Department of Microbiology

Semester	Major				Minor		On Job Training, Research Projects		Credits/Semester	Cumulative Credits
	Mandatory	Credits	Elective	Credits	Course	Credits	OJT/FP/CEP/RP	Credits		
First Year Masters (M. Sc. – I) Level - 6										
I	Course 1	4	Elective 1	4	Research Methodology	4	--	--	22	44
	Course 2	4								
	Course 3	4								
	Course 4	2								
II	Course 5	4	Elective 2	4	--	--	On Job Training	4	22	
	Course 6	4								
	Course 7	4								
	Course 8	2								
Second Year Masters (M. Sc. – II) Level – 6.5										
III	Course 1	4	Elective 3	4	--	--	Research Project	4	22	44
	Course 2	4								
	Course 3	4								
	Course 4	2								
IV	Course 5	4	Elective 4	4	--	--	Research Project	6	22	
	Course 6	4								
	Course 7	4								
	Course 8	2								

Janardan Bhagat Shikshan Prasarak Sanstha's

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'Best College Award' by University of Mumbai

Program: M. Sc. I

Revised Syllabus of M. Sc. I Microbiology (Elective Course)

Choice Based Credit System (CBCS)

w.e.f. Academic Year 2023-24

M. Sc. I Microbiology Syllabus

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

INDEX **SEMESTER I** **THEORY**

Course Code	Unit	Topic Headings	Credits	Lecture/Topic
PSC1MI-4 Environmental Microbiology & Sustainability	I	Extremophiles	02	15
	II	Environment & Natural resource Management & Safety Standards		15

INDEX **SEMESTER II** **THEORY**

Course Code	Unit	Topic Headings	Credits	Lecture/Topic
PSC2MI-4 Bioinformatics & Immunodiagnostics	I	Bioinformatics	02	15
	II	Immunodiagnostics		15

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 : 60 (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**

	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	**Biosafety:** 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**
	Self-study topics: 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
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/

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

Course Code: PSC2MI-2 **Title of the Paper: Research Methodology, Bioinformatics & Biostatistics**
Credits : 4 **Total No. of Lectures: 60 (15 Lectures/Unit)**

Course Name and No.: Elective 1 Bioinformatics & Immunodiagnostics		**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 immunodiagnostics 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 4..1.1 Biological databases-nucleic acid sequence databases- gene bank/ EMBL/ DDBJ 4.1.2 Protein sequence data bases- (UniProtKB), Derived databases(Prosite, BLOCKS, Pfam/Prodom) Structural databases (PDB , NDB) and Enzyme databases	**01** **01** **03**
1.2	4.2.1 Concept in sequence analysis - Needleman & Wunsch , Smith & Waterman alignment algorithms 4.2.2 Scoring Matrix for nucleic acids and protein- MDM.BLOSUM.CSW 4.2.3 Alignment: Pair wise BLAST, FASTA 4.2.4 Multiple sequence alignment, PRAS, CLUSTAL W	**01** **01** **01** **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	**Immunodiagnostics**	
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 % 20 Marks

Sr. No.	Particular	Marks
01	One periodical class test / online examination to be conducted in the given semester	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 % 30 Marks

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

Question Paper Pattern

Theory question paper pattern

1. There shall be three questions each of 10 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.

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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

INDEX **SEMESTER II** **THEORY**

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 *E. coli* Lac operon 3.1.2 The *E.coli* Gal operon 3.1.3 The *E. coli* ara operon 3.1.4 The *E. coli* Maltose operon 3.1.5 Trp operon of *Bacillus subtilis* 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 *E coli* 4.1.4 Iron regulation in *E coli* 4.1.5 Regulation of Sporulation in *Bacillus subtilis*	 **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 Willey 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. Elsiever 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. Shoesmith. 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 Code: PSC1MI-3 **Title of the Paper: Medical Microbiology and Microbial Pathogenesis**
Credits : 4 **Total No. of Lectures: 60 (15 Lectures/Unit)**

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: *Legionella*, *Salmonella*, and *Mycobacterium* 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. *Acinetobacter* d. *Candida auris* 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 *Staphylococci spps.* 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. violaecium*
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 Microbiol56: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 Microbiol56: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 II Syllabus

Course Code: PSC2MI-1 **Title of the Paper: Molecular Genetics -2**

Credits : 4 **Total No. of Lectures: 60 (15 Lectures/Unit)**

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 *Drosophila* , Organelle DNA & Population Genetics**	
2.1	**Drosophila developmental** a. Stages b. Embryonic development c. Maternal effect genes d. Segmentation genes e. Homeotic genes	**04**
	Self-study: Drosophila a traditional geneticist's and embryologist ‘s tool.	**04**
2.2	**2.2.1 Organelle DNA:** a. The genetics of organelle encoded traits b. The endosymbiotic theory **2.2.2 Mitochondrial DNA** 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** a. Properties similar to Eubacterial DNA b. Gene structure and organization of chloroplast DNA c. Replication, transcription and translation of chloroplast DNA	**02** **03** **02**

2.3	**Population genetics** 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: a. Mutation b. Random genetic drift c. Migration d. Natural selection e. Balance between mutation and selection f. Assertive 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** 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, foot printing 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** 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, 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)
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, Pastermak, 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 **Title of the Paper: Applied Biochemistry**
Credits : 4 **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 βGlucans, 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 CO2 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 spps*
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

Course Code	**: PSC2MI-3**	**Title of the Paper: Applied Immunology**	
Credits	**: 4**	**Total No. of Lectures:**	**60 (15 Lectures/Unit)**

Sub unit	Topics	No. of Lectures
Unit I	**Adversarial strategies during infection**	
1.1	1.1.1 Bacterial survival strategies a. Evading complement b. Evading killing by macrophages 1.1.2 The host counter attack against bacteria a. Toxin neutralization b. Opsonization of bacteria 1.1.3 The habitat of intracellular bacteria: Bacterial survival strategies a. Defence against intracellular bacteria b. Role of activated Macrophages 1.1.4 Viral survival strategies 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** 1.2.1. Subunit vaccines 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	**05**
	Self-study : Vaccines under development	
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** 2.2.1 Major mechanisms for achieving tolerance	**07**

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

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

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)

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		xxxxxxxxxxxxxxxxxxxxx	
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

Syllabus for F.Y.B. 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 : 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

Syllabus for F.Y.B. Sc. (Microbiology) Semester I

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.

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, Pl-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; HiddePloegh; 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

Syllabus for F.Y.B. 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 : PSc4Mi1

Course Title : Applied 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	Describe various bioremediation strategies for different types of pollutants, including synthetic compounds, petrochemicals, inorganic waste, metals, and gaseous pollutants.
CO-2	Differentiate between *in situ* and *ex situ* bioremediation techniques and understand their advantages and limitations.
CO-3	Describe the potential of bioengineering using rDNA technology for enhancing bioremediation capabilities.
CO-4	Describe the utilization of enzymes as analytical tools for assessing food quality, safety, and monitoring food processing efficiency.
CO-5	Explore emerging applications of enzymes in cosmetics, biopreservation, hard surface cleaning, oil field applications, wastewater treatment, and pH manipulation.
CO-6	Describe the diverse range of protein therapeutics derived from microorganisms, including hormones, cytokines, monoclonal antibodies, and vaccines, and their roles in treatment and prevention of diseases.
CO-7	Explain the concept and applications of biosensors utilizing microorganisms for detecting environmental pollutants, toxins, and pathogens.
CO-8	Analyze the contribution of microbes to climate change through greenhouse gas production and nutrient cycling.

Syllabus for F.Y.B. Sc. (Microbiology) Semester I

Choice Based Credit System

Under New Education Policy (NEP) 2020

Course Code: PSc4Mi1

Course Title: Applied Microbiology

Unit 1	**Applications of Microbiology in Bioremediation & Pollution Control**	
	Introduction to Bioremediation strategies for synthetic compounds, petrochemicals, inorganic waste	02
	Bioremediation strategies and techniques in situ and testing its efficacy and side effects	03
	Bioremediation of metals & gaseous ex situ. Environment modification for bioremediation	03
	Approaches to bioremediation: Microbial seeding & bioengineering using rDNA technology	03
	Bioremediation of various ecosystems-Soil, aquifers, marine, ai	03
Unit 2	**Applications of Enzymes**	
	Enzymes as analytical tool for the assessment of food quality, safety, and monitoring food processing	05
	Applications of enzymes in food: Baking, fruit juice production, processing, brewing, and dairy. Applications of non-food enzymes in detergents, laundry, Textiles, medical, therapy and chemical industry.	05
	New industrial enzyme applications: Cosmetics, enzymes for preservation. Hard surface cleaning, oil field application, waste water treatment, pH Shift	05
Unit 3	**Microbial Biomolecules in Diagnostics and Therapeutics**	
	Protein therapeutics: Hormones, cytokines, Monoclonal antibodies, regenerative medicines, molecular diagnostics, NAS as therapeutic agents, Vaccines	09
	Use of monoclonal antibodies in diagnostics: RA, Blood grouping.	06
Unit 4	**Novel Uses of Microorganisms and Microbial Products**	
	Biosensors, microbial concrete, Bioleaching, Enhanced oil recovery, Biofuels	05
	Biotech of the marine environment, microbial contribution of climate change	05
	Biopolymers, Bio surfactants	05

References

S. N.	Reference
Unit I	
1.	Scragg, A. . Environmental Biotechnology (2nd ed.). Publisher.
Unit II	
2	Aehle, W. . Enzymes in Industry. Publisher.
3.	Chandrasekaran, M. (Ed.). . Enzymes in Food and Beverage Processing. CRC Press.
4.	Nallari, P. . Medical Biotechnology. Publisher.
5.	Ramawat. . Comprehensive Biotechnology (4th ed.). Publisher.
Unit III	
6.	Glick, B. R. . Molecular Biotechnology: Principles and Applications of Recombinant DNA (3rd ed.). Publisher.
Unit IV	
8.	Scragg, A. . Environmental Biotechnology. Publisher.
9.	Singh, B. D. . Biotechnology. Kalyani Publishers.

Course Structure

Course Code: PSc4Mi2

Course Title: Applied 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 bioremediation process and its application in pollution control
CO-2	Demonstrate proficiency of application of microbial enzymes in various industries.
CO-3	Understand the innovative uses of microorganisms and microbial products in various fields.
CO-4	Apply proficiency in evaluating the efficacy and potential side effects of bioremediation techniques.
CO-5	Distinguish between in-situ & ex -situ approaches.
CO-6	Understand the microbiological techniques &principles in environmental sustainability.

Course Code: PSc4Mi2

Course Title: Applied Microbiology

Unit I: Applications of Microbiology in Bioremediation & Pollution Control

Unit II: Applications of Enzymes

Unit III: Microbial Biomolecules in Diagnostics and Therapeutics

Unit IV: Novel Uses of Microorganisms and Microbial Products.

Sub unit	Topics	No. of Lectures
Unit I	**Applications of Microbiology in Bioremediation & Pollution Control**	
1.1	Introduction to Bioremediation strategies for synthetic compounds, petrochemicals, inorganic waste	02
1.2	Bioremediation strategies and techniques in situ and testing its efficacy and side effects	03
1.3	Bioremediation of metals & gaseous *ex situ*. Environment modification for bioremediation	03
1.4	Approaches to bioremediation: Microbial seeding & bioengineering using rDNA technology	03
1.5	Bioremediation of various ecosystems-Soil, aquifers, marine.	04
Unit II	**Applications of Enzymes**	
2.1	Enzymes as analytical tool for the assessment of food quality, safety, and monitoring food processing	05
2.2	Applications of enzymes in food: Baking, fruit juice production, processing, brewing, and dairy. Applications of non-food enzymes in detergents, laundry, Textiles, medical, therapy and chemical industry.	05
2.3	New industrial enzyme applications: Cosmetics, enzymes for preservation. Hard surface cleaning, oil field application, waste water treatment, pH Shift	05
Unit III	**Microbial Biomolecules in Diagnostics and Therapeutics**	
3.1	Protein therapeutics: Hormones, cytokines, Monoclonal antibodies, regenerative medicines, molecular diagnostics, NAS as therapeutic agents, Vaccines	**09**
3.2	Use of monoclonal antibodies in diagnostics: RA, Blood grouping.	**06**
Unit IV	**Novel Uses of Microorganisms and Microbial Products**	
4.1	Biosensors, microbial concrete, Bioleaching, Enhanced oil recovery, Biofuels	**05**
4.2	Biotech of the marine environment, microbial contribution of climate change	**05**
4.3	Biopolymers, Bio surfactants	**05**

References:

Unit I

1. Environmental Biotechnology by Alan Scragg 2nd edition

Unit II

1. Wolfang Aehle, Enzyme in industry
2. Muthuswamy - Enzymes in Food and Beverage Processing Edited by Muthusamy Chandrasekaran,CRC Press
3. Medical Biotechnology – Pratibha Nallari
4. Comprehensive Biotechnology - Ramawat 4th Edition.

Unit III

1. Glick: Molecular Biotechnology - Principles and Applications of Recombinant DNA (3rd, ThirdEdition) By Bernard R. Glick

Unit IV

1. Alans Cragg, Environmental Biotechnology by Alan Scragg
2. B. D. Singh Kalyani Publishers, 2010 - Biotechnology

Course Code : PSC4MI-3

Course Title : Plant, Agriculture and Animal Biotechnology

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	**Describe** the basic principle of genetic engineering
CO-2	**Explain** the biocontrol strategies used in agriculture.
CO-3	**Application** of transgenic plant and animal in agriculture and pharming field.
CO-6	**Apply** biocontrol strategies in agriculture field.

Course Code: PSC4MI-3

Course Title: Plant, Agriculture and Animal Biotechnology

Unit I: Introduction to Cell Biology and Cell Membrane

Unit II: Organization and Function of Mitochondria, Chloroplast and Cytoskeleton

Unit III: Cell Division, Cell Cycle and Cell Junctions

Unit IV: Cell Communication and Multicellular Cell Development

Units / Subunits	Topics	Lectures
Unit 1	**Plant Biotechnology**	**15**
1.1	**Genetic Engineering of Plants**: Plant transformation with Ti plasmids of Agrobacterium tumefaciens, Ti plasmid derived vector systems, physical methods of transferring genes to plants: Use of guns and electric shock to transfer DNA into plant cells, Microprojectile bombardment, Chloroplast engineering.	04
1.2	**Advancements in Plant Genetic Engineering: Techniques, Applications, and Implications:** Bombardment with DNA coated beads can produce transgenic organelles, Plant genes can be cloned by using transposable elements, T-DNA is used as an insertion mutagen. Use of reporter genes in transformed plant cells, viruses can be used as vectors for whole plants, Manipulation of gene expression in plants: Gene targeting, Facilitating protein purification: Oleosins, Rhizo secretion, Glycosylation.	04
1.3	**Uses genetically engineered plants:** To overcome Biotic and abiotic stress: Insect resistance: Increasing expression of the *B. thuringiensis* protoxin, other strategies for protecting plants against insects, Virus resistance, Herbicide resistance, fungus and bacterium resistance, Oxidative stress, Salt and drought stress, Fruit ripening and Flower wilting. To improve plant quality and proteins.	04

1.4	**Enhancing Plant Traits:** Modification of plant nutritional content, Modification of plant taste and appearance, Plants as bioreactors, edible vaccines.	03
Units / Subunits	**Topics**	**Lectures**
Unit-2	**Animal Biotechnology**	**15**
2.1	**Transgenic animals**: Transgenic Mice: methodology: The retroviral Vector method, The DNA microinjection method, The engineering embryonic stem cell method, Genetic modification with the Cre -loxP recombination system, RNA interference, Transgenesis with high-capacity vectors	07
2.2	**Uses of transgenic animals:** Transgenic disease model, transgenic mice as a test system, Conditional regulation of transgene expression, Cloning livestock by Nuclear transfer, Transgenic livestock: production of pharmaceuticals, Production of Donor organs, Disease resistant livestock, Improving milk quality, Improving animal production traits, Transgenic poultry and transgenic fish	08
Units / Subunits	**Topics**	**Lectures**
Unit 3	**Bioaugmentation and Bio stimulation in Agriculture**	**15**
3.1	Introduction:	02
3.2	Vermicomposting:	03
3.3	**Bio-intensive Management and Biofertilizer Utilization:** Bio-intensive Nutrient Management, Use of Biofertilizers: Rhizobium, blue-green algae, phosphate solubilizers, Mycorrhiza	09

3.4	**Organic Farming:** Definition and scope of organic farming in India	01
Units / Subunits	**Topics**	**Lectures**
Unit 4	**Biocontrol in Agriculture**	**15**
4.1	**Biological control of Pests:** Biological Control agent, mechanism of biocontrol, biopesticide, bioinsecticide, bioherbicide	05
4.2	**Induced systemic resistance in Biocontrol of Plant diseases:** a) Induction of systemic resistance by *Pseudomonas, Bacillus, Trichoderma*, Fungi, and others. b) Mechanism of Induced systemic resistance	04
4.3	**Microbial control strategies:** Postharvest diseases of Fruits, Vegetables, Roots and Tubers a) Mode of action of biocontrol agents b) Extensive use of biocontrol agents c) Enhancing biocontrol efficacy of Microbial Antagonist d) Biotechnological Approach	06

References

S. N.	Reference
1.	B.R. Glick, J.J. Pasternak and C.L. Patten. Molecular Biotechnology: Principles and Applications of Recombinant DNA. 4th Edition. ASM Press, Washington D.C.
2.	J.D. Watson, M. Gilman, J. Witkowski and M. Zoller. Recombinant DNA. 2nd Edition. Scientific American Books.
3.	A.K. Sharma. A handbook of Organic Farming. 2004. Agrobios India.
4.	A. Singh, A. Parmar and R. C. Kuhad. Bioaugmentation, Biostimulation and Biocontrol. Soil Biology Volume 28. Springer.
5.	H. M. Gupta. Organic Farming and Sustainable Agriculture. 2005. ABD Publishers, Jaipur, India.

Course Structure

Course Code : PSc4Mi1 & PSc4Mi2 Practical

Course Type: Major **No. of Credits: 2**

Course Outcomes (COs)

CO No.	COs Statement
	After completing the Bachelor of Science Program, students will be able to-
CO-1	Apply knowledge separate the pigments
CO-2	Design protocols of purification of proteins
CO-3	Evaluate the microbial load in pharmaceutical products

PRACTICALS BASED ON PSC3MIPR-1

1. Extraction and Qualitative detection of different phytochemicals using chemical methods. (Tannins, Saponins, Flavonoids, Alkaloids, Glycosides, Steroids, Phenolic compounds)
2. Extraction and separation of different pigments using TLC
3. Spectrum analysis of pigments using UV spectrophotometer
4. Separation of proteins using gel filtration
5. Generation of phylogenetic tree
6. Extraction of DNA from soil and checking its purity using agarose electrophoresis and UV 260/280 ratio

PRACTICALS BASED ON PSC3MIPR-2

1. Perform an audit of any test, with proper documentation.
2. Preservative efficacy test as per ISO 11930
3. Bio burden test
4. Quality control of microbial content of cosmetics as per IS 14648:2011 wrt to heterotrophic count, presence of *Pseudomonas spps., Staphyloccocci spps* & *P. acne*
5. MIC of an antibiotic by tube method using Indian Pharmacopeia protocol

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)

As per National Education Policy - 2020

Sr. No.	Heading	Particulars
1	**Title of program**	M.Sc. (Microbiology)
2	**Eligibility**	The 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 by BOS and Academic Council
11	**To be implemented from Academic Year**	Academic Year 2024-25

Signature

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

Signature

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

Preamble

1) Introduction

Algae biotechnology is an ever-expanding field of research that aims to use the biological properties of algae to develop products and solutions for diverse sectors, from food and energy to medicines and cosmetics. Algae are considered highly versatile and sustainable organisms, as they can carry out photosynthesis and grow quickly in different environments, in addition to producing bioactive compounds with interesting properties

In this context, nanotechnology has played an important role in algae biotechnology, allowing the development of new technologies and products with greater efficiency and precision.

Thus, the combination of algae biotechnology with nanotechnology has generated current and prospective trends that have the potential to revolutionize various sectors, such as biofuel production, the pharmaceutical industry, agriculture and food production. In addition, algae biotechnology can contribute to reducing the environmental impact of various human activities, providing sustainable and innovative solutions to current and future challenges. Through this course, students can learn the importance of nanotechnology and algal technology.

Aims and Objectives

Aim: To provide a basic and advanced level understanding of algal and nanobiotechnology.

Objectives:

1. To introduce ethical issues in Biotechnology ethics.
2. To learn the principles of nanotechnology.
3. To understand the importance of algal biotechnology.

2) Learning Outcomes

CO1	Relate to various applications of nanotechnology.	**BTL: Apply**
CO2	Explain the basics of nanotechnology.	**BTL : Understand**
CO3	Perform the culturing of algae by using photo bioreactor.	**BTL: Apply**

Syllabus for F.Y.B. Sc. (Chemistry) 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 : Nano Biotechnology & Algal Biotechnology

Course Type:Elective Course 2 **No. of Credits: 4**

Unit	Title of Unit: Nano Biotechnology & Algal Biotechnology	
Unit 1	**Nano Biotechnology**	**No. of Hrs.**
1	Basics of Nanotechnology 1. Types of Nanomaterials 2. Properties of Nanomaterials	01
2	Fundamentals of Bio-nanotechnology – 1. Nanomotors of biological systems 2. ATP synthase: a Nano turbine 3. Flagellar motors in bacteria 4. Linear molecular motors	05
3	Biosynthesis of nanomaterials biosystems as Nano factories 1. Bacteria as machinery for synthesis of Nano metals: gold, silver, Zinc, cadmium, platinum 2. Fungi and Actinomycetes as fabricators of nanometals 3. Plants as Nano engineers 4. Algae as nanotechnologists	03
4	DNA and proteins as templates for molecular Nanotechnology and Nanoelectronics	03

5	Applications of nanotechnology – Nano medicine, Nano biodevices, Nano implants, applications in agriculture, food and cosmetics	03
Unit 2:	**Title of Unit: Algal Biotechnology**	
S. N.	**Algal Biotechnology**	**No. of Hrs.**
1	Culture techniques and media for growth of freshwater algae: - Measurement of algal growth in culture - lag phase, log phase, stationary phase and death phase using biomass, chlorophyll content, and Measurement of algal pigments.	5
2	Culturing microalgae in Photobioreactors, Fermenter and Outdoor ponds: Variation in design, culture conditions, scale-up, economics, advantages and disadvantages	5
3	Applications of Algal Biotechnology: Food Supplements and fertilizers, Bioactive compounds and cosmetics, Biofuel, high-value commercial products, and Bioplastics.	5

	Title of Practical: Nano Biotechnology & Algal Biotechnology	
S. N.	**Practical**	**No. of Hrs.**
1	Preparation of growth culture medium for freshwater algae and study of its diversity with respect to its type count and morphology.	
2	Counting algal Cells in Cultures with the Light Microscope.	
3	Isolation, inoculation and growth of microalgae	
4	Disruption of bacterial cells followed by characterization of cellular proteins by SDS PAGE	
5	Isolation of lymphocytes and their Viability staining using trypan blue	
6	Determination of cell viability of lymphocytes by MTT Assay& neutral red uptake assay	
7	Comparison of various cell viability techniques	
8	Isolation of mitochondria and check activity of respiratory enzyme succinate dehydrogenase	
9	Preparation and characterization of Silver Nanoparticles	
10	Survival Curve and antibacterial activity of nanosilver particles	
11	Study of nanosilver coated gauze / textiles for antimicrobial effect on different bacteria.	
12	Isolation of chloroplast and checking photophosphorylation	
13	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
	Unit 1
1.	Bionanotechnology –concepts and applications. Madhuri Sharon, Maheshwar Sharon, Sunil Pandey,Goldie Oza
2.	Nanotechnology- Principles and Practices 2 nd edition Sulabha K. Kulkarni Capital Publishing Company
3.	Nanotechnology- Nanomaterials and Nanodevices G.Mohan Kumar .Narosa Publications
	Unit 2
1	Bellinger, E. G. and Sigee, D. C. (2010). Freshwater algae: Identification and use as a bioindicators.Wiley-Blackwell (Pre-read Book)
2	Lee, R. E. (2008). Phycology. 4ed. Cambridge University Press (Pre-read Book)
3	Andersen, R. A. (2005). Algal culturing techniques. Elsevier Academic Press
4	Sahoo, D. and Seckbach, J. (2015). The Algae World. Springer
5	Prescott, G. W. (1954). How to Know Fresh-Water Algae. WM C. Brown Company (For practicals only)
6	Vuuren, S. J. (2006). Easy identification of the most common freshwater algae. A guide for the identification of microscopic algae in South African freshwaters. DWAF and NWU (For practicals only)
7	Sharma, P., Sharma, N. (2017) Industrial and Biotechnological Applications of Algae: A Review. Journal of Advances in Plant Biology - 1(1):01-25. (Review Paper)
8	Barkia, I., Saari, N., Manning, S. R. (2019). Microalgae for High-Value Products Towards Human Health and Nutrition. Mar. Drugs 2019, 17, 304; doi:10.3390/md17050304 (Review Paper)
9	Rasul, I. et. al. (2017) Algae Biotechnology: A green light for engineered algae. From Algae Based Polymers, Blends and Composites. Elsevier (Book Chapter)
10	Barsanti, L. and Gualtieri P. (2014). Algae: Anatomy, Biochemistry, and Biotechnology, 2ed. CRC Press.
11	Richmond, A. and Hu, Q. (2013). Handbook of Microalgal Culture: Applied Phycology and Biotechnology, 2ed. John Wiley & Sons, Ltd.

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Janardan Bhagat Shikshan Prasarak Sanstha's

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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)

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

Name
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)

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**

Syllabus for M.Sc.. (Micrbiology) 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- Unleading 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.v1i2.6817Article · December 2015DOI 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.

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'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)

As per National Education Policy - 2020

Sr. No.	Heading	Particulars
1	**Title of program**	M.Sc. (Microbiology)
2	**Eligibility**	The 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**	IV
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

Name
Head, Department of Microbiology
Changu Kana Thakur
A.C.S. College, New Panvel
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Signature of

Prof. (Dr.) S.K. Patil
Principal
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Preamble

1) Introduction

Mycology is the study of fungi, a group that includes mushrooms and yeast. Many fungi are useful in medicine and industry. Mycological research has led to the development of such antibiotic drugs as penicillin, streptomycin, and tetracycline, as well as other drugs, including statins (cholesterol-lowering drugs). PROTOZOOLOGY, a science that has only in most recent times attracted general attention, is nothing more or less than the study of a group of organisms which zoologists term protozoa. Many fundamental processes in cell biology and biochemistry were first discovered in protozoa. A wide range of human and animal diseases are caused by protozoa. Protozoa play key roles in nutrient cycling and soil fertility and are the main predators of bacteria in many environments. By this course, students will learn the importance of mycology and protozoology.

Aims and Objectives

Aim: To provide a basic and advanced level understanding of Mycology and protozoology

Objectives:

1. To provide a broad background to some of the fastest developing areas in current fields of Mycology and Protozoology.
2. To study potential importance of fungi and protozoa in various areas other than Medical Microbiology
3. To learn the Parasites associated with Protozoa.

2) Learning Outcomes

CO1	Summarize Fungal Pigments and Mycotoxins, siderophores.	**BTL: Apply**
CO2	Demonstrate the importance of fungi in various ecological roles.	**BTL : Understand**
CO3	Illustrate the role of Protozoa used in Wastewater Microbiology and soli bioremediation.	**BTL: Apply**

Syllabus for F.Y.B. Sc. (Chemistry) 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 : PSc4Mi4

Course Title : Mycology and Protozoology

Course Type:Elective Course 2 **No. of Credits: 4**

	Title of paper: Mycology and protozoology	
Unit no 1	**Fungal technology**	**No. of Hrs.**
1	Mycology a) A neglected Mega Science b) The diversity of fungi and fungus-like organisms c) Fungal molecular taxonomy:	02
2	Fungal Pigments and Mycotoxins a) Genetic basis of pigment production b) Factors affecting pigment production c) Fermentation for pigment synthesis d) Mycotoxins and their replacement e) Relevance of pigments in various fields	02
3	Fungal siderophores – structure, function and applications	02

4	Fungal Lipid production a) Oleaginous fungi b) Lipid production from lignocelluloses and crude glycerol c) Production of specific chemicals and fuels derived from lipid metabolism	05
5	Fungal Metabolites a) Enzymes - Xylanase, Laccase, Galactosidase, Inulinase, Catalase and b) Flavours and Aroma c) Engineering of fungal biomolecules	04
Unit 2:	**Title of unit: Protozoology**	
	Protozoology	**No. of Hrs.**
1	Introduction to Protozoa a) Classification of Protozoa b) Processes in Protozoa: Motility, Nutrition, Reproduction c) Cultivation of Protozoa	1
2	Protozoa used in Wastewater Microbiology a) Sarcodina b) Flagellates c) Ciliates d) Sporozoa e) Rhizopod	2
3	Importance of Protozoans in water and wastewater treatment a) Protozoa as indicators of wastewater treatment efficiency b) Types of Protozoans (Key groups)	4

	c) Activated sludge ecosystems d) Microfaunas as indicators	
4	Importance of Protozoans in Soil Bioremediation	3
5	Protozoan Parasites a) Giardia spps. b) Cryptosporidium c) Microsporidia d) Toxoplasma e) Naegleria fowleri	5

Module 1:	**Title of Module: Practical**	
S. N.	**Practical**	**No. of Hrs.**
1	Isolation & Characterization of organisms with probiotic potential from food samples.	
2	Isolation of pigment-producing bacteria from marine environments and extraction of pigments through solvent extraction procedures 3	
3	Isolation of biopolymer-producing bacteria and quantify the biopolymer-produced	
4	A qualitative and quantitative study of Phosphate solubilizers	
5	Qualitative and quantitative estimation of fungal Laccase enzyme	
6	Cultivation of protozoa from the natural environment	
7	Assignment on Emerging protozoa/fungal Diseases	

References

S. N.	Unit 1 – Applications of Fungal Technology
1.	Applied Mycology by Mahendra Rai, Paul Dennis Bridge, 2009, CAB International.
2.	Fungal Biology 4thed. By J. W. Deacon,2006, Blackwell Publishing.
3.	Fungal Biomolecules – sources, Applications and Recent Developments by Vijay Kumar Gupta, Robert L. Mach, S. Sreenivasaprasad2015, Published by John Wiley & Sons .ltd.
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7	Biotechnology of Yeasts and Filamentous Fungi by Andriy A. Sibirny 2017, Springer International Publishing AG.
8	Radhika Deshmukh , Anshuman A. Khardenavis and Hemant J. Purohit Review Article, Indian J. Microbiology (July–Sept 2016) 56(3):247–264.
S. N.	Unit 2 – Applications of Fungal Technology
1	The Handbook of Water and Waste Water Microbiology by Duncan Mara and Nigel Horan,2003
2	Wastewater Microbiology, 2nd edition by Bergey, D.H
3	Wastewater Microbiology, 4th edition by Gabriel Bitton,2011
4	Pauli W, Berger S, Protozoa in wastewater treatment: Function and Importance. Biodegradation and Persistence,2001,Pg 203-252.doi:10,1007/10508767_3
5	Atlas of Medical Helminthology and Protozoology, 2001 Peter L. Chiodini, A.H.Moody, D.W.Manser
6	Textbook of Medical Parasitology: Protozoology and Helminthology, 4 th edition by S. C. Parija
7	https://www.sciencedirect.com/science/article/abs/pii/S1872203207600687
8	. https://www.nature.com/articles/ismej201320

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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)

As per National Education Policy - 2020

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7	**Semesters**	IV
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

Name
Head, Department of Microbiology
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Signature of

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Syllabus for F.Y.B. Sc. (Chemistry) 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 : PSc4Mi4

Course Title : Mycology and Protozoology

Course Type:Elective Course 2 **No. of Credits: 4**

	Title of paper: Mycology and protozoology	
Unit no 1	**Fungal technology**	**No. of Hrs.**
1	Mycology a) A neglected Mega Science b) The diversity of fungi and fungus-like organisms c) Fungal molecular taxonomy:	02
2	Fungal Pigments and Mycotoxins a) Genetic basis of pigment production b) Factors affecting pigment production c) Fermentation for pigment synthesis d) Mycotoxins and their replacement e) Relevance of pigments in various fields	02
3	Fungal siderophores – structure, function and applications	02

4	Fungal Lipid production a) Oleaginous fungi b) Lipid production from lignocelluloses and crude glycerol c) Production of specific chemicals and fuels derived from lipid metabolism	05
5	Fungal Metabolites a) Enzymes - Xylanase, Laccase, Galactosidase, Inulinase, Catalase and b) Flavours and Aroma c) Engineering of fungal biomolecules	04
Unit 2:	**Title of unit: Protozoology**	
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Module 1:	**Title of Module: Practical**	
S. N.	**Practical**	**No. of Hrs.**
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4	A qualitative and quantitative study of Phosphate solubilizers	
5	Qualitative and quantitative estimation of fungal Laccase enzyme	
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4	Pauli W, Berger S, Protozoa in wastewater treatment: Function and Importance. Biodegradation and Persistence,2001,Pg 203-252.doi:10,1007/10508767_3
5	Atlas of Medical Helminthology and Protozoology, 2001 Peter L. Chiodini, A.H.Moody, D.W.Manser
6	Textbook of Medical Parasitology: Protozoology and Helminthology, 4 th edition by S. C. Parija
7	https://www.sciencedirect.com/science/article/abs/pii/S1872203207600687
8	. https://www.nature.com/articles/ismej201320