



SOMAIYA
VIDYAVIHAR

K J Somaiya College of Science & Commerce

Department: Microbiology



TRUST
M.Sc. Syllabus

M.Sc. Microbiology Revised Autonomous Syllabus
Semester III and Semester IV
to be implemented
for the Academic Year 2020-2021



Preamble

Microbiology is a Research-oriented subject and has proved to be an indispensable domain in biology catering to an enormous spectrum of activities relevant to humanity and the environment. Syllabus for M.Sc. Microbiology primarily consists of four Semesters, each having four Courses with four Modules. Semester I and II consist of topics on Fundamental and Advanced concepts of Evolution, Cell Biology, Molecular Biology, Biochemistry, Immunology, Food, and Environmental Microbiology.

This syllabus for Semester III and Semester IV is a version that has been exclusively designed to be implemented in the current Covid-19 pandemic scenario. The rationale is to inculcate scientific temperament for Research and to enrich the learners with higher knowledge. Semester III and IV consist of topics on Research Methodology, Plant and Animal Biotechnology, Pharmaceutical Microbiology, IPR, Microbiome, Synthetic biology, Soil, and Environmental Microbiology, Ecology, Epidemiology, and Molecular Biotechnology. Emphasis is to prepare the learners with global requirements of Research, Innovation, and Employability.

M.Sc. Microbiology Revised Autonomous Syllabus-Courses and Modules

SEMESTER III	MODULES	CREDITS
2OPS3MB1 Course I: Tools and Techniques: Research Methodology		4
	Research Fundamentals	
	Defining Research Problem and Data Collection	
	Biostatistics	
	Data Analysis and Scientific writing	
2OPS3MB2 Course II: Trends in Biotechnology		4
	Plant Tissue Culture (PTC)	
	Animal Tissue Culture (ATC)	
	Biofuels	
	Molecular Biotechnology	
2OPS3MB3 Course III: Pharmaceutical Microbiology		4
	Biopharmaceuticals	
	Drug Development Process	
	Analysis of Pharma and Cosmetic Products	
	GMP Management and Regulatory Aspects in Pharma industry	
2OPS3MB4		4



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Course IV: IPR, Bioinformatics and Biotechnology	IPR: Intellectual Property Rights	
	Advances in IPR and Bioethics	
	Bioinformatics	
	Techniques in Molecular Biotechnology	
SEMESTER IV		
2OPS4MB1 Course I: Microbial Ecosystems		4
	Microbial Diversity	
	Cultivation and Application of Extremophiles	
	Microbiome	
	Biofilm and its Management	
2OPS4MB2 Course II: Applications in Biotechnology		4
	Application in plant Biotechnology	
	Application in Animal Biotechnology and Stem cells	
	Medical Biotechnology	
	Synthetic Biology	
2OPS4MB3 Course III: Viruses, Vaccines and Public Health		4
	Viruses of Bacteria, Mycobacteria, Humans and Animals	
	Vaccines	
	Advanced Vaccines	
	Epidemics, Pandemics and Outbreaks	



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2OPS4MB4		4
Course IV: Environmental Microbiology	Soil & Agricultural Microbiology	
	Pollution control and Monitoring	
	Marine Microbiology	
	Techniques in Microbial Ecology	

Semester III-2020-21

Course I: Tools and Techniques: Research Methodology

Course Code: 2OPS3MB1

Module	Topic	Number of Lectures (15)
I	Research Fundamentals:	
	1.1 Meaning and Objective of research, features of a good research study and scientific method	3L
	1.2 Sampling and its types:	5L
	1.2.1 Sampling frame	
	1.2.2 Importance of probability sampling	
	1.2.3 Simple random sampling, systematic sampling, stratified random sampling and cluster sampling	
	1.2.4 Problems due to unintended sampling	
I	1.2.5 Ecological and statistical population in the laboratory	
	1.3 Study designs and variations:	
	1.3.1 Basic, applied, historical, exploratory, experimental and ex- post-facto	3L
	1.3.2 Case study, diagnostic research, crossover design and case control design	2L
	1.3.3 Cohort study design and multifactorial design	2L
II	Defining Research Problem and Data Collection	4L
	2.1 Hypothesis, theory and Scientific law:	
	2.1.1 Development, structure, conditions,	

	<p>sources, formulation and explanation of hypothesis</p> <p>2.1.2 Structure, identification, elements, classification and functions of theory</p> <p>2.1.3 Scientific laws and principles</p> <p>2.2 Methods and techniques of data collection:</p> <p>2.2.1 Types of data collection methods</p> <p>2.2.2 Methods of primary data collection: (Observation/ Experimentation / questionnaire/ interviewing/ case / pilot study methods)</p> <p>2.2.3 Methods of secondary data collection (internal/ external)</p> <p>2.3 Schedule method</p>	<p>3L</p> <p>2L</p> <p>2L</p> <p>2L</p> <p>2L</p>
III	<p>Biostatistics</p> <p>3.1 Introduction to Biostatistics and its Significance in Research:</p> <p>Terminologies used and different tests as per the data</p> <p>3.2 Measures of Central Tendencies:</p> <p>3.2.1 (Revision of Mean, Median, and Mode with grouped and ungrouped data), Geometric mean and Harmonic mean</p> <p>3.3 Measures of Variation:</p> <p>3.3.1 Range, Quartile Deviation, Standard Deviation, Coefficient of Variation</p> <p>3.3.2 Concept of Standard error</p> <p>3.4 Introduction to Skewness and Kurtosis:</p> <p>3.4.1 Brief interpretation of the data on the basis of Skewness</p>	<p>1L</p> <p>3L</p> <p>2L</p> <p>1L</p>

<p>and Kurtosis</p> <p>3.4.2 Concept of Parametric and Non-Parametric tests</p> <p>3.5 Concept of Variables and types of Scales:</p> <p>3.5.1 Nominal, Ordinal, Interval and Ratio scales</p> <p>3.6 Basic principles of Testing of Hypotheses:</p> <p>3.6.1 Null and Alternate Hypothesis</p> <p>3.6.2 Type I and Type II errors</p> <p>3.6.3 Level of Significance</p> <p>3.6.4 Two-tailed and One-Tailed Tests</p> <p>3.6.5 p-value Approach</p> <p>3.6.6 Concept of Statistical table</p> <p>3.7 Parametric test – T test:</p> <p>Testing of Hypothesis concerning Means</p> <p>3.8 Non-Parametric test-Chi square test:</p> <p>3.8.1 Test of Difference of more than two Proportions</p> <p>3.8.2 Test of Goodness of Fit</p> <p>3.9 Analysis of Variance-ANOVA</p> <p>3.9.1 One-way ANOVA</p> <p>3.10 Correlation and Regression:</p> <p>3.10.1 Correlation Analysis- Karl Pearson's Coefficient of</p>	<p>1L</p> <p>2L</p> <p>1L</p> <p>1L</p> <p>1L</p>
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4. Data analysis: R programming

References 2OPS3MB1

Module	
I	<ol style="list-style-type: none"> 1. Kothari, C.R. (1985). Research Methodology- Methods and Techniques, New Delhi, Wiley Eastern Limited. 2. Das, S.K. (1986). An Introduction to Research, Kolkata, Mukherjee and Company Pvt. Ltd.
II	<ol style="list-style-type: none"> 1. Misra R.P. (1989). Research Methodology: A Handbook, New Delhi, Concept Publishing Company. 2. Kumar, R. (2005). Research Methodology-A Step-by-Step Guide for Beginners, (2nd.ed.), Singapore, Pearson Education.
III	<ol style="list-style-type: none"> 1. Panneerselvam R. (2012). Research Methodology, New Delhi, PHI Learning Pvt. Ltd. 2. Bhattacharya, D.K. (2006). Research Methodology, (2nd. Ed.), New Delhi Excel Books. 3. Khan, Irfan Ali. (2008). Fundamentals of Biostatistics, Ukaaz Publications.
IV	<ol style="list-style-type: none"> 1. Rosner B.A. (2011) Fundamentals of Biostatistics, Cengage Learning. 2. Katz J.M., (2009), From Research to Manuscript: A guide to scientific writing, USA, Springer Science. 3. Saravanavel, P. (1990) Research methodology. Allahabad, Kitab Mahal.

Course II: Trends in Biotechnology

Course code: 2OPS3MB2

Module	Topic	Number of Lectures (15)
I	<p>Plant Tissue Culture (PTC)</p> <p>1.1. Plant tissue culture for crop improvement:</p> <p>1.1.1. Initiation and maintenance of Callus and suspension culture</p> <p>1.1.2. Direct and Indirect organogenesis, and Micropropagation</p> <p>1.1.3. Artificial seeds, Anther culture and dihaploids</p> <p>1.1.4. Protoplast isolation culture and fusion</p> <p>1.1.5. Production of haploids and Somaclonal variations</p> <p>1.1.6. Somatic hybrids, Cybrids and Germplasm conservation</p> <p>1.2. Plant Transformation technology:</p> <p>1.2.1. Direct gene transfer methods: Particle bombardment, Polyethylene glycol (PEG) mediated transformation and Electroporation</p> <p>1.2.2 Development of Plant transformation vectors:</p> <p>a. Basic features of vectors for plant transformation</p> <p>b. Promoters and terminators selectable markers</p> <p>c. Reporter genes</p>	<p>6L</p> <p>3L</p> <p>5L</p>

	<p>d. Agrobacterium mediated genes transfer e. Agrobacterium based vectors and viral vectors</p> <p>1.3 Transgene silencing: Strategies to avoid transgene silencing</p>	1L
II	<p>Animal Tissue Culture</p> <p>2.1 Types of tissue culture: Organ culture, Explant Culture, Dissociated cell culture, and Organotypic culture</p> <p>2.2 Equipment's of ATC laboratory: Inverted Microscope, Dissecting Microscope, Cell counting, Incubator, Humidified CO₂ chamber</p> <p>2.3 Biosafety: Safety, Risk assessment and Bioethics</p> <p>2.4 Culture Vessel and Substrate: Common Substrate material, Alternative substrate and Specialized System</p> <p>2.5 Serum free media: Advantages and disadvantages and Replacement of serum</p> <p>2.6 Primary culture: Initiation and types of primary culture</p> <p>2.7 Subculture and cell lines: Selection of cell lines</p>	<p>1L</p> <p>2L</p> <p>3L</p> <p>2L</p> <p>1L</p> <p>2L</p>

	<p>and their maintenance</p> <p>2.8 Scale -up: Stirrer Culture, Roller Culture, Microcarriers and Macro-carriers</p> <p>2.9 Cryopreservation</p>	<p>1L</p> <p>2L</p> <p>1L</p>
III	<p>Biofuels</p> <p>3.1 Potential Bioresources for Biofuel Production:</p> <p>3.1.1 Classification of biofuels based on substrates used</p> <p>3.1.2 First and Second-Generation Biofuels</p> <p>3.1.3 Lignocellulosic materials: Types (cellulose, hemicellulose and lignin), physical and chemical properties</p> <p>3.1.4 Pre-treatment Methods (overview): Physical/Mechanical, Three Chemical and Biological Pre-treatment with emphasis on fungal enzymes for bio refining.</p> <p>3.2 Liquid Biofuels:</p> <p>3.2.1 Biodiesel: substrates, Tree born oils, animal fats and microbial oils and Future Perspectives</p> <p>3.2.2 Bioethanol substrates, pre-treatment and enzyme hydrolysis</p> <p>3.3 Biohydrogen:</p> <p>3.3.1 Types of production Mechanisms Dark Fermentation and Photo-</p>	<p>1L</p> <p>2L</p> <p>3L</p> <p>2L</p> <p>2L</p> <p>3L</p>

	<p>Fermentation</p> <p>3.3.2 Bottleneck in Biohydrogen Production and Avenues for Improvement</p> <p>3.4 Microbial Fuel Cells: Green approach</p> <p>3.4.1 Principles of MFC, and Applications of MFC (list examples)</p>	<p>2L</p>
<p>IV</p>	<p>Molecular Biotechnology</p> <p>4.1 Manipulation of Gene Expression in Prokaryotes:</p> <p>4.1.1 Regulatable promoters</p> <p>4.1.2 Fusion proteins</p> <p>4.1.3 Increasing protein stability</p> <p>4.1.4 Protein folding</p> <p>4.1.5 DNA integration into the host chromosome</p> <p>4.2 Heterologous protein production in eukaryotic cells:</p> <p>4.2.1 <i>Saccharomyces cerevisiae</i></p> <p>4.2.2 <i>Pichia pastoris</i></p> <p>4.2.3 Baculovirus -Insect cell lines</p> <p>4.2.4 Mammalian cell lines</p> <p>4.3 Directed Mutagenesis:</p> <p>4.3.1 Oligonucleotide directed mutagenesis with M13</p> <p>4.3.2 Oligonucleotide directed mutagenesis with</p>	<p>5L</p> <p>5L</p> <p>5L</p>



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	<p>plasmid DNA</p> <p>4.3.3 PCR amplified oligonucleotide directed mutagenesis</p> <p>4.3.4 Random mutagenesis with degenerate oligonucleotide</p> <p>4.3.5 Primer, Random mutagenesis with nucleotide analogues</p> <p>4.3.6 Error-prone PCR</p> <p>4.3.7 DNA shuffling</p> <p>4.3.8 Mutant proteins with unusual amino acids</p>	
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Practical: 2OPS3MBP2

Practical

Course II: Trends in Biotechnology

1. Initiation of callus from Tulsi /Neem explant on MS medium
2. Demonstration of Chick embryo fibroblast culture and viable staining of Lymphocytes
3. Enumeration of animal cells (Lymphocytes)
4. Preparation of complete medium. Sterilization and sterility checking of medium.
5. Terminology and Laboratory design of Animal tissue culture laboratory
6. Visit to an animal cell culture laboratory
7. Isolation of cellulose digestors from soil/ cow-dung/ biogas plant
8. Production of bioethanol / biodiesel
9. Case study on Biofuel production

References 2OPS3MB2

Module	
I	<ol style="list-style-type: none"> 1. Plant Biotechnology: The genetic manipulation of plants, 2005, A. Slater, N. Scott & M. Fowler, Oxford Univ Press, Oxford. 2. Glick B R, Pasternak J J, and Patten C L, Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, Washington, DC: ASM Press 2010 3. Introduction to Plant Biotechnology (3rd Edtn), H.S. Chawla 4. Roberta Smith, Plant Tissue Culture: Techniques and Experiments, 2nd Edtn, Academic Press, 2000 5. H. K. Das (ed), Textbook of Biotechnology, Wiley India, 2004 6. J. H. Hammond, P. Mcgarvey, and V. Yusibov (eds), Plant Biotechnology, Springer Verlag, Heidelberg, 2000 7. B. B. Buchanan, W. Gruissen and R. L. Jones (eds), Biochemistry and Molecular Biology of Plants, American Society of Plant Biology, Rockville, USA, 2000.

	<p>8. Plant Biotechnology and Agriculture: Prospects for the 21st Century, Arie Altman, Paul Michael Hasegawa.</p> <p>9. Plant Biotechnology and Genetics: Principles, Techniques & Applications, Stewart, C. Neal, June 2008, John Wiley & Sons</p>
II	<p>1. Culture of animal cell; A manual of basic technique and specialized application, R. Ian Freshney, 4th Edition, Wiley and Sons 2010</p> <p>2. Basic Cell Culture. Ed. J. M. Davis 2nd.Ed 2007. Oxford press</p> <p>3. Principles and practice of Animal Tissue Culture, 2nd Edition, Sudha Gangal, Universities Press (India private limited 2010)</p> <p>4. Bernard R. Glick, Jack J. Pasternak, Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th edition, ASM Press. 2010</p>
III	<p>1. Vijai Kumar Gupta, Maria G. Tuohy, eds. (2013). <i>Biofuel Technologies: Recent Developments</i>. Springer. ISBN 978-3-642-34518-0 ISBN 978-3-642-34519-7 (eBook). DOI 10.1007/978-3-642-34519-7</p>
IV	<p>1. Bernard R. Glick, Jack J. Pasternak, Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th edition, ASM Press. 2010</p> <p>2. John M Walker: Molecular Biology and Biotechnology ,5th edition, RSC publishers. 2007</p> <p>3. Alexander N Glazer, Microbial Biotechnology Fundamental and Applied Microbiology, 2nd edition, ISBN 13, 2007.</p> <p>4. An Introduction to Molecular Biotechnology: Molecular Fundamentals, Methods and Applications in Modern Biotechnology edited by Michael Wink, 2006 Wiley VCH.</p> <p>5. Molecular biotechnology: principles and practices Channarayappa, 2006, Universities Press.</p>

Course III: Pharmaceutical Microbiology

Course code: 2OPS3MB3

Module	Topic	Number of Lectures (15)
I	<p>Biopharmaceuticals</p> <p>1.1 Biologics: Microbial and mammalian type and Biopharmaceuticals</p> <p>2L</p> <p>1.2 Protein therapeutics:</p> <p>Upstream and downstream processing, cytokines, interferon production, interleukins productions</p> <p>3L</p> <p>1.3 Therapeutic hormones: Insulin human growth hormones, Recombinant blood products and therapeutic enzymes</p> <p>3L</p> <p>1.4 Nucleic acid as therapeutic agent:</p> <p>a. Antisense Oligonucleotides</p> <p>b. Chimeric RNA-DNA molecules</p> <p>c. Aptamers</p> <p>1.5 Drug discovery tools: Combinatorial chemistry, Cheminformatics, in silico Modelling, Molecular modelling, structure Prediction, Rational, drug designing, and Drug Development</p> <p>5L</p>	
II	<p>Drug Development Process</p> <p>2.1 Overview of drug development process</p> <p>1L</p> <p>2.2 Impact of genomics and related technologies in drug discovery:</p> <p>3L</p>	

	<p>2.2.1 Gene chips</p> <p>2.2.2 Proteomics</p> <p>2.2.3 Structural genomics</p> <p>2.3 Introduction to Pharmacogenetics: Basic concepts</p> <p>2.4 Delivery of Biopharmaceuticals</p> <p>2.4.1 Oral delivery system</p> <p>2.4.2 Pulmonary delivery</p> <p>2.4.3 Nasal, transmucosal and transdermal delivery systems</p> <p>2.5 Pharmacokinetics and pharmacodynamics</p> <p>2.6 Clinical trials</p> <p>2.7 The role and remit of regulatory authorities</p>	<p>1L</p> <p>3L</p> <p>2 L</p> <p>3 L</p> <p>2 L</p>
III	<p>Analysis of Pharma and Cosmetic Products</p> <p>3.1 Testing of Cosmetic: Pyrogen test, LAL test, Microbiological test, safety & microbiology and toxin detection</p> <p>3.2 Sterile and other products:</p> <p>3.2.1 Injections</p> <p>3.2.2 Non-Injectable Sterile fluids</p> <p>3.2.3 Ophthalmic preparations</p> <p>3.2.4 Dressings</p> <p>3.3 Method validation & process validation:</p> <p>3.4 Cosmetic Microbiology-Testing method and preservation:</p> <p>3.4.1. Anti-Microbial preservation efficiency and microbial content</p> <p>3.4.2 Validation methods for cosmetics</p> <p>3.4.3 Preservation strategies</p> <p>3.4.4 Evaluations and Antimicrobial mechanis</p>	<p>3L</p> <p>4L</p> <p>5L</p> <p>3L</p>



IV	GMP Management and Regulatory Aspects in Pharma industry	
	4.1 Quality assurance beyond GMP, ICH & Pharmacopoeias and Sanitary practices in cosmetic manufacture	4L
	4.2 Premises and contamination control, location, design, structure, layout, services and cleaning	4L
	4.3 Personal /management training, hygiene and health, and documentation	3L
	4.4 Global regulatory and toxicological aspects of cosmetic preservation	4L

Practical: 2OPS3MBP3

Practical
Course III: Pharmaceutical Microbiology
<ol style="list-style-type: none">1. Visit to Pharmaceutical industry2. Sterility testing and reporting3. Microbial load in cosmetic product4. Product design – hand wash, shampoo5. Efficacy testing of preservatives like parabens6. Efficacy of preservation and shelf life study7. LAL and other tests for QC

References 2OPS3MB3

Module	
I	<ol style="list-style-type: none"> 1. Sharp John (2000) Quality in the manufacture of medicines and other healthcare products. Pharmaceutical Press. 2. Philip A, Taylor and Francis (2006) Cosmetic Microbiology a practical approach. 2nd Ed. 3. Glick B R, Pasternak J J, and Patten C L, Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, Washington, DC: ASM Press 2010.
II	<ol style="list-style-type: none"> 1. Gary Walsh (2007) Pharmaceutical Biotechnology: Concepts and Applications. John Wiley & Sons, Ltd. Page no (57-100) 2. Hillisch A and Hilgenfeld R (2009) Modern Methods of drug discovery. Springer International Edition. 3. Jogdand S. N., Biopharmaceuticals, Himalaya Publishing House, Mumbai (2006) 4. K. Sambamurthi, Pharmaceutical Biotechnology, New Age International (2006) Daan. J 5. Crommelin, Robert D. Sindelar and Bernd Meibohm Pharmaceutical Biotechnology: Fundamentals and Applications, informa healthcare, (Oct 30, 2007)
III	<ol style="list-style-type: none"> 1. Hillisch A and Hilgenfeld R (2009) Modern Methods of drug discovery. Springer International Edition. 2. Kadam s s, Mahadik K R and Bothara K G (2009). Principles of medicinal Chemistry. Vol II Nirali Prakashan Pune. 3. Lemke T L and Williams D A (2008) Foye's Principles of Medicinal Chemistry. 6th Ed. Wolter Luwer, Lippincott Williams and Wilkins. N Delhi. 4. Philip A. Taylor and Francis (2006) Cosmetic Microbiology a practical approach. 2nd Ed.
IV	<ol style="list-style-type: none"> 1. Bhatia R and Ichhapujani R L (1995) Quality Assurance in Microbiology. CBS publishers and distributors. 2. Bibek Ray and Arun Bhunia (2008) Fundamental Food Microbiology. 4th



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	<p>Ed. CRC Press.</p> <ol style="list-style-type: none">Denyer S p, Hodges N A and Gorman S P (2005)Hugo and Russell's Pharmaceutical Microbiology. Blackwell Publishing.Iyer S. (2003) Guidelines on cGMP and quality of Pharmaceutical products. D K Publishers Mumbai.Philip A, Taylor and Francis (2006) Cosmetic Microbiology a practical approach. 2nd Ed.Sharp John (2000) Quality in the manufacture of medicines and other healthcare products. Pharmaceutical Press.
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Course IV: IPR, Bioinformatics and Biotechnology

Course code: 2OPS3MB4

Module	Topic	Number of Lectures (15)
I	IPR: Intellectual Property Rights	
	1.1 Intellectual Property Rights (IPR) and Protection (IPP)	1L
	1.2 Biotechnology and IPR-Rationale of Patent in Research and Scientific Innovations and Biotechnological Patents	1L
	1.3 Acquiring a patent, Drafting of a Patent, patent specifications and claims, patentability of life forms	5L
	1.4 TRIPS, GATT, WTO, PCT, BUDAPEST treaty, Madrid Agreement and WIPO	6L
	1.5 Geographical indications	2L
II	Advances in IPR and Bioethics	
	2.1 Patent thickets and Patent clusters	2L
	2.2 Patinformatics	2L
	2.3 Patent infringement: IPR protection and disputes in patents (pharma patents)	2L
	2.4 Global scenario in IPR: America, Europe, Japan and Australia	3L
	2.5 Indian patenting process: IPO, Patentable and Nonpatentable intellectual property in India	3L
	2.6 Ethical limits of Biotechnology IPP, Global Issues of Technology Transfer and Regulations	3L

<p>III</p>	<p>Bioinformatics</p> <p>3.1 Introduction to bioinformatics- General introduction, Scope and Applications</p> <p>3.2 Biological databases:</p> <p>3.2.1 Introduction & Classification (Raw & Processed, Sequence & Structure databases, specialized databases)</p> <p>3.2.2 Data retrieval from biological databases – ENTREZ</p> <p>3.3 Sequence alignment:</p> <p>3.3.1 Introduction, Scoring Matrices (PAM & BLOSUM), local & global alignment</p> <p>3.3.2 Pairwise sequence alignment & Multiple sequence alignment</p> <p>3.3.3 Overview of molecular phylogenetics</p> <p>3.4 Protein Structure analysis:</p> <p>3.4.1 Basic tools & databases</p> <p>3.4.2 Visualization, classification & structure prediction</p> <p>3.5 Basic concepts of computer aided drug design (CADD)</p>	<p>2L</p> <p>3L</p> <p>3L</p> <p>4L</p> <p>3L</p>
<p>IV</p>	<p>Techniques in Molecular Biotechnology</p> <p>4.1 Variations/ Modifications of PCR:</p> <p>4.1.1 Hot- Start PCR</p> <p>4.1.2 Multiplex PCR</p> <p>4.1.3 Nested PCR</p> <p>4.1.4 Broad Range PCR</p> <p>4.1.5 Arbitrarily primed PCR</p>	<p>3L</p>

4.1.6 Quantitative PCR	3L
4.2 Hybridization array technology:	
4.2.1 Microarray platform technologies (Oligonucleotide and cDNA Microarrays) and Applications of microarrays in microbiology	1L
4.3 Cryoelectron Microscopy	1L
4.4 Next-generation Sequencing	1L
4.5 Transcriptomics	2L
4.6 Metagenomics: Microbial DNA shotgun sequencing: Principle and interpretation	2L
4.7 Metaproteomics: Principle and Interpretation	2L
4.8 Metabolomics: Principle and Interpretation and health implications	

Practical: 2OPS3MBP4

Practical
Course IV: IPR, Bioinformatics and Biotechnology
<ol style="list-style-type: none"> 1. Biological Databases: Sequence databases: Gene bank, EMBL, DDBJ, UNIPROT Structure database: PDB Literature database: PubMed 2. Genome Databases: Viral genomes, Archeal and Bacterial Genomes, Eukaryotic genomes - yeast 3. Sequence alignment BLAST: identification of homologs, paralogs & amp orthologs Multiple sequence alignment using Clustal W/Omega 4. Molecular phylogenetics: Construction of phylogenetic tree using 16S Ribosomal RNA Genes 5. Protein structure analysis Visualization of protein 3Dstructure Classification – CATH & amp; SCOP 6. Protein 3D structure prediction using SWISS MODEL server

7. Bacterial transformation
8. PCR, Gibson and DNA assembly (Virtual Lab)
9. Engineering expression (simulation studies)
10. Assignment on Provisional Patents
11. Case study on Patent
12. Practical to read a Patent
13. Practical on search of databases for Patents

References 2OPS3MB4

Module	
I	<ol style="list-style-type: none"> 1. Biodiversity, Biotechnology & Traditional Knowledge- Understanding Intellectual Property Rights, Aravind Kumar, Govind Das, Narosa,2010 2. IPR under Globalisation- Talwar Sabanna,2012 3. IPR, Globalisation and Global Relations: A reflection through Indian Paradigm – Kashinath Jena and Abhijit K.,2005 4. WTO and IPR- Talwar Sabanna,2007 5. The law of IPR- edited by Shiv Sahay Singh (Deep and Deep Publications),2004 6. Modern Intellectual Property Law by Catherine Colston. 7. Law relating to Patents, Trademarks, Copyright Designs and Geographical Indications- B.L. Eadhera (Universal Law Publishing House),2007 8. Components of Patent System- B.K. Keayla. 9. Biotechnology, Second Completely Revised Edition-Volume 12- Legal, Economic and Ethical Dimensions. Volume Editor-D. Brauer(A multi-Volume Comprehensive Treatise),H. J. Rehm and G. Reed, A. Puhler ,P Stadler,2006
II	<ol style="list-style-type: none"> 1. Biodiversity, Biotechnology & Traditional Knowledge- Understanding Intellectual Property Rights, Aravind Kumar, Govind Das, Narosa,2010 2. IPR under Globalisation- Talwar Sabanna,2012 3. IPR, Globalisation and Global Relations: A reflection through Indian Paradigm – Kashinath Jena and Abhijit K., 2005 4. WTO and IPR- Talwar Sabanna, 2007 5. The law of IPR- edited by Shiv Sahay Singh (Deep and Deep Publications),2004

	<ol style="list-style-type: none"> 6. Modern Intellectual Property Law by Catherine Colston,2005 7. Law relating to Patents, Trademarks, Copyright Designs and Geographical Indications- B.L. Eadhera (Universal Law Publishing House),2007 8. Components of Patent System- B.K. Keayla 9. Biotechnology, Second Completely Revised Edition-Volume 12- Legal, Economic and Ethical Dimensions. Volume Editor-D. Brauer (A multi-Volume Comprehensive Treatise), H. J. Rehm and G. Reed, A. Puhler P Stadler, 2006
III	<ol style="list-style-type: none"> 1. Mount, D.W., Bioinformatics sequence and genome analysis, Cold Spring Harbour Laboratory Press. 2. S. C. Rastogi, Parag Rastogi, Namita Mendiratta.,2007, Bioinformatics Methods and Applications: Genomics Proteomics and Drug Discovery, PHI Learning Pvt. Ltd 3. Jonathan Pevsner.,2010 Bioinformatics and Functional Genomics. Wiley-Blackwell: John Wiley & Sons, Inc. 4. David Edwards, Jason Stajich., David Hansen.,2015 Bioinformatics Tools and Applications. Springer New York Dordrecht Heidelberg London. 5. M. Lesk. 2002 Introduction to Bioinformatics Oxford University Press
IV	<ol style="list-style-type: none"> 1. Methods in Molecular Biology, Vol 2016: PCR detection of Microbial Pathogens: edited by Konard Sachse and J. Frey, Human Press.inc 2. The New science of Metagenomics: Revealing the secret of our Microbial Planet, The national academic press. 3. Principle and techniques of Biochemistry and Molecular Biotechnology, Keith Wilson and John Walker, 7th edition, Cambridge University Press (2010). 4. Glick B R, Pasternak J J, and Patten C L, Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, Washington, DC: ASM Press 2010 5. Sonderkar. M (2012). Bioinformatics tools for next generation DNA sequencing. Development and Analysis of Model



SOMAIYA
VIDYAVIHAR

K J Somaiya College of Science & Commerce

Department: Microbiology



TRUST

M.Sc. Syllabus

	System. Alborg University.
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Semester IV-2020-21

Course I: Microbial Ecosystems

Course code: 2OPS4MBI

Module	Topic	Number of Lectures (15)
I	1.1 Microbial Diversity	
	1.1.1 Microbial Ecology: Concepts: Niche, Habitat and Ecosystem	1L
	1.2 Introduction to Microbial Diversity:	5L
	1.2.1 Types of microorganisms- Bacteria, Archaeobacteria and Algae	
	1.2.2 Interactions between microorganisms	
	1.3 Introduction and types of extremophiles: Habitat, cellular organization, biodiversity, survival strategy and limitations of:	
	1.3.1 Thermophiles	6L
	1.3.2 Psychrophiles	
	1.3.3 Acidophiles	
	1.3.4 Alkaliphiles	
1.3.5 Halophiles		
1.3.6 Barophiles		
1.3.7 Radiation resistant microorganisms		
1.4 Rumen Microbiology:		
1.4.1 Rumen microbial ecosystem		
1.4.2 Significance of rumen methanogens with respect	3L	

	to animal nutrition	
II	<p>Cultivation and Applications of Extremophiles</p> <p>2.1 Cultivation protocols for Extremophiles</p> <p>2.2 Extremolytes</p> <p>2.2.1 Production and purification</p> <p>2.2.2 Detection, Identification and Quantification</p> <p>2.2.3 Limitations</p> <p>2.3 Applications</p> <p>2.3.1 Biodegradation and Bioremediation under different extreme environments</p> <p>2.3.2 Extremophiles and their products in food processing</p> <p>2.3.3 Extremophiles in food spoilage and contamination (meat, milk products, canned foods) and extremophiles as pathogens of food species</p> <p>2.3.4 Extremophiles and fuels</p> <p>2.3.5 Bacterial polymers by Extremophile: Biosynthesis Characterization, and applications of Exopolysaccharides</p> <p>2.3.6 Biomedical applications</p> <p>2.3.7 Extremophilic enzymes and their use in the textile industry</p> <p>2.3.8 Biomining extremophiles and their industrial applications</p>	<p>4L</p> <p>3L</p> <p>8L</p>
III	<p>Microbiome</p> <p>3.1 Introduction:</p> <p>3.1.1 Microbiome Ecosystem Ecology</p> <p>3.2 Human Microbiome project</p> <p>3.2.1 Scientific background; Initiation of the HMP</p>	<p>2L</p> <p>3L</p>

	<p>3.2.2 The goal of the HMP</p> <p>3.2.3 Implementation of the NIH HMP</p> <p>3.2.4 The International Human Microbiome Consortium (IHMC)</p> <p>3.3 Healthy Human Microbiome:</p> <p>3.3.1 Typical components and diversity of the microbiome</p> <p>3.3.2 Archaea, viruses, fungi, and other eukaryotes</p> <p>3.3.3 Geographical variation in the healthy microbiome</p> <p>3.3.4 Microbiome establishment and early colonization</p> <p>3.4 Hallmarks of health</p> <p>3.5 Future outlook</p> <p>3.6 Human Microbiome at the interface of health and disease</p> <p>3.6.1 Influences on the microbiota during host life cycles</p> <p>3.6.2 Disease links and health implications</p>	<p>5L</p> <p>2L</p> <p>1L</p> <p>2L</p>
<p>IV</p>	<p>Biofilm and its Management</p> <p>4.1 Structure and properties of biofilms</p> <p>4.1.1 Formation of a biofilm and its Regulation:</p> <p>Role of Multiple Convergent Genetic Pathways:</p> <p>a. Early Attachment Events</p> <p>b. Maturation of the Biofilm</p> <p>c. Detachment and return to the Planktonic Growth Mode</p> <p>4.1.2 Multispecies biofilms: Clinical Relevance</p>	<p>4 L</p> <p>2 L</p> <p>2 L</p>

	<p>4.2 Biofilms in plant-associated habitats</p> <p>4.2.1 Phyllosphere: Impact on survival and bacterial interactions, interaction of plants with epiphytic biofilms</p> <p>4.2.2 Rhizosphere: Ubiquity and importance for rhizosphere bacteria, impact of rhizosphere biofilms on plant biology</p> <p>4.3 Biofilms from different Environments:</p> <p>4.3.1 Impact of environment on biofilm development and its composition</p> <p>4.3.2 Biofilms in water bodies, prosthetics associated biofilms, human associated biofilms. e.g. – Gut</p> <p>4.4 Study of Quorum Sensing:</p> <p>4.4.1 Cell- Cell Communication amongst bacteria in Biofilms</p> <p>4.5 Management of Biofilms</p> <p>4.5.1 Biofilm eradication: Use of biocides such as surfactants, enzymes, triclosan, chlorhexidine and quaternary ammonium compounds</p> <p>4.5.2 Use of other biofilm management methods: Restoration using Probiotics and Prebiotics</p>	<p>2 L</p> <p>2 L</p> <p>2L</p> <p>1L</p>
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Practical: 2OPS4MBPI

<p>Practical</p> <p>Course I: Microbial Ecosystems</p>
<ol style="list-style-type: none"> 1. Enrichment & isolation of thermophiles from hot springs/compost heaps & extraction of thermophilic enzymes & determination of its specific activity. 2. Different types of media preparation for extremophiles. 3. Isolation of halophiles from mangrove soil. 4. Laboratory scale cultivation of algae.

5. Biofilm visualization by staining a slide immersed in different environments such as soil, water, saliva (to emphasize compositional and structural variations in biofilms from different environments).
6. Determination of MIC of disinfectant/antimicrobials with sessile and planktonic bacteria (to show higher resistance of biofilms to antimicrobials as compared to Planktonic cells) quantified using crystal violet assay.
7. Think well and Gut check: The Microbiome game by Jonathan Eisen's lab.
8. Hand Microbiome print (Diversity analysis).
9. Effects of sanitizers/soaps/deodorants on skin.
10. IHMC: Report/Assignment (<http://www.human-microbiome.org/>).

References 2OPS4MBI

Module	
I	<ol style="list-style-type: none"> 1. Brock Biology of microorganisms 12th ed Madigan, Martinko, Dunlap, Clara, Pearson Intl Ed. 2. R. M. Atlas and R. Bartha - 1998 - Microbial Ecology - Fundamentals and Applications. Addison Wesley Longman, Inc. 3. Microbial Diversity- Current Perspective and Potential Application-- Johri and Satyanarayana 4. EXTREMOPHILES, Sustainable Resources and Biotechnological Implications edited by Om. V. Singh, Ph. D, published by Wiley-Blackwell Publications 2013 5. Methods in Microbiology Vol 35- Extremophiles (2006) Edited by Fred Rainey, Aharon Oren (Academic press). 6. Rumen Microbiology: From Evolution to Revolution edited by Anil Kumar Puniya, Rameshwar Singh, Devki Nandan Karma.
II	<ol style="list-style-type: none"> 1. EXTREMOPHILES, Sustainable Resources and Biotechnological Implications edited by Om. V. Singh, Ph.D. published by Wiley-Blackwell Publications 2013 2. Bioreactor Development for the Cultivation of Extremophilic Microorganisms by F.J. Deive, M.A Sanroman, University of VIGO, Spain.

	<p>3. Extremophiles, Methods in Microbiology Volume 35 Edited by Fred A. Rainey & Aharon Oren</p>
III	<p>1. The human microbiome: at the interface of health and disease: Ilseung Cho and Martin J. Blaser DOI: 10.1038/nrg3182. 13 March 2012</p> <p>2. Microbiome community ecology: Fundamentals and applications: Muhammad Saleem: Springer Briefs.2915</p> <p>3. The NIH HMP: 19:2317–2323; ISSN 1088-9051/09; www.genome.org</p> <p>4. The healthy human microbiome Lloyd-Price et al. Genome Medicine (2016)</p>
IV	<p>1. Microbial Biofilms. (2014). Methods and Protocols, Gianfranco Donelli, Springer Protocols Humana Press.</p> <p>2. Bacterial Biofilms. (2008). Tony Romeo, Volume 322, Springer.</p> <p>3. Davies DG, Parsek MR, Pearson J.P. Iglewski BH, Costerton JW, Greenberg EP. (1998). The involvement of cell-to cell signals in the development of a bacterial biofilm. Science 280. (5361):295–98</p> <p>4. O'Toole GA, Kolter R. (1998). The initiation of biofilm formation in <i>Pseudomonas aeruginosa</i> WCS365 proceeds via multiple, convergent signalling pathways: a genetic analysis. Mol. Microbiol. 28:449–61</p> <p>5. Morris, C. E. and Monier, J. M. (2003). The ecological significance of biofilm formation by plant-associated bacteria. Annu. Rev. Phytopathol. 41:429–53</p> <p>6. O'Toole, G., Kaplan, H. B. and Kolter, R. (2000). Biofilm formation as microbial development. Annu. Rev. Microbiol. 2000. 54:49–79</p> <p>7. Bacterial biofilms: from the Natural environment to infectious diseases. Nature Reviews Microbiology 2, 95-108 (February, 2004)</p>

Course II: Applications in Biotechnology

Course code: 2OPS4MB2

Module	Topic	Number of Lectures (15)
I	Application in Plant Biotechnology	5L
	1.1 Plant genetic engineering for productivity and performance:	
	1.1.1 Biotic stress Tolerance:	
	a) Insect resistance (Bt toxin)	
	b) Virus Resistance	
	c) Bacterial & Fungal Disease resistance	
	d) Herbicide Resistance (Glyphosate)	
	1.1.2 Abiotic stress Tolerance:	2L
	a) The nature of abiotic stress	
	b) The nature of water deficit stress	
c) Target approaches toward the manipulation of tolerance to salt stress and oxidative stress		
1.1.3 Improvement of crop yield and quality	3L	
a. By manipulation of Photosynthesis.		
b. By manipulation of nutritional Content: Amino acids, vitamins and minerals		
1.2 Plants as bioreactors	2L	
1.3 Edible Vaccines	1L	
1.4 Concerns about GM crops:	2L	
1.4.1 Antibiotic resistance genes		
1.4.2 Superweeds		
1.4.3 Gene containment		

	1.4.4 Techniques for gene containment	
II	<p>Application in Animal Biotechnology and Stem cells</p> <p>2.1 Stem cell niches and Stem cell lineage tracing</p> <p>2.2 Isolation, characterization and maintenance of embryonic stem cells, adult stem cells, embryonic germ cells and embryonic carcinoma cells</p> <p>2.3 Hematopoietic stem cells and neuronal stem cells</p> <p>2.4 Applications:</p> <p>2.4.1 Transgenic mice:</p> <ol style="list-style-type: none"> Transgenic Disease Models: Alzheimer Disease Using Transgenic Mice as Test Systems Conditional Regulation of Transgene Expression Conditional Control of Cell Death <p>2.4.2 Transgenic Livestock: Global advantage from livestock of developing countries</p> <ol style="list-style-type: none"> Production of Pharmaceuticals Production of Donor Organs Disease-Resistant Livestock Improving Milk Quality I Improving Animal Production Traits <p>2.4.3 Transgenic poultry</p> <p>2.4.4 Transgenic Fish</p>	<p>2L</p> <p>3L</p> <p>2L</p> <p>3L</p> <p>3L</p> <p>1L</p> <p>1L</p>
III	<p>Medical Biotechnology</p> <p>3.1 Genetic Testing of diseases and disorders, Immunogenetics; prenatal diagnosis-chorionic villus sampling, amniocentesis, Preimplantation diagnosis and Genetic counselling</p> <p>3.2 Vectors, gene targeting and tissue-specific</p>	<p>3L</p> <p>2L</p>

	<p>expression and Antisense Technology</p> <p>3.3 Introduction to pharmacogenomics, Pharmacogenetics and toxicogenomics.</p> <p>3.4 Social- genetic discrimination: insurance and employment, human cloning, foeticide and Sex determination</p> <p>3.5 Tissue Engineering, Methods of Synthesis and Biomolecular Engineering</p>	<p>5L</p> <p>2L</p> <p>3L</p>
IV	<p>Synthetic Biology</p> <p>4.1 History: Origins and Initial experiments</p> <p>4.2 Introduction to Synthetic Biology:</p> <p>4.2.1 What is Synthetic Biology?</p> <p>4.2.1 Introduction to engineering and design</p> <p>4.2.3 The synthetic biology tool kit and Biobrick</p> <p>4.3 Synthetic Biology Approaches:</p> <p>4.3.1 Top-down approaches</p> <p>4.3.2 Bottom-up synthetic biology</p> <p>4.3.3 Biodesign process overview</p> <p>4.3.4 Planning vaccinations to bio- design</p> <p>4.4 Applications:</p> <p>4.4.1 Constructing Microbial Cell Factories</p> <p>4.4.2 Medical and Health Applications</p> <p>4.4.3 Synthetic Biology for a Sustainable World and Cas-9 tool</p>	<p>2L</p> <p>3L</p> <p>5L</p> <p>5L</p>

Practical: 2OPS4MBP2

Practical

Course II: Applications in Animal Biotechnology

1. Visit to Plant Biotechnology industries (Kumar Florist, etc.) Report writing on the visit
2. Demonstration of PCR
3. Primer designing
4. Demonstration of microarray technology
5. Assignment on Advanced techniques in diagnosis of Genetic diseases and disorders
6. Assignment on Gene Knockout Technology/Overview of different types of biotechnology
7. Estimation of total Amino-acid content (Plant material) by Ninhydrin Method
8. Amino-acid profile of plant material by 2D Chromatography
9. Protein 3D structure prediction using SWISS MODEL server
10. Bacterial transformation
11. PCR, Gibson and DNA assembly (Virtual Lab)
12. Engineering expression (simulation studies)

References 2OPS4MB2

Module	
I	<ol style="list-style-type: none"> 1. Plant Biotechnology: The genetic manipulation of plants, 2005, A. Slater, N. Scott & M. Fowler, Oxford Univ Press, Oxford. 2. Glick B R, Pasternak J J, and Patten C L, Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, Washington, DC: ASM Press 2010 3. Introduction to Plant Biotechnology (3rd Edtn), H.S. Chawla 4. Roberta Smith, Plant Tissue Culture: Techniques and Experiments, 2nd Edtn, Academic Press, 2000 5. H. K. Das (ed), Textbook of Biotechnology, Wiley India, 2004 6. J. H. Hammond, P. Mcgarvey, and V. Yusibov (eds), Plant Biotechnology, Springer, Verlag, Heidelberg, 2000 7. B. B. Buchanan, W. Gruissen and R. L. Jones (eds), Biochemistry and

	<p>Molecular Biology of Plants, American Society of Plant Biology, Rockville, USA, 2000.</p> <p>8. Plant Biotechnology and Agriculture: Prospects for the 21st Century, Arie Altman, Paul Michael Hasegawa.</p> <p>9. Plant Biotechnology and Genetics: Principles, Techniques & Applications, Stewart, C. Neal, June 2008, John Wiley & Sons</p>
II	<p>1. Glick B R, Pasternak J J, and Patten C L, Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, Washington, DC: ASM Press 2010</p> <p>2. Essentials of Stem Cell Biology, 2 Edition, (2009) Robert Lanza, et al. Elsevier Academic Press, USA</p> <p>3. Stem cells and the future of regenerative medicine, International Council and Institute of medicine, National Academic press, Washington DC</p> <p>4. Molecular Biotechnology: 4 ASM press, USA III edition. (2010), Glick B.R., Pasternak J.J., Patten C. L</p>
III	<p>1. Jogdand S. N., Medical Biotechnology, Himalaya Publishing House, Mumbai, (2008)</p> <p>2. Judit Pongracz, Mary Keen, Medical Biotechnology, Churchill Livingstone, Elsevier (2009)</p> <p>3. Pratibha Nallari & V. Venugopal Rao, Medical Biotechnology, Oxford University (2010)</p>
IV	<p>1. Synthetic Biology handbook- edited by Darren N Nesbeth, April 2016.</p> <p>2. Synthetic Biology- A Primer: edited by Freemont Paul Simon, Kitney Richard I, 2015.</p> <p>3. Extreme Genetic Engineering: An Introduction to Synthetic Biology, ETC group, 2007.</p> <p>4. Biobuilder: Synthetic Biology in Lab- Natalie Kuldell and Rachel Bernstein, 2015.</p>

Course III: Viruses, Vaccines and Public Health

Course code: 2OPS4MB3

Module	Topic	Number of Lectures (15)
I	Viruses of Bacteria, Mycobacteria, Humans and Animals	
	1.1 <i>E. coli</i> phage T₄:	3L
	1.1.1 Properties and genetic organization of T ₄ genes	
	1.1.2 stages of replication of T ₄ DNA and its growth cycle	
	1.2 Lambda phage: Organization of the Lambda phage genes	
	1.2.1 Growth cycle	2L
	1.2.2 Regulation of life-cycle of Lambda phage- (Lytic and Lysogeny)	
	1.3 Mycobacteriophages:	
	1.3.1 Types of Mycobacteriophages	
	1.3.2 Applications of Mycobacteriophages: Genetic tools (Mycobacterial recombineering) and Clinical tools (Phage-based diagnosis of <i>M. tuberculosis</i>)	2L
	1.4 H1N1 Influenza virus	
	1.4.1 Virus structure and Replication	
	1.4.2 Natural Reservoirs	
	1.4.3 Swine Influenza (H1N1v) Pandemic of 2009	
	1.4.4 Pathogenesis, Diagnosis and Management	3L

	<p>1.5 Nipah Virus.</p> <p>1.5.1 Genome Structure and Gene function</p> <p>1.5.2 Epidemiology</p> <p>1.5.3 Treatment and Prognosis</p> <p>1.6 SARS- CoV and SARS- CoV-2</p> <p>1.6.1 Animal Reservoir</p> <p>1.6.2 Life-cycle</p> <p>1.6.3 Epidemiology</p> <p>1.6.4 Pathogenesis and Immunity</p> <p>1.6.5 Diagnosis, Prevention and Control</p>	<p>2L</p> <p>3L</p>
II	<p>Vaccines</p> <p>2.1 Introduction</p> <p>2.2 Subunit Vaccine</p> <p>2.2.1 HSV</p> <p>2.2.2 Foot & Mouth Disease Virus (FMD)</p> <p>2.2.3 SARS</p> <p>2.3 Peptide vaccine</p> <p>2.3.1 FMD</p> <p>2.3.2 Malaria</p> <p>2.4 Genetic Immunization: DNA Vaccine: Delivery</p> <p>2.5 Attenuated Vaccines</p> <p>2.5.1 Cholera</p> <p>2.5.2 Leishmania</p>	<p>1L</p> <p>4L</p> <p>3L</p> <p>2L</p> <p>3L</p> <p>2L</p>

	2.6 Vector vaccine (Bacteria as Antigen Delivery Systems)	
III	<p>Advanced vaccines</p> <p>3.1 RNA Vaccines</p> <p>3.1.1 Introduction to RNA Vaccines</p> <p>3.1.2 Self-Replicating RNA Vaccine Delivery to Dendritic Cells</p> <p>3.1.3 Non-replicating mRNA Vectors (Principle)</p> <p>a. RNaive® Technology: Generation and Testing of Stable and Immunogenic mRNA Vaccines.</p> <p>b. Generation and Evaluation of Prophylactic mRNA Vaccines against allergy.</p> <p>c. Electroporation of mRNA as Universal Technology</p> <p>3.2 Cancer Vaccine</p> <p>3.2.1 Potency of Cancer Vaccines</p> <p>3.2.2 Vaccine Platforms: Peptide Vaccines, Recombinant Proteins, Tumor Cell Vaccines Dendritic Cells and Antigen Presenting Cells and Recombinant Vectors</p> <p>3.2.3 Clinical Efficacy of Cancer Vaccines</p> <p>3.3 New Concept of Preventive and Therapeutic Vaccines</p> <p>3.3.1 Therapeutic Vaccines Targeting Alzheimer's Disease</p> <p>3.3.2 Immunotherapy for Obesity</p> <p>3.3.3 Immunotherapy for Spondyloarthritis (SpA)</p> <p>3.3.4 Vaccines for Invasive Fungal Infections (CD4+ T Cells Mediate Aspergillosis Vaccine Protection and Heat-Killed Yeast as a Pan-Fungal Vaccine)</p>	<p>5L</p> <p>5L</p> <p>5L</p>
IV	<p>Epidemics, Pandemics and Outbreaks</p> <p>4.1 Introduction: Concepts of epidemics, pandemics and</p>	<p>2L</p>

	<p>outbreaks, Learning from pandemics past and Past as prologue.</p> <p>4.2 Contemplating pandemics:</p> <p>4.2.1 The role of historical inquiry in developing pandemic-mitigation strategies for the twenty-first century</p> <p>4.3 Dealing with pandemic</p> <p>4.4 Strategies for disease containment</p> <p>4.4.1 Public health and ethical considerations in planning for quarantine</p> <p>4.4.2 The role of modeling in infectious disease mitigation and containment</p>	<p>3L</p> <p>5L</p> <p>5L</p>
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Practical: 2OPS4MBP3

<p>Practical</p> <p>Course III: Viruses, Vaccines and Public Health</p>
<ol style="list-style-type: none"> 1. Enrichment and Enumeration of Coliphages from Sewage 2. Phage Typing of <i>E. coli</i> and <i>Salmonella</i> strains 3. Study of One Step Growth Curve of Coliphages 4. Study of Lysogeny in <i>E. coli</i> 5. Assignment on Virology – Research 6. Assignment on Therapeutic Vaccines 7. Heat killed vaccine preparation 8. Sterility checking of the prepared heat killed vaccine 9. Studying how diseases spread: Online mystery game: The Blackout Syndrome. 10. Gather information on which immunizations are required in your state, and describe the health effects of a preventable disease 11. Assignment: Pandemics e.g. COVID-19

12. Modelling the Transmission of a Communicable Disease

References 2OPS4MB3

Module	Topic
I	<ol style="list-style-type: none"> 1. General Virology – Luria. (2008). 2. Virology – Dulbecco and Giasberg. Harper and Ravi Pub. NY. (2016). 3. Bacterial and Bacteriophage Genetics – Edward Birge. (2000). 4. Understanding Viruses – Teri Shors. Jones and Bartlett pub. (2013). 5. Chemistry of Viruses – Knight C. Springer Verlag. NY (1975). 6. Hatfull, Graham F. "The secret lives of mycobacteriophages." <i>Advances in virus research</i>. Vol. 82. Academic Press, (2012). 7. Jonathan Cohen, <i>Infectious Disease</i>, Vol I, Third edition, Mosby Elsevier. (2010). 8. Richard Guerrant. <i>Tropical Infectious Diseases</i>. Third edition, Saunders Elsevier. (2011).
II	<ol style="list-style-type: none"> 1. Glick B R, Pasternak J J, and Patten C L, <i>Molecular Biotechnology: Principles and Applications of Recombinant DNA</i>, 4th Edition, Washington, DC: ASM Press 2010 2. Kalkum Markus and Semis Margarita, <i>Vaccines for invasive fungal infections: methods and Protocols</i>, New York: Humana Press 2017 3. ManMohan Singh, Maya Salnikova, <i>Novel Approaches and Strategies for Biologics, Vaccines and Cancer Therapies</i> 1st Edition, Academic Press: Elsevier, 2015 4. Nakagami, Hironori, ed. <i>Therapeutic Vaccines as Novel Immunotherapy: Biological and Clinical Concepts</i>. Springer Nature, 2019 5. Thomas Kramps and Knut Elbers, <i>RNA vaccines: methods and protocols</i>, New York: Humana Press, 2017



III	<ol style="list-style-type: none">1. Glick B R, Pasternak J J, and Patten C L, Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, Washington, DC: ASM Press 20102. Kalkum Markus and Semis Margarita, Vaccines for invasive fungal infections : methods and protocols , New York : Humana Press 20173. ManMohan Singh, Maya Salnikova, Novel Approaches and Strategies for Biologics, Vaccines and Cancer Therapies 1st Edition, Academic Press: Elsevier , 20154. Nakagami, Hironori, ed. Therapeutic Vaccines as Novel Immunotherapy: Biological and Clinical Concepts. Springer Nature, 2019
IV	<ol style="list-style-type: none">1. Institute of medicine (us) forum on microbial threats. Ethical and legal considerations in mitigating pandemic disease: workshop summary. Washington (dc): national academies press (us); 2007.2. Outbreaks and epidemics: battling infection from measles to coronavirus by Meera Senthilingam;2008.



Course IV: Environmental Microbiology

Course code: 2OPS4MB4

Module	Topic	Number of Lectures (15)
I	Soil & Agricultural Microbiology	
	1.1 Soil Microbiology: The litho ecosphere: Soil formation, Properties (physical and chemical), Soil communities. Link to microbial interactions. Soil sampling for surface and subsurface soil Processing and storage of samples	4L
	1.2 Agricultural microbiology: Factors affecting microbial load of soils Relationship between plants and microbes- rhizosphere, phyllosphere. Beneficial uses of microorganisms for plant growth and development and Interactions with aerial plant structures	4L
	1.3 Microbial Diseases of Phytopathogens	1L
	1.4 Biogeochemical cycles: Carbon, Nitrogen, Sulphur and Oxygen	4L
	1.5 Combating Greenhouse effect using microbes	
	1.5.1 Concept of Carbon credits	2L
II	Pollution Control and Monitoring	
	2.1 Introduction:	
	2.1.1 Introduction to Pollution, Pollution Control and Monitoring, Natural and anthropogenic pollution 2.1.2 Role of government and public in pollution control	1L
	2.2 Air pollution:	

	<p>2.2.1 Sources - Organic and inorganic pollutants, particulate matter, photochemical smog, acid rain, ozone depletion, greenhouse effect, global warming, and role of microorganisms in cause and mitigation of global warming and climate change</p> <p>2.2.2 Control measures of air pollution - dust control equipment and control measures for specific gaseous pollutants</p> <p>2.2.3 Effects of air pollution, assessment & monitoring (Indoor air pollution, vehicular pollution and control, odour control)</p> <p>2.3 Water pollution:</p> <p>2.3.1 Sources of water and their contamination</p> <p>2.3.2 Types of pollutants</p> <p>2.3.3 Effects of water pollution on plants, animals and human beings</p> <p>2.3.4 Indicator microorganisms</p> <p>2.3.4 Eutrophication – causes, effects and control measures</p> <p>2.4 Wastewater treatment –</p> <p>2.4.1 Aerobic and Anaerobic</p> <p>2.4.2 CETP, Water quality criteria and standards for discharge</p> <p>2.4.3 Assessment & monitoring of water pollution</p> <p>2.5 Marine pollution: Sources, effects and coastal management</p> <p>2.6 Thermal pollution: Sources, effects and control</p> <p>2.7 Soil Pollution:</p> <p>2.7.1 Chemical composition and classification (hazardous and non-hazardous) of soil and sources of soil pollution</p> <p>2.7.2 Effects on plants, animals and human beings,</p>	<p>4L</p> <p>2L</p> <p>2L</p> <p>1L</p> <p>1L</p> <p>2L</p>
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	<p>biomagnification, control measures and assessment and monitoring</p> <p>2.8 Noise pollution: Sources, impact, measurement and indices, control and abatement</p> <p>2.9 Radioactive pollution: Sources, effects, prevention and control measures</p>	<p>1L</p> <p>1L</p>
III	<p>Marine Biotechnology</p> <p>3.1 Characterization and stratification of the oceans</p> <p>3.1.1 Brief description of vertical and horizontal zones of marine habitats</p> <p>3.2 Extreme Environmental conditions</p> <p>3.2.1 Distinguishing features of marine microbes</p> <p>3.2.2 Marine life forms: Sulphate reducing bacteria, Magnetotactic bacteria, Oxygenic and anoxygenic marine photosynthesis, Quorum Sensing in <i>Vibrio fischeri</i> and <i>Vibrio harveyi</i></p> <p>3.3 Mariculture:</p> <p>3.3.1 Avenues for Research and development relevant to Mariculture</p> <p>3.4 Microbial Aspects of Marine Biofouling and Biodeterioration</p> <p>3.4.1 Marine Microbial Biofilms in brief and microbial induced corrosion</p> <p>3.5 Methods in Marine Microbiology</p> <p>3.5.1 Techniques of sampling and Remote Sensing</p> <p>3.5.2 Measurement of specific cell constituents as Biomarkers</p> <p>3.5.3 Use of Microelectrodes and Biosensor</p>	<p>2L</p> <p>2L</p> <p>1L</p> <p>1L</p> <p>3L</p> <p>1L</p>

	<p>3.6 Direct observation and enumeration of microbes</p> <p>3.6.1 Only Application of Epifluorescence Light Microscopy, Confocal Laser Scanning Microscopy and Flow Cytometry</p> <p>3.7 Culture based methods for isolation and identification of microbes</p> <p>3.7.1 Culture media and growth conditions</p> <p>3.8 Nucleic-acid based methods:</p> <p>3.8.1 Denaturing Gradient Gel Electrophoresis (DGGE), Terminal Restriction Length Polymorphism (TRFLP) and Fluorescence <i>in-situ</i> Hybridization (FISH)</p> <p>3.9 Marine derived Biomimetic materials:</p> <p>3.9.1 Biomimetic mineralization and Biomimetic Artificial Muscles</p>	<p>1L</p> <p>2L</p> <p>2L</p>
<p>IV</p>	<p>Techniques in Microbial Ecology</p> <p>4.1 Environmental sample collection and processing:</p> <p>4.1.1 Soils and Sediment</p> <p>4.1.2 Water</p> <p>4.1.3 Air</p> <p>4.1.4 Detection of Microorganisms on fomites</p> <p>4.2 Cultural Methods</p> <p>4.2.1 Cultural methods for isolation & enumeration of Bacteria</p> <p>4.2.2 Introduction to metagenomics of VBNC</p> <p>4.3 Physiological Methods:</p> <p>4.3.1 Measuring microbial activity in pure culture</p> <p>4.3.2 Carbon respiration</p> <p>4.3.3 Stable isotope probing</p>	<p>3L</p> <p>2L</p> <p>2L</p>

4.3.4 use of radioisotopes as tracers Adenylate energy charge	
4.3.5 Enzyme assays	
4.4 Functional genomics & proteomics-based approach	
4.5 Immunological methods: Immunoassays	2L
4.6 Nucleic acid-based methods of analysis:	
4.6.1 Obtaining Nucleic acids from Environment	2L
4.6.2 Use of Gene probes	4L
4.6.3 PCR	
4.6.4 Recombinant DNA Techniques	
4.6.5 RFLP	
4.6.6 Denaturing /Temperature gradient	
4.6.7 Plasmid analysis	
4.6.8 Reporter genes	

Practical: 2OPS4MBP4

Practical

Course IV: Environmental Microbiology

1. Analysis of sludge: sewage and industrial for the following parameters: sludge volume index (SVI), Mixed liquor suspended solids (MLSS), Mixed liquor volatile suspended solids (MLVSS), F/M ratio
2. Demonstration of Analysis of SO_x, NO_x, heavy metal (As/Cr) pollutants using volumetric/ spectrophotometric methods
3. Assignment on molecular techniques of ecology
4. Enrichment, isolation and characterization of thermophiles from marine hot-springs
5. Case study

References 2OPS4MB4

Module	Topic
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II	<ol style="list-style-type: none"> 1. APHA 1998. Standard Methods for the examination of water and wastewater, 20th Ed. 7. 2. Dara, S. S., and D. D. Mishra. A textbook of environmental chemistry and pollution control. S. Chand Publishing, 2006. 3. De, A. K. "Environmental chemistry 7th edn." New Age International Publications, New Delhi (2010) 4. Maiti, S. K. Handbook of methods in environmental studies. Vol. 2. Jaipur: ABD publishers, 2003. 5. Rao, C. S. Environmental pollution control engineering. New Age International, 2007. 6. Shareefdeen, Zarook. Biotechnology for odor and air pollution control. Springer Science & Business Media, 2005. 7. Sharma, B. K. Environmental chemistry. Krishna Prakashan Media, 2014. 8. Sharma, P. D. (2005). Environmental microbiology. Alpha Science Int'l Ltd. 9. Soil analysis Volume 2. Handbook of methods in environmental studies. S. K. Maiti. ABD Publishers 2004 10. Tchobanoglous, George, Franklin L. Burton, and H. David Stensel. "Wastewater engineering: treatment and reuse, 4th edn. Metcalf & Eddy Inc." (2003).
III	<ol style="list-style-type: none"> 1. Marine Microbiology: Ecology and Applications. Colin Munn. Garland

	<p>publishing. ISBN: 0815365179</p> <ol style="list-style-type: none"> 2. David H. Attway & Oskar R. Zabosky: Marine Biotechnology: Volume 1, 2, 3, Plenum Press, 1993. 3. P. J. Scheuer: Marine. Natural Products, Volume 1 & 2 1978 and 1980-81 Academic Press. 4. O. Kinne: Marine Ecology, Vol. V. Ocean Management 3&4, John Wiley & Sons, 1984. 5. Rita Colwell (Ed.): Biotechnology in Marine Sciences, Academic Press, 1981 6. R. R. Colwell (ed), Biotechnology of Marine Science, 1982 7. R. R. Colwell et. al (eds) Biotechnology of Marine polysaccharides, 1985 8. David H. Attway & Oskar R. Zabosky: Marine Biotechnology, Volume 1, 2, 3, plenum press 1993
<p>IV</p>	<ol style="list-style-type: none"> 1. Soil Microbiology, Ecology, and Biochemistry .4th edition, Eldor. Paul, 2007, Elsevier. Inc 2. R. M. Atlas and R. Bartha - 1998 - Microbial Ecology - Fundamentals and applications. Addison Wesley Longman, Inc. 3. R.M Maier, I.L. Pepper and C. P. Gerba 2010, Environmental Microbiology Academic Press 4. Rastogi & Sani, Microbes and Microbial Technology, 2011, pp 29-57, 5. Molecular Techniques to Assess Microbial Community Structure, Function, and Dynamics in the Environment, \?? 6. A K Bej and M H Mahbubani, Applications of the polymerase chain reaction in environmental Microbiology. Genome Res. 1992 1: 151-159 7. The Metagenomics of soil by Rolf Daniel,470/June2005/vol3,www.nature.com/reviews 8. Metagenomics: DNA sequencing of environmental samples, Susannah Green Tringe and Edward M. Rubin,806/November2005/Volume6 9. www.nature.com/reviews/genetics



Different Modes of Internal Evaluation:

Sr. No.	Mode of Internal Evaluation
1	Assignments
2	Oral Presentations
3	Review of Research Articles
4	Viva