria, Caulobacter, bioluminescence systems similar to LuxR/LuxI in non-luminescent bacteria	04
Unit III	Natural and Unusual bio-molecules and bioactive compounds	
3.1	Bioactive proteins & peptides: peptides as bioactive agents, peptides with anti-oxidative activity, antimicrobial peptides, enzyme based antimicrobial proteins, non-enzyme based antimicrobial proteins, commercialization of antimicrobial proteins and peptides. Lectins, surfactants, albumin, cryoprotectants, lyoprotectants	09
3.2	Classes of Natural Products: polyketides, terpenes & steroids, alkaloids, phenylpropanoids, Flavonoids. Non coding RNAs	04
3.3	Functional carbohydrates and hydrocolloids Cereal β Glucans, modified starch, microbial Polysaccharides, Chitosan	02
	Self-study: A report on source, structure and application on unusual hydrocolloid/ lipid(etc) molecules other than that listed above	
Unit IV	Metabolism of one and two carbon compounds	
4.1	Metabolism of one carbon compounds a. Methylotrophs: Oxidation of methane, methanol, methylamines and carbon assimilation in methylotrophic bacteria and yeasts b. Methanogens: Methanogenesis form H_2 , CO_2 , CH_3OH , $HCOOH$, methylamines, energy coupling and biosynthesis in methanogenic bacteria c. Acetogens: autotrophic pathway of acetate synthesis and CO_2 fixation, d. Carboxidotrophs: Biochemistry of chemolithoautotrophic metabolism e. Cynogens and cynotrophs: cynogenesis and cyanide degradation	11
4.2	Metabolism of two carbon compounds a. Acetate-TCA and Glyoxylate cycle, modified citric acid cycle, carbon monoxide dehydrogenase pathway and disproportionation to methane b. Ethanol-acetic acid bacteria c. Glyoxylate and glycollate-dicarboxylic acid cycle, glycerate pathway, beta hydroxy aspartate pathway d. Oxalate as carbon and energy source	04

PRACTICALS BASED ON PSC2MIPR-3

1. Isolation, partial purification and study of enzyme kinetics of amylase.
2. Adaptation of *E. coli* to anaerobiosis
3. Effect of temperature and water activity on swarming of *Proteus spp*s
4. Isolation of amylopectin and amylose from potato starch.
5. Isolation of Lycopene from tomatoes
6. Preparation of lectin from plant source and its application
7. Isolation of *Oxalobacter Sp.*

REFERENCE BOOKS

Unit I

1. Biochemistry: The chemical reactions of living cells (Vol 1) David E. Metzler. Academic Press.
2. Fundamentals of enzymology. 2nd edition. Nicholas C. Price and Lewis Stevens. Oxford Science Publication. Reprint 1998.

Unit II:

1. The physiology and biochemistry of prokaryotes, White D., Drummond, T. J. and Fuqua C., 3rd edition, 2007, Oxford University Press

Unit III:

1. Bioactive food proteins & peptides Applications in human health, ed Navam S. Hettiarachchy, CRC press, 2012
2. Natural products: the secondary metabolites. James R. Hansen. Royal Society of Chem.
3. Development & manufacture of Protein Pharmaceuticals. Ed Steven L. Nail and Michael J. Akers. Springer Science 2002 [ISBN 978-1-4615-0549-5]
4. Functional food carbohydrates. Costas G. Biliaderis and Marta S. Izydorczyk. CRC press 2007.
5. Chemistry of Natural products by SV Bhat, BA Nagasampagi & M Sivakumar, Berlin Springer (2005) (ISBN 3-540-40669-7).
6. Handbook of hydrocolloids. 2nd edition. Ed G.O. Phillips and P.A. Williams. CRC Press. Woodhead Publishing Limited [ISBN-978-1-84569-587-3]

Unit IV

1. Bacterial metabolism by Gottschalk, Springer-Verlag, 1985
2. Biotechnology H.J. Rehm and G. Reed (ed.), Volume 6a. Biotransformations, Verlag and Chemie, 1984

REFERENCE BOOKS

1. Laboratory manual in biochemistry by Jayaraman J. , New Age International Publishers .
2. Enzymes 3rd edition. Malcolm Dixon and Edwin C. Webb. Longman Group 1979.
3. An introduction to practical biochemistry 3rd . edition, David T Plummer, Tata McGraw Hill edition 1998
4. Experimental biochemistry –A student companion, Rao Beedu, S. Deshpande, IK international Pvt. Ltd.
5. Laboratory manual in biochemistry, Immunology and Biotechnology, Nigam A and Ayyagiri A. Tata McGraw Hill edition
6. Source of Experiments for teaching Microbiology, Primrose and Wardlaw
7. Microbial Physiology and Biochemistry Laboratory manual: A quantitative approach , David White

Sub unit	Topics	No. of Lectures
Unit I	Adversarial strategies during infection	
1.1	1.1.1 Bacterial survival strategies <ul style="list-style-type: none"> a. Evading complement b. Evading killing by macrophages 1.1.2 The host counter attack against bacteria <ul style="list-style-type: none"> a. Toxin neutralization b. Opsonization of bacteria 1.1.3 The habitat of intracellular bacteria: Bacterial survival strategies <ul style="list-style-type: none"> a. Defence against intracellular bacteria b. Role of activated Macrophages 1.1.4 Viral survival strategies <ul style="list-style-type: none"> a. Antigenic variations b. Non-functional T- cell epitopes c. Interference with antigen processing and/ or presentation d. Interference with immune effector mechanism 1.1.5 Immunity to fungi	10
1.2	Vaccines <ul style="list-style-type: none"> 1.2.1. Subunit vaccines <ul style="list-style-type: none"> a. Purified components as bacterial vaccines b. Viral subunit as vaccine c. Carbohydrate vaccine d. DNA and RNA vaccines 1.2.2 Newer approaches to vaccine development 1.2.3 Current vaccines 1.2.4 Difficulties in the development of Parasitic vaccines : Malaria 1.2.5 Vaccines for protection against bioterrorism 1.2.6 Immunization against cancer Self-study : Vaccines under development	05
Unit II	Immunodeficiency	
2.1	2.1.1 Deficiencies of pattern recognition -Receptor signalling 2.1.2 Phagocytic cell defects 2.1.3 Complement system deficiencies 2.1.4 Cytokine and cytokine receptor deficiencies 2.1.5 Primary B-cell deficiency 2.1.6 Primary T- cell deficiency 2.1.7 Severe combined immunodeficiency 2.1.8 Diagnosis and treatment of primary immunodeficiency	08
2.2	Immune Tolerance <ul style="list-style-type: none"> 2.2.1 Major mechanisms for achieving tolerance 	07

	<p>2.2.2 Central Tolerance</p> <p>2.2.3 Peripheral Tolerance</p> <p>2.2.4 Tolerance induction</p> <p>2.2.5 Immunoprivileged sites - The brain, the eyes</p>	
Unit III	Advances in Allergy and other hypersensitivities	
3.1	<p>3.1.1 Type – I hypersensitivity</p> <p>3.1.2 Type – II hypersensitivity</p> <p>3.1.3 Type – III hypersensitivity</p> <p>3.1.4 Type – IV hypersensitivity</p> <p>3.1.5 Type - V hypersensitivity (Mechanism/principle, examples, diagnosis and treatment of these hypersensitive)</p>	07
3.2	<p>Transplantation and Transfusion Immunology</p> <p>3.2.1 Types of Graft</p> <p>3.2.2 Types of graft rejection</p> <p>3.2.3 Mechanisms of graft rejection</p> <p>3.2.4 Matching the donor and recipient</p> <p>3.2.5 Immuno-suppression</p> <p>3.2.6 The foetus as an allograft</p> <p>3.2.7 Blood transfusion - Blood grouping and cross matching - Transfusion reactions - Criteria for selection and rejection of Blood Donor</p>	08
Unit IV	Immunological disorders	
4.1	<p>Tumor Immunology</p> <p>4.1.1 Cell- intrinsic and extrinsic mechanisms of tumor suppression</p> <p>4.1.2 Role of inflammation in the enhancement of tumor initiation, promotion and progression</p> <p>4.1.3 Tumor antigens and their classes</p> <p>4.1.4 Approaches to cancer immunotherapy</p> <p>a. Passive immunotherapy with monoclonal antibodies</p> <p>b. Unmasking of the latent T- cell responses</p> <p>c. Antigen independent cytokine therapy</p>	07
4.2	<p>Autoimmune diseases</p> <p>4.2.1 Causes</p> <p>4.2.2 Mechanisms</p> <p>4.2.3 Pathogenic effects of autoantibody</p> <p>4.2.4 Pathogenic effects of complexes with auto antigens</p> <p>4.2.5 T cell mediated hypersensitivity as a Pathogenic factor in autoimmune disease</p>	08
	<p>Self-Study Topics</p> <p>1. Case studies – Autoimmune diseases</p> <p>2. Case studies - Use of Immune therapies in cancer, transplantation and other immunological disorders</p>	

PRACTICALS BASED ON PSC2MIPR-2

1. Hemoglobin estimation by Cyanmethaemoglobin method using Drabkins Fluid as one of the criteria used for selection of blood donor during collection of blood for safe transfusion.
2. Blood grouping and Compatibility testing /cross matching of blood for safe blood transfusion.
3. Determination Of Enzymes Of Oxidative Stress (SOD And Catalase)
4. NBT (nitroblue tetrazolium) Analysis Of Blood Sample
5. Serum Lysozyme Activity
6. Serum Myeloperoxidase Activity (MPO)
7. Rheumatoid factor test for laboratory diagnosis of Rheumatoid arthritis
8. Lupus erythematosus (LE) cell preparation-Principle, Procedure and Significance to be explained during the practicals using permanent slides/ color atlas of diagnostic immunology/Microbiology
9. RIST and RAST- Principle, Procedure and Significance to be explained during the practicals using power point presentation/ youtube.

Text books

1. Roitt's Essential Immunology 13th Ed. –Wiley Blackwell
2. Kuby Immunology 6th Ed – W. H. Freeman and Company, New York

Reference Books

1. Immunology –Essential and Fundamental – Sulbha Pathak, Urmi Palan, 3rd Ed. Capital Publishing Company (New Delhi-Kolkata)
2. Kuby Immunology 7th Ed – W. H. Freeman and Company, New York
3. Kuby Immunology 8th Ed – Macmillan education
4. Immunology – An Introduction 4th Ed – Tizard
5. Elements of Immunology- Fahim Halim Khan –Pearson Education
6. Medical Laboratory Technology - Kanai Mukherjee vol. 1

**M. Sc. I Microbiology Semester II Syllabus
(Elective Course)**

Course Name and No.: Elective 1 Bioinformatics & Immunodiagnosics		BTL
After Completion of course, the learner will be able to		
CO1	Explain the fundamental concepts of biological databases, sequence alignment, and phylogenetic analysis	Understand
CO2	Describe the role of immunodiagnosics in disease prevention, diagnosis, and monitoring	Remember
CO3	Critically evaluate the clinical utility of immunodiagnostic tests	Evaluate

Sub unit	Topics	No. of Lectures
Unit I	Bioinformatics	
1.1	4.1 Introduction and Revision of T.Y.B.Sc topics to give an overview of bioinformatics	01
	4..1.1 Biological databases-nucleic acid sequence databases- gene bank/ EMBL/ DDBJ	01
	4.1.2 Protein sequence data bases- (UniProtKB), Derived databases(Prosite, BLOCKS, Pfam/Prodom) Structural databases (PDB , NDB) and Enzyme databases	03
1.2	4.2.1 Concept in sequence analysis - Needleman & Wunsch , Smith & Waterman alignment algorithms	01
	4.2.2 Scoring Matrix for nucleic acids and protein- MDM.BLOSUM.CSW	01
	4.2.3 Alignment: Pair wise BLAST, FASTA	01
	4.2.4 Multiple sequence alignment, PRAS, CLUSTAL W	01
1.3	Phylogenetic analysis and Tree construction Basic concepts of phylogenetic analysis, rooted/uprooted trees, approaches for phylogenetic tree construction	02
1.4	Structure predictions for proteins- Basic approaches for protein structure predictions, comparative modelling, fold recognition	02
1.5	Chemo-informatics- Introduction, applications in pharmaceutical industries	01
1.6	Immuno-informatics- Overview, Reverse vaccinology , Rational Vaccine design	01
	Self-Study : Study of 3D structures of enzymes /protein	
Unit 2	Immunodiagnosics	
2.1	Proteomics and the proteome, branches	05
2.2	Overview of techniques and challenges	05
2.3	Applications : Disease diagnosis[cancer biology, autoimmune, allergic response], Glycomics, use of protein biomarkers	05
	Self-study: one application in agriculture / environmental/ toxicogenomics/ nutraceuticals etc.	

REFERENCE BOOKS

Unit I:

1. Mount, D. W. (2001) Bioinformatics: sequence and genome analysis. Cold Spring Harbor Laboratory Press, New York.
2. Introduction to Bioinformatics T.K. Attwood and D.J Perry-Smith
3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by Baxevanis A.D. and Ouellette, Third Edition. John Wiley and Son Inc., 2005

Unit II

1. Introduction to proteomics Tools for the new Biology. Daniel C. Liebler. Humana Press 2002
2. OMICS Applications in Biomedical, Agricultural and Environmental Sciences. Ed Debmalya Barh, Vasudeo Zambare, Vasco Azevedo. CRC press. 2013

Evaluation Pattern

Choice Based Credit System (CBCS)

❖ Revised 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	Any two tools out of these (10 Marks each) 1. Group/ Individual Project 2. Presentation and write up on the selected topics of the subjects (Semester I & II) / Case studies (Semester II). 3. Test on Practical Skills 4. Open Book Test 5. Quiz (Semester I)	20 Marks

Question Paper Pattern

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

❖ Maximum Marks: 20

❖ Duration: 30 Minutes

Particular	Marks
Match the Column / Fill in the Blanks / Multiple Choice Questions/ True/False/Answer in One or Two Lines (Concept based Questions) (1 Marks each)	20 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**

1. There shall be five questions each of 12 marks.
2. All questions shall be compulsory with internal options.
3. Question may be subdivided into sub-questions a, b, c... and the allocation of marks depends on the weightage of the unit.

❖ 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.

Academic Council Date –

Item No. –



Janardan Bhagat Shikshan Prasarak Sanstha's

CHANGU KANA THAKUR

Arts, Commerce and Science College, New Panvel (Autonomous)

Re-accredited A+ Grade by NAAC (Third Cycle-CGPA-3.61)
'College with Potential for Excellence' Status Awarded by UGC
'Best College Award' by University of Mumbai

As per National Education Policy - 2020

Title of the Programme

M. Sc. in Microbiology

(Faculty of Science)

Syllabus for M.Sc. (Microbiology)

Semester III and IV

(With effect from the academic year 2024-25)



Janardan Bhagat Shikshan Prasarak Sanstha's
CHANGU KANA THAKUR



Arts, Commerce and Science College, New Panvel (Autonomous)

As per National Education Policy - 2020

Sr. No.	Heading	Particulars
1	Title of program	M.Sc. (Microbiology)
2	Eligibility	Learner must have attempted examinations of Sem I and Sem II of M.Sc. Microbiology
3	Duration of program	2 Years
4	Intake Capacity	12
5	Scheme of Examination	Theory: 100 Marks- Internal: External (40:60) Practical: 50 Marks
6	Standards of Passing	40%
7	Semesters	III
8	Program Academic Level	6.5
9	Pattern	Revised as per NEP 2020
10	Status	Approved in BOS and Academic Council
11	To be implemented from Academic Year	Academic Year 2024-25

Signature of

Mr. N. C. Vadnere
Head, Department of Microbiology
Changu Kana Thakur
A.C.S. College, New Panvel
(Autonomous)

Signature of

Prof. (Dr.) S.K. Patil
Principal
Changu Kana Thakur
A.C.S. College, New Panvel
(Autonomous)



Janardan Bhagat Shikshan Prasarak Sanstha's
CHANGU KANA THAKUR



Arts, Commerce and Science College, New Panvel (Autonomous)

Preamble

1) Introduction

This course delves into essential tools for analyzing molecules and microorganisms, providing valuable insights into their structure, function, and composition. You'll explore the principles and applications of various spectroscopic techniques like UV-visible, infrared (IR), mass spectrometry (MS), and nuclear magnetic resonance (NMR). Additionally, you'll delve into the diverse world of chromatography and microscopy, uncovering powerful methods for separating and visualizing molecules and cells.

2) Aims and Objectives

This course aims to equip you with a comprehensive understanding of spectroscopic and chromatographic techniques, along with advanced microscopy methods used in modern scientific research. You'll explore the fundamental principles of these techniques, delve into their instrumentation and operation, and gain insights into their applications in various fields, particularly microbial identification.

3) Credit Structure of the M. Sc. (Microbiology) Semester III and IV

No. of Courses	Semester III	Credits	No. of Courses	Semester IV	Credits
A	Discipline Specific Course (Major)		A	Discipline Specific Course (Major)	
1	Tools and Techniques in Microbiology	04	1	Applied Microbiology	04
2	Pharmaceutical & Cosmetic Microbiology	04	2	Industrial & Food Microbiology	04
3	Cell Biology	04	3	Plant, Agriculture and Animal Biotechnology	04
4	Practical Based on Paper 1 and 2	02		XXXXXXXXXXXXXXXXXXXXXXXXXXXX	
B.	Discipline Specific Course (Elective) (Select any One)		B	Discipline Specific Course (Elective) (Select any One)	
5	IPR and Biodiversity Law, Bioethics (2 cr) + Practical (2cr)	04	4	Virology (2 cr) + Practical (2cr)	04
	Nanobiotechnology and Algal Biotechnology (2 cr) + Practical (2cr)	04		Mycology & Protozoology (2 cr) + Practical (2cr)	04
C	OJT/FP/CEP/RP		C	OJT/FP/CEP/RP	
6	Research Project	04	5	Research Project	06
Total Credits		22	Total Credits		22

Abbreviations Used

- POs : Program Outcomes
- PSOs : Program Specific Outcomes
- COs : Course Outcomes
- TLP : Teaching-Learning Process
- AM : Assessment Method
- DSC : Discipline Specific Core
- DSE : Discipline Specific Elective
- OJT : On Job Training (Internship)
- RP : Research Project
- MJ : Major Course
- MN : Minor Course



Janardan Bhagat Shikshan Prasarak Sanstha's
CHANGU KANA THAKUR



Arts, Commerce and Science College, New Panvel (Autonomous)



Choice Based Credit System
Under New Education Policy (NEP) 2020
(To be implemented from the academic year 2024-2025)

Course Structure

Course Code : PSc3Mi1

Course Title : Tools and Techniques in Microbiology

Course Type: Major

No. of Credits: 4

Course Outcomes (Cos)

CO No.	COs Statement
	After completing the Bachelor of Science Program, students will be able to-
CO-1	Explain the principles and applications of UV-visible spectroscopy, IR spectroscopy, Mass Spectrometry (ESI-MS & MALDI-MS), and NMR spectroscopy.
CO-2	Apply chromatographic techniques for separation and analysis.
CO-3	Explain the principles and applications of various PCR techniques
CO-4	Identify and classify microorganisms using various methods

Choice Based Credit System
Under New Education Policy (NEP) 2020

Course Code: PSc3Mi1

Course Title: Tools and Techniques in Microbiology

Unit I : Spectroscopic Techniques

Unit II : Chromatographic Techniques

Unit III : Advanced Microscopy Techniques and variations of PCR

Unit IV : Identification methods in microbiology

Unit Subunit	Topic	Lectures
Unit 1	Spectroscopic Techniques	
	UV-visible spectroscopy: Beer- Lambert`s Law, Instrumentation, operation, calibration, accuracy and applications	04
	IR: Principles, Instrumentation, operation, calibration, accuracy and applications	03
	Mass Spectroscopy: ESI -MS and MALDI - MS	02
	FTIR	03
	NMR: Approach to determine structure of Carbohydrate by NMR	03
Unit 2	Chromatographic Techniques	
	Gas Chromatography: Principles, Instrumentation, operation, calibration, accuracy and applications	04
	High Performance Liquid Chromatography: Principles, Instrumentation, operation, calibration, accuracy and applications	03
	Supercritical Liquid Chromatography: Properties of SFE/SFC, Instrumentation, operation, advantages and applications	03
	HPTLC	02
	Ion exchange chromatography	02
	Gel filtration chromatography	02
Unit 3	Advanced Microscopy Techniques and variations of PCR	
	Principle and working of	06

	1. TEM & SEM 2. Confocal Microscopy 3. AFM	
	Principle & working of 1. Fluorescence Microscopy, 2. High Resolution Fluorescent Microscope,	02
	Concept Understanding of 1. Fluorescence recovery after photobleaching (FRAP), and 2. Forster Resonance Energy Transfer (FRET)	02
	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
Unit 4	Identification methods in microbiology	
	Introduction of microbial systematic Phylogeny: Overview of phylogeny and Phylogenetic trees. Importance of ribosomal RNA	02
	i) Culture dependent analysis of microbial communities: a. Laser Tweezer b. Flow cytometry	02
	ii) classification & identification through Phenotypic analysis using a. VITEK b. API 20 c. FAME and d. BIOLOG	02
	Culture independent methods i) Methods for DNA / RNA extraction ii) Basic PCR methods with respect to identification of microorganisms iii) Gene sequence analysis 1. Amplification of 16S rRNA gene for prokaryotes and SSU, LSU, ITS. 2. Multi-locus sequence typing 3. Genome fingerprinting (Multi gene and whole genome)–Ribotyping iv) Sequencing genomes 1. First generation - Sanger sequencing and sequence analysis using different tools (Chromas – Pro, SeqMan) 2. Shotgun – genomic library 3. Second generation - Amplicon sequencing Illumina 4. Third and fourth generation - Heliscope and Ion torrent Oxford nanopore 5. Genome assembly v) Environmental genomics An introduction to meta-genomics, meta transcriptomes and Meta-proteomics	08

References

S. N.	Reference
1.	Kazmiruk, V. Scanning Electron Microscopy.
2.	Ayache, J., Beaunier, L., Boomendil, J., & Ehret, G. (Eds.). Handbook of TEM.
3.	Santos, N. C.. Atomic force Microscopy.
4.	Paddock, S. W. (Ed.). Methods in molecular biology: Confocal Microscopy.
5.	Koehler, J. K. Advanced Techniques in Biological Electron Microscopy.
6	Wall, P. E. (2010). Thin layer chromatography: A modern practical approach. Royal Society of Chemistry.
7	Arumugan, N., & Kumaresan, V. Biotechniques.
8	Roy, R. N. A Textbook of Biophysics.
9	Ma, H., Shieh, K.-J., & Qiao, T. X. Study of Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM).
10	Hamid, A. U. A beginner's Guide to SEM.
11	Walla, P. J. (2014). Modern Biophysical Chemistry, Detection and Analysis of Biomolecules. Wiley-VCH Verlag GmbH & Co. KGaA.
12	Zerbe, O., & Jurt, S. (2014). Applied NMR Spectroscopy for Chemists and Life Scientists. Wiley-VCH Verlag GmbH & Co. KGaA.
13	Srivastava, M. M. (2011). High-Performance Thin-Layer Chromatography (HPTLC). Springer-Verlag Berlin Heidelberg.
14	Janson, J.-C. (2011). Protein Purification: Principles, High Resolution Methods, and Applications (3rd ed.). John Wiley & Sons, Inc.
15	Madigan, M. T., Bender, C. M., Buckley, D. H., Satou, D. S., & Stahl, D. A. (2015). Brock biology of microorganisms (15th ed.). Pearson Education Limited.
16	Green, M. R., & Sambrook, J. (2012). Molecular cloning: A laboratory manual (4th ed.). Cold Spring Harbor Laboratory Press.

Course Structure

Course Code: PSc3Mi2

Course Title: Pharmaceutical & Cosmetic Microbiology

Course Type: Major

No. of Credits: 4

Course Outcomes (Cos)

CO No.	COs Statement
	After completing the Bachelor of Science Program, students will be able to-
CO-1	Explain the role of microbiology in pharmaceuticals & cosmetic microbiology
CO-2	Apply the knowledge for data validation, documentation, complying with IS & ISO standards
CO-3	Demonstrate proficiency in laboratory management, design, and documentation to ensure regulatory compliance
CO-4	Distinguish between GMP & GLP & other methods for quality control in industries.
CO-5	Explain the standard i.e., IS, ISO to be followed in industries.
CO-6	Emphasize the importance of environmental monitoring, cleaning, disinfection, and the use of antibiotics and preservatives in ensuring product quality and safety.



Course Code: PSc3Mi2

Course Title: Pharmaceutical & Cosmetic Microbiology

Unit I: Introduction to Pharmaceutical Microbiology

Unit II: Pharmaceutical Analysis & Regulation

Unit III: Cosmetic Microbiology

Unit IV: Audit, Validation & Documentation

Sub unit	Topics	No. of Lectures
Unit I	Introduction to Pharmaceutical Microbiology	
1.	Role of Microbiology for pharmaceuticals industries	01
1.2	GMP and Regulations	03
1.3	Laboratory management and design	02
1.4	Microbiological culture media & Microbiology laboratory techniques	02
1.5	Bio burden determination	02
1.6	Specified and objectionable microorganisms	01
1.7	Guidelines for preparing a laboratory information file	04
Unit II	Pharmaceutical Analysis & Regulation	
2.1	Assessment of pharmaceutical water systems and Endotoxin and pyrogen testing	01
2.2	Sterilization and sterility assurance. Use of Biological indicators for measuring sterilization	01
2.3	Cleaning and disinfection Use of Antibiotics and preservatives, clean rooms and environmental monitoring	01
2.4	Rapid microbiological methods	03
2.5	Risk assessment and microbiology	03
2.6	Good practices for pharmaceutical quality control laboratories	02
	Good manufacturing practices for pharmaceutical Products Pharmaceutical Legislation & Regulation	04
Unit III	Cosmetic Microbiology	
3.1	History of cosmetic Microbiology, Preservation of cosmetics	03
3.2	Antimicrobial preservative efficacy & microbial content testing	02
3.3	Microbiology Laboratory methods in support of sterility Assurance	03

	System	
3.4	Bio burden testing & Environmental monitoring	02
3.5	Sampling: Principles and Practice	03
3.6	Global regulations & toxicological aspects	02
Unit IV	Audit, Validation & Documentation	
4.1	Microbiological hazard analysis & audit Validation	04
4.2	IS and ISO standards: 9000, 17025	05
4.3	Introduction to Validation and documentation	03
4.4	Auditing sterilization processes and facilities	03

References:

UNIT I

1. Pharmaceutical Microbiology by Tim Sandle.
2. WHO Guidelines for preparing a laboratory information file.

UNIT II

1. WHO Good practices for pharmaceutical microbiology laboratories.
2. WHO-GMP for pharmaceutical products.

UNIT III

1. Cosmetic Microbiology: A practical Approach, 2nd edition. Philip A Geiss. Taylor & Francis group.

UNIT IV

2. Handbook of Microbiological Quality Control for Pharmaceuticals and Medical Devices, Rosamund Baird, Stephen P.Denyer, Norman Hodges.
3. International standard ISO/IEC-17025, Third edition,2017-11.
4. Validation Standard Operating Procedures - A Step-by-Step Guide for Achieving Compliance in the Pharmaceutical, Medical Device, and Biotech Industries by Syed Imtiaz Haider.
5. Sterility, sterilization and sterility assurance for pharmaceuticals. by Tim Sandle.



Janardan Bhagat Shikshan Prasarak Sanstha's
CHANGU KANA THAKUR



Arts, Commerce and Science College, New Panvel (Autonomous)

Course Code: PSc3MiP2

Course Title: Pharmaceutical & Cosmetic Microbiology

Course Type: Major

No. of Credits: 1

CO No.	COs Statement
	After completing the Bachelor of Science Program, students will be able to-
CO-1	Conduct MIC & MBC determination.
CO-2	Apply the acquired knowledge for quality control of cosmetics.
CO-3	Understand audit, documentation process.
CO-4	Analyze bioburden determination.

Practical's

Sr No.	Experiment	Hrs.
01	Perform an audit of any test, with proper documentation.	3
02	Preservative efficacy test as per ISO 11930	3
03	Bio burden test	3
04	Quality control of microbial content of cosmetics as per IS 14648:2011 wrt to heterotrophic count, presence of Pseudomonas spps, Staphylococci spps & P. acne	3
05	MIC of an antibiotic by tube method using Indian Pharmacopeia protocol	3

Course Code : PSC3MI-3

Course Title : Cell Biology

Course Type: Major

No. of Credits: 04

Course Outcomes (Cos)

CO No.	COs Statement
	After completing the Bachelor of Science Program, students will be able to-
CO-1	Explain the Cell Structure and Function.
CO-2	Explore the Cellular Processes and Regulation in eukaryotic cell.
CO-3	Analyse the Cell Communication, Signalling pathways and its role in multicellular development of organism.
CO-4	Describe the fundamentals process of cell cycle and its regulation.

Syllabus for M.Sc. (Microbiology) Semester III
Choice Based Credit System
Under New Education Policy (NEP) 2020

Course Code : PSC3MI-3

Course Title: Cell Biology

Unit/Subunit	Topics	Lectures
Unit-1	Introduction to Cell Biology and Cell Membrane	15
1.1	Introduction to cell biology: Structural organization and function of intracellular organelles (Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast)	02
1.2	Membrane structure: Cell membrane structure: Lipid bilayer, membrane proteins, Spectrins, Glycophorin, Multipass membrane proteins Bacteriorhodopsin	03
1.3	Membrane Transport: Principles of membrane transport, ion channels and electrical properties of membranes. protein transport, post translation transport and co translation transport, protein transport and protein secretion pathways in bacteria. endocytosis	03
1.4	Intracellular Compartments and protein sorting: Compartmentalization of cells, transport of molecules between the nucleus and cytosol, peroxisomes, Endoplasmic reticulum transport of proteins into mitochondria and chloroplasts	03
1.5	Cell wall and extracellular matrix: matrix proteins, matrix polysaccharides	02
1.6	Cell-cell interaction:	02
Unit/Subunit	Topics	15
Unit 2	Organization and Function of Mitochondria, Chloroplast and Cytoskeleton	
2.1	Mitochondria: Structure, electron-transport chains and proton pump, Chloroplasts: Structure, energy capture from sunlight, genetic system of Mitochondrion and chloroplast	05

2.2	Intracellular vesicular traffic: The molecular mechanism of membrane transport and the maintenance of compartmental diversity, transport from the ER through the Golgi apparatus, transport from trans Golgi network to lysosomes	05
2.3	Cytoskeleton: The self-assembly and dynamic structure of cytoskeletal filaments, How cells regulate their cytoskeletal filament, (Cytoskeletal filaments, Microtubules, Actin and intermediate filaments), molecular motors, cell behaviour	05
Unit/Subunit		
	Topics	15
Unit 3:	Title of Module: Cell Division, Cell Cycle and Cell Junctions	
3.1	Mechanism of cell division: M-phase, Mitosis, Cytokinesis, Germ cells and fertilization, Meiosis, eggs, sperm, fertilization	04
3.2	Cell cycle and Programmed cell death: Control system, intracellular control of cell cycle events, Apoptosis, extracellular control of cell growth and apoptosis. Autophagy	05
3.3	Cell Junctions and cell-cell adhesion: Anchoring, adherence junctions, Desmosomes, Gap junctions, cell-cell adhesion, Cadherins, Selectins, N-CAM, The extracellular matrix of animals., Integrins	06
Unit/Subunit		
	Topics	15
Unit 4:	Title of Module: Cell Communication and Multicellular Cell Development	
4.1	Cell communication: General principles of cell communication (Nitric oxide gas signal and nuclear receptors, Three classes surface receptors), Signalling through G-protein linked cell surface receptors	04
4.2	Signalling through enzyme linked cell surface receptors: Tyrosine kinase, Docking sites, Ras, MAP kinase, PI-3 kinase, TGF- β , Signaling pathways by regulated proteolysis. Signalling in plants: Serine / Threonine kinases, role of ethylene, Phytochromes	06
4.3	Development of multicellular organisms: Caenorhabditis elegans, Drosophila melanogaster, Mouse Neural development	05

References:-

SR. NO.	References
1.	Molecular Biology of the Cell – Alberts, Johnson, Lewis, Raff, Roberts & Walter, 6th edition.
2.	Cooper, G.M., Hausman R.E. (2009) The Cell: A Molecular Approach- 6th edition.
3.	Molecular Cell Biology. Harvey Lodish; Arnold Berk; Chris A. Kaiser; Monty Krieger; Anthony Bretscher; Hidde Ploegh; Angelika Amon; Kelsey C. Martin , 8th edition
4.	Karp G. (2008). Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons.
5.	Gilbert , Barresi (2016) Developmental Biology : 11th Edition

Academic Council Date –

Item No. –



Janardan Bhagat Shikshan Prasarak Sanstha's

CHANGU KANA THAKUR

Arts, Commerce and Science College, New Panvel (Autonomous)

Re-accredited A+ Grade by NAAC (Third Cycle-CGPA-3.61)

'College with Potential for Excellence' Status Awarded by UGC

'Best College Award' by University of Mumbai

As per National Education Policy - 2020

Title of the Programme

M. Sc. in Microbiology

(Faculty of Science)

Syllabus for M. Sc. (Microbiology)

Semester III and IV

(With effect from the academic year 2024-25)



Janardan Bhagat Shikshan Prasarak Sanstha's
CHANGU KANA THAKUR



Arts, Commerce and Science College, New Panvel (Autonomous)

As per National Education Policy - 2020

Sr. No.	Heading	Particulars
1	Title of program	M.Sc. (Microbiology)
2	Eligibility	Theory: 100 Marks- Internal: External (40:60) Practical: 50 Marks.
3	Duration of program	2 years
4	Intake Capacity	12
5	Scheme of Examination	Internal and external
6	Standards of Passing	40%
7	Semesters	III
8	Program Academic Level	6.5
9	Pattern	Revised as per NEP 2020
10	Status	Approved by BOS and Academic Council
11	To be implemented from Academic Year	Academic Year 2024-25

Signature of

Signature of

Name

Head, Department of Microbiology
Changu Kana Thakur
A.C.S. College, New Panvel
(Autonomous)

Prof. (Dr.) S.K. Patil

Principal
Changu Kana Thakur
A.C.S. College, New Panvel
(Autonomous)



Preamble

1) Introduction

Bioethics is the study of the typically controversial ethical issues emerging from new situations and possibilities brought about by advances in biology and medicine. • It is also moral discernment as it relates to medical policy and practice. The laws relating to intellectual property (IP) and biodiversity are recent ones. Both the IP and biodiversity concepts have their historical roots. While biodiversity evolved with the evolution of nature and civilisations, the intellectual property system has evolved through statutes to protect the improvements made to biological resources and grant monopoly rights to the inventor. By this course students will understand and become familiar with the system of IP and biodiversity also will study the subject by going through the historical background of both concepts and national and international laws governing them from the right perspective.

2) Aims and Objectives

Aim: To understand Student's relationship between IPR and bioethics and biosafety concerning patents.

Objectives:

1. To understand the significance of IPR and patents in Biotechnology.
2. To introduce ethical issues in Biotechnology ethics.
3. To learn about the biodiversity law.

3) Learning Outcomes

CO1	Explain the importance of the IPR in biotechnology.	BTL: Understand
CO2	Relate to the biodiversity law.	BTL: Apply
CO3	Demonstrate the bioethical guidelines in Biotechnology and Microbiology.	BTL: Apply



Janardan Bhagat Shikshan Prasarak Sanstha's
CHANGU KANA THAKUR



Arts, Commerce and Science College, New Panvel (Autonomous)

Syllabus for M.Sc.. (Microbiology) Semester I and II

Choice Based Credit System

Under New Education Policy (NEP) 2020

(To be implemented from the academic year 2024-2025)

Course Structure

Course Code: PSc3Mi4

Course Title: Elective Course 1: IPR and Biodiversity Law and Bioethics

Course Type: Elective 1

No. of Credits: 4

Unit I: IPR and Biodiversity Law

Unit II: Bioethics

Title of Paper: Elective Course 1: IPR and Biodiversity Law and Bioethics

Unit 1	Title of Unit: IPR and Biodiversity Law	
S. N.	IPR and Biodiversity Law	No. of Hrs.
1	Need for IPR in Biotechnology	02
2	Patents for Biotechnology	02
3	Implications of Patents in Biotechnology	03
4	Case Studies 1. Basmati Rice Issue 2. Turmeric Patent 3. Agriculture Neem Patent 4. Chakraborty case 5. Corn genetically engineered with an insecticide	05
5	Biodiversity law: introduction, Development, International and National Biodiversity laws	03
Unit2:	Title of Unit: Bioethics	
S. N.	Bioethics	Hrs.

1	The goals of biotechnology, Challenging characteristics of biotechnology	1
2	Bioethics and microbiology Ethical issues and Perspectives in the Discipline of Microbiology Ethics Perspectives from India Bioethics, bioweapons and the microbiologist	3
3	Ethical guidelines for Biomedical Research on Human subjects	5
4	Case study –Infectious disease 1. Effects, Causes and Prevention of Infectious Diseases Through Vaccination 2. Benefits and risks of vaccination 3. Alternative approaches to vaccination: voluntary, quasi-mandatory and incentivized Schemes, Comparing and assessing vaccination strategies, Children as special cases, Surveillance 4. HIV and AIDS as notifiable diseases, - Control of infectious diseases, 5. Issues raised by quarantine and isolation, 6. Use of vaccines in the control of infectious diseases	4
5	Public perception of biotechnology: Genetic engineering –safety, social, moral and ethical considerations	2

Module 1:	Title of Module: IPR and Biodiversity Law	
S. N.	Practical (Based on Paper 3)	Hrs.
1	Disruption of bacterial cells followed by characterization of cellular proteins by SDS PAGE	
2	Isolation of lymphocytes and their Viability staining using trypan blue	
3	Determination of cell viability of lymphocytes by MTT Assay & neutral red uptake assay	
4	Comparison of various cell viability techniques	
5	Isolation of mitochondria and check activity of respiratory enzyme succinate dehydrogenase	
6	Isolation of chloroplast and checking photophosphorylation	
7	Preparation and characterization of Silver Nanoparticles	
8	Survival Curve and antibacterial activity of nano silver particles	
9	Study of nano silver coated gauze / textiles for antimicrobial effect on different bacteria.	
10	SELF STUDY 1. Assignment on Measurement of Chlorophyll a and carotenoid concentration in Cyanobacteria 2. Study various types of microalgae and its role in climate change	

References

S. N.	Reference
Module 1	
1.	Molecular Biology by M D Morris
2.	Microbial Biotechnology – principles and applications by Lee Yuan Kun
3.	IPR- Unleashing the Knowledge Economy by Prabuddha Ganguli
4.	Issues and Dilemmas of Biotechnology by Bernice Schacter
5.	Biotechnology and IPR – Legal and Social Implications by Kshitij Kumar Singh
6.	Law and National Biodiversity Strategies and Action Plans by the Law Division for the United Nations Environment Programme
Module 2	
1	https://www.researchgate.net/publication/23467644 Bioethics and Biotechnology Article in Cytotechnology · May 2007
2	Ethical issues in microbiology, *P Desikan, A Chakrabarti, V Muthuswamy. Indian Journal of Medical Microbiology, (2011) 29(4): 327-301.
3	Ethical Perspectives in the Discipline of Microbiology: Article · December 2015 DOI: 10.18099/ijetv.v1i2.6817 Article · December 2015 DOI 10.18099/ijetv.v1i2.6817
4	Health Ethics in South-East Asia. Health ethics in six sear countries. Volume 1 Edited by Nilam Kasturiaratchi, Redar Lie, Jens Seeberg.
5	Bioethics, bioweapons and the microbiologist: Fernando Anaya-Velázquez*RevLatinoamMicrobiol2002;44 (1)
6	Ethical guidelines For Biomedical Research on Human subjects. National Institute of Tuberculosis and Respiratory Diseases. Based on ICMR, CDSCO, and GCP & International Ethical Guidelines.
7	Ethics in medical research: General principles with special reference to psychiatry research. Ajit Avasthi, Abhishek Ghosh, Sidharth Sarkar, Sandeep Grover. Indian Journal of Psychiatry 55(1), Jan-Mar 2013 8. Case study: Public health - ethical issues, Nuffield Council on Bioethics, Chapter 4 page no.51- 77
8	Biotechnology- John E. Smith Fifth edition, Chapter 15, 232-242.